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FOREWORD

The Portuguese Society of Occupational Safety and Hygiene (SPOSHO) organises on 9 and 10 February 2012, the 8th edition of the International Symposium on Occupational Safety and Hygiene - SHO 2012. Similarly to the past five years, the event will be held in the main Auditorium of the School of Engineering at University of Minho in Guimarães, which is the European Capital of Culture during this year.

The 2012 edition covers the issues of Ergonomics and Physical Environment, Chemical and Biological Risk, Fire Safety and Prevention Management, which will occur both in plenary sessions and parallel sessions.

For the first time, the selection of the studies to be considered in the final program was made through the submission of extended abstracts with 2 to 3 pages length and using an electronic platform, both for the submission and review.

Throughout this submission process more than 200 papers were submitted, corresponding to an equal number of extended abstracts, which were reviewed by the international Scientific Committee (SC) of the Symposium, consisting of more than 90 specialists in the various scientific fields covered by the event.

Papers submitted correspond to a total of 400 authors from 10 countries.

Also for the first time, the submission and review process previewed that the submission of accepted abstracts could subsequently be submitted in full-paper format, with a length between 5 and 8 pages and written entirely in English. The reviewed and accepted full-papers by the SC are published in the Conference Proceedings book, which is published electronically, hoping that this can be a motivation for the increasing international diffusion of the presented works.

At the end of the event, there will be a selection of articles with the aim of publishing a special issue in the International Journal of Human Factors and Ergonomics.

This edition of the symposium will also include the completion of two pre and post-symposium courses, one on "Heat Stress and Comfort", by Prof. Jacques Malchaire, from Belgium, and another entitled "Is it possible to influence safety in construction?", by Prof. Paul Swuste, from the Netherlands.

We appreciate the participation of all the national and foreign experts, who kindly acceded to our invitation.

We appreciate the institutional support of the School of Engineering of the University of Minho, School of Engineering of the University of Porto, Faculty of Human Kinetics of the Technical University of Lisbon and the Polytechnic University of Catalonia, as well as the scientific sponsorship of the Portuguese Engineers Professional Association (OE), the European Network of Safety and Health Professionals' Organisations (ENSHPO), the International Social Security Association (ISSA / ISSA), the Latin American Association of Work Safety Engineering (ALAEST), the Brazilian Society of Safety Engineering (SOBES) and its subsidiary of the State of Rio de Janeiro (SOBES-RIO), the Portuguese Society of Occupational Medicine (SPMT), the Portuguese Society of Occupational Health (SPSO), the Portuguese Association of Ergonomics (APERGO), the Portuguese Society of Acoustics (SPA), the Brazilian Association of Civil Engineers (ABENC), the Asociación de Especialistas de Prevención y Salud Laboral (AEPSAL), the Galician Society of Occupational Risk Prevention, the Research Network on Working Conditions (RICOT), and the Portuguese Society of Environmental Health (SPSA).

We also thank the official support of the Authority for Working Conditions (ACT), European Agency for Safety and Health at Work, Municipality of Guimarães and Guimarães ECC 2012, as well as the valuable support of several Companies and Institutions.

Again, we believe that we will count with the participation of a big and active audience and wish that this event would continue to have an increasing importance in the field of Occupational Hygiene and Safety, not only nationally but also internationally.

We want to highlight again the fact that this edition occurs during the celebration of Guimarães European Capital of Culture, which supports our initiative, and will surely provide to SHO2012 attendants a vast and rich cultural program.

Guimarães, February 9th, 2012

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Prevention of airborne disposal from staff in the O.R. reducing the risk of infection: What are the benefits of using clean air suits or scrub suits?

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ABSTRACT
Experts in infection control are often asked about issues related to the use of scrubs and clean air suits in the operating room (OR). So, what are clean air suits and scrub suits?
This article seeks to highlight the most relevant information of this products and try to define the benefits of using them for preventing airborne disposal from the surgical staff, reducing the risk of infection.
No scientific data support the practice of using scrub suits as a means for preventing transmission of infection, but on the other side we have a vast amount of studies regarding the effectiveness of clean air suits. However this won´t invalidate the use of scrub suits, just validating that this type of studies has to be done for scrubs suits.

Keywords: Clean air suits, scrub suits, infection control, operating room.

1. INTRODUCTION

Experts in infection control are often asked about issues related to the use of scrubs and clean air suits in the operating room (OR). So far there is no clear explanation or mandatory obligation why the surgical team has to wear clean air suits or scrub suits in the operating rooms (OR´s) and more importantly, what are the main differences between these two type of clothing. There is a general perception that the two are equal or very similar.
So, what are clean air suits and scrub suits? Where did the concept and employ originate? Are they necessary from an infection control point of view, are they an useful resources of preventing or controlling transmission of infection?
The clean air suits are considered a Class I medical devices according to the definition and classification rules of the consolidated EU directive 93/42/EC as amended by 2007/47/EC and the scrub suits don´t have any regulation for their use in any hospital area.
Routes of infection are contact or airborne. In the last case, dispersed human skin particles are often carriers of infection. A healthy individual can disperse to the air approximately 5000 bacteria-carrying skin particles per minute during walking and males disperse more than females. The particles are 5 µm to 60 µm in size and the average number of aerobic and anaerobic bacteria carried is estimated to be about 5 per skin particle. The airborne particles contaminate the surgical site directly by sedimentation or indirectly by first setting on instruments or other items that are then brought into contact with the surgical wound. Fabrics with interstices larger than 80 µm do little to prevent the dispersal of skin scales.
This article seeks to highlight the most relevant information of this products and try to define the benefits of using them for preventing airborne disposal from the surgical staff, reducing the risk of infection.
This issue is more important now, because in the next year the European Commission will release a standard, specifically for clean air suits. The clean air suits are used mostly in the Scandinavian countries and are not very spread in other European countries or over the world. As a result, will this standard influence the use of clean air suits or perhaps increase the consumption of this product in Europe, turning it as an obligatory item in the OR such as the surgical gowns and drapes? Will there be any reference regarding the scrub suits?

2. HISTORY OF SURGICAL CLOTHING

The figure 1 represents a painting of Thomas Eakins *The Gross Clinic* from 1875 and portray the reality of late nineteenth century surgical theatre. This portrait brings the viewer into the amphitheater of the surgical classroom in the late nineteenth century. The painting represents a team of five surgeons and one anesthesiologist treating a young man with osteomyelitis of the femur removing a piece of dead bone from a man's leg. Here, surgeons crowd around the anesthetized patient in their frock coats. The patient lies on his right side with his knees drawn up, wearing only a pair of socks. To twentieth one century viewers, *The Gross* Clinic may seem to portray a very backward ideal of medicine. This is just prior to the adoption of a hygienic surgical environment. In fact, this was the perception even in the late 1880's after the adoption of aseptic procedures.

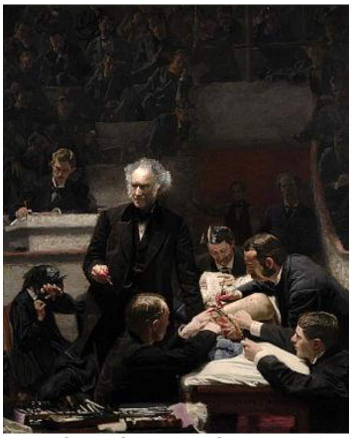

Figure 1 - Thomas Eakins, The Gross Clinic, 1875 (Dustin Kidd 2004)

The Gross Clinic is thus often contrasted with Eakins's later painting *The Agnew Clinic* from1889 (Figure 2), which represents a cleaner, brighter, surgical theater and illustrates the evolving understanding of surgical hygiene and clothing during the intervening 14 years. In comparing the two, we see the advancement in our understanding of the prevention of infection. Notice that the surgeons are dressed in the white, specifically medical clothing, whereas those of *The Portrait of Professor Gross* are wearing street clothes. The felt-lined instrument tray of the earlier painting has been replaced with the sterile covered case. Eakins was able, and indeed forced, to give greater detail to the audience members in the later painting because of the introduction of artificial lighting into the surgery.

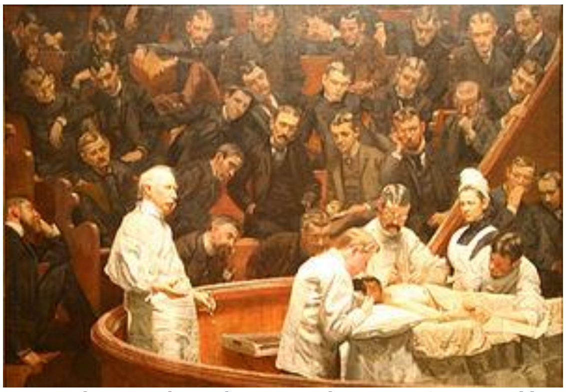

Figure 2 - Thomas Eakins, The Agnew Clinic, 1889 (Dustin Kidd 2004)

At the turn of the twentieth century, some doctors still resisted the new "germ theory" but others had begun to wear face masks and rubber gloves in surgery. Some surgeons wore surgical gowns and used heat treatments to sterilize dressings and surgical tools. The figure 3 shows surgery circa 1906-1908. At that time , some surgeons had begun to wear surgical masks.

Figure 3 - Surgery at the beginning of the XX century (White 2008)

In the following years the medical staff strengthened the concern of the adequacy of textile materials for making surgical clothing, giving more attention to the protection and comfort of the patient and surgical team.

Throughout the twentieth century, a number of materials were used in the manufacture of surgical clothing to use in the operating room. The woven textiles, such as carded cotton were considered most suitable for this application, often referred as muslin. This material was easy to purchase, easy to work, economic and seemed to have the characteristics to be considered an acceptable barrier for this type of application.
The cotton muslin fabric is a lightweight, absorbent and soft fabric, but extremely porous, having no resistance to liquid penetration and release small particles, causing linting. Linting is the release of fiber fragments and other particles during handling and use of the fabric. So, it turns out that cotton fabrics are not suitable for the O. R. and that the micro-particles released by wearing the uniforms has became a mean of transmission of micro-organisms into the wound and that in the wet state, the fluids pass through the fabric in contact with the skin of the healthcare professional (Abreu, 2004).
Every person lose about 5 000 to 55 000 skin scale/minute. About 10 to 20 % of these scales contain live bacteria. Loose cotton scrub or clean air suits helps in detaching. Higher the temperature and humidity, more will be the detaching.
While some hospital administrations stood still in time, others went in search of new materials and fabrics, which led to the development of numerous attempts to solve the problem penetration and density of the fabrics. this attempt led to the development of two different fabrics: reusable textiles and single-use nonwoven fabrics (Abreu, 2004) used to produce the clean air suits and scrub suits.

3. CLEAN AIR SUITS

The clean air suits are considered a Class I medical devices according to the definition and classification rules of the MDD 93/42/EEC.
The definition of clean air suit is "a suit intended and shown to minimize contamination of the operating wound by the wearer´s skin scales carrying infective agents via the operating room air thereby reducing the risk of wound infection".
EN 13795-1 (2002) - "Surgical drapes, gowns and clean air suits, used as medical devices for patients, clinical staff and equipment - general requirements for manufacturers, processors and products (Part 1)", EN 13795-2 (2004) - "Surgical drapes, gowns and clean air suits, used as medical devices for patients, clinical staff and equipment - test methods (Part 2)" and EN 13795-3 (2006) - "Surgical drapes, gowns and clean air suits, used as medical devices for patients, clinical staff and equipment - performance requirements and performance levels (Part 3)" identifie the relevant characteristics of clean air suits, specifies test methods for evaluating the identified characteristics and sets performance requirements for finished products (Table 1). In addition this standard sets requirements for manufacturing and for processing and specifies information to be supplied by the manufacturer. Unlike the gowns usually worn in the operation room, the clean air suit is designed to reduce the operating room air contamination by the personnel. The clean air suit should be used in addition to surgical gowns and not as a substitute.

Table 1 – Performance requirements for clean air suits (EN 13795-3:2006)

Characteristic	Test method	Unit	Requirement
Resistance to microbial penetration	EN ISO 22612	cfu	≤2,0 [a,b]
Cleanliness-Microbial	EN ISO 11737-1	cfu/100 cm^2	<2[b]
Cleanliness-Particular matter	EN ISO 9073-10	IPM (index for particulate matter)	≤3,5
Linting	EN ISO 9073-10	Log_{10} (lint count)	≤4
Bursting strength-Dry	EN ISO 13938-1	kPa	≥40
Tensile strength-Dry	EN 29073-3	N	≥20

[a] Test conditions: challenge concentration 10^8 cfu (colony forming unit)/g talc and 30 minutes vibration time
[b] For the purpose of this standard, $\log_{10}$ cfu ≤2 means maximum 300 cfu

This standards were revised this year to an unique standard (pr EN 13795, 2010) and the clean air suits appear, but will emerge soon in an entirely new standard for this type of products, "Clean air suits, used as medical devices for clinical staff - General requirements for manufacturers, processors and products, test methods, performance requirements and performance levels". This document will supersede those parts of prEN 13795 (2010) that deal with clean air suits.
The conception of the clean air suit should be sufficient to enclose the dispersed bacteria-carrying particles in the suit and not dispersed through the openings of the suit at the neckline, sleeves, waist, leg and boot openings. So, this part has to be closed, preferably by cuffs. If a clean air suit with a wide neckline is used, the gap should be closed by wearing a hood that covers all uncovered body parts (Figure 1 and 2). If the clean air suit is a two piece ensemble (shirt and trousers), the shirt has to be put into the trousers.

Figure 1 – Single-Use Clean air suit from Mölnlycke Health Care

Figure 2 – Reusable Clean air suit from Lojigma Int.

Following studies demonstrated that a reduction in airborne bacteria arising from the perineum, thighs and feet could be accomplished by using specially designed trouserlike garment that was sealed at the feet and waist and made from tightly woven fabrics that restricted the dissemination of skin particles.
The correlation between a low surgical wound infection rate and a high microbiological air cleanliness during the operation has been demonstrated in total joint replacement operations (Lidwell et al, 1983) and hip or knee-joint replacement (Lidwell et al, 1984). The ultraclean air conditions have been shown to be obtained either using special ventilation systems or special clean air suits by Bergman et al, 1985 and Blomgren et al, 1990.
Clean air suits to reduce dispersal of bacteria carrying skin particles from the human body out into the air and the effectiveness has been established by Verkala et al, 1998 and Blomgren et al, 1990.
The test of a clean air suit is quite expensive, because it´s important to do the test in a dispersal chamber (very expensive) or in an OR with laminar vertical system.

4. SCRUB SUITS

The definition of scrub suit is quite wide-ranging. Outside the OR, scrubs have been adopted as a replacement for the more traditional uniform worn by healthcare staff. Inside the OR, it´s used under the surgical gown and frequently denominated as "pajamas" that consists of pants and shirt.
Since the turn of the XX century, clothing known as surgical scrub suits has been worn by health care workers in the OR. Today, a wide variety of this type of suits is being used for many applications in healthcare also outside the OR (Belkin, 1997), but scrub suits don´t have any regulation for their use in any hospital area. This should be viewed as a uniform over which a sterile gown is worn. The use of scrubs began in the OR around 1900 and was preceded by the surgical cap and gown (Doberneck, Kleinman, 1984). The word scrub was derived from the practice of surgical staff who scrubbed their hands before performing surgery or assisting in surgical procedures. The first mention of scrubs was published in the final of the XIX century stating that it is safer and better that all should put on a complete change of costume rather than simply put a sterilised coat and pair of trousers over the ordinary clothing as has been recommended by the German school.
In the late 1950s of the XX century, concern for the level of airborne contamination comes out as possible influence on the occurrence of surgical wound infection (Belkin, 1997). Once the bacteria are airborne, their subsequent journey to the wound depends also of the scrub suit used by the surgical team and other personnel present in the OR.
It had already been demonstrated that dissemination of skin bacteria occurred as a result of friction between areas of heavy skin colonisation and that many more bacteria were liberated by movement involving the lower extremities (Bernard et al, 1965).
Tests have demonstrated that that a person wearing a standard cotton scrub suit actually sheds more bacteria than without clothing (Kulkani, 2008).
A scrub development later took place that included changes in the color, design and materials of which they were made and also expanded outside the OR to other healthcare facilities (Figure 3 and 4).

Figure 3 – Single Use Scrub suit from Mölnlycke Health Care

Figure 4 - Reusable Scrub Suit from Lojigma Int. Lda.

4.1 Scrub suits in the OR

The Association of Operating Room Nurses (AORN) suggests that scrubs in the OR promote high level cleanliness and hygiene within the practice setting. Further it recommends that all scrub attire should be placed in appropriately designed containers for washing or disposal, depending if it is a single-use or a reusable scrub and should not be hung or put in a locker for wearing in another time (AORN, 1995).

Traditional scrubs are generally not made of a barrier type, a liquid resistant material and therefore may not provide adequate protection, but on the other hand if it´s used under the surgical gown the protection has to be guaranteed by the gown and not by the scrub suit, so the use of scrub suits is tightly related with the prevention of infection.

OR gowns with front and sleeves made of material that is resistant to liquid penetration reduces the risk of transfer of bacteria between patients in the operating theatre via scrub suits (Hoborn, 2005).

5. FINAL REMARKS

No scientific data support the practice of using scrub suits as a means for preventing transmission of infection, but on the other side we have a vast amount of studies regarding the effectiveness of clean air suits. However this won´t invalidate the use of scrub suits, just validating that this type of studies has to be done.

In the next future the Textile Engineering Department of the University of Minho and an enterprise interested in this study, between comparison of scrub suit and clean air suit with the same fabrics (nonwoven, when single-use and micro-polyester if reprocessed and reused afterwoods) will be done, testing the same performance measurements. Perhaps this comparison will bring more explicitness. Also the cost-effectiveness, since the scrub suits are less expensive than the clean air suits, is an important issue for the healthcare system in the different countries, when it guarantee the same prevention of infection. Cost deliberation include purchase price, maintenance and management.

At last, the scrub suits are certainly more effective as the use of normal underwear beneath the surgical gown and the obligation to use this suits under the gowns is undoubtedly a positive attitude of the hospital administrations.

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Audiological Findings among Workers from Brazilian Food Industry Exposed to Continuous and Impulsive Noise

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ABSTRACT
Studies show that exposure to noise is present in most of the work processes, which may cause hearing damage to workers. However, few studies are directed to do research on combined exposure, continuous noise and impulsive noise, especially when the impact noise exceeds the threshold limit value and the maximum assessment level of sound level meters. This exposure occurs in approximately 900 industries in the food sector, in general small businesses in Brazil, causing hearing loss of cochlear origin in operators of popcorn expansion machines, called “cannons” based on the noise they generate. The noise levels found in one of the factories were TWA = 92.6 dB (A) for 08 hours with levels above 160 dB (linear).

Keywords: Impulsive noise; Popcorn Industry; Occupational Noise; Impulsive noise; NIHL; SHO2010

1. INTRODUCTION

There are approximately 900 companies in the expansion of corn food industry sector, distributed throughout Brazil and this sector can be found in other countries in similar conditions of exposure and risk. Among the risks, there is a combined exposure to both impulse and continuous noise.

Studies confirm that exposure to continuous noise is present in most of the work processes, and may cause health risks to workers, including damage to the cochlea. Exposure to impulse noise can also cause cochlear damage, with mechanical disruption or disruption of inner ear sensory structures, physiological or anatomical changes, temporary or permanent in the cochlea, leading to hearing problems such as changes in hearing thresholds, difficulty in speech perception and immediate symptoms such as pain, tinnitus and a feeling of a blocked ear (Morata and Dunn 1995; Plontke *et al*. 2002; Starck, 2003, Silva *et al*., 2005).

According to Starck *et al*. (2003), Gerges (2000) and NIOSH (2009), the impulse noise can be more harmful to hearing than continuous noise and the risk of noise induced hearing loss is greater and faster, even if it has the same intensity of continuous noise (Toppila *et al*, 2000).

In the case of impulse noise, a major problem is being able to estimate the attenuation that is obtained with the use of hearing protection due to the characteristics of this type of noise (Berger, 2003). For Gerges (2000) and Starck et al. (2003), the earplugs can reduce the noise impact but they do not prevent hearing loss among workers. There are no international standards on testing of hearing protectors for this type of noise, and there are no methods to evaluate the efficiency of guards of this kind.

The aim of this study was to evaluate the sound pressure levels and auditory effects of simultaneous exposure to continuous and impact noise on people working in the corn expansion food industry in the city of Curitiba, in southern Brazil.

2. MATERIALS AND METHOD

This is a cross-sectional study and begun in 2007 due to a request of the Environmental Health Department from Curitiba City Council, capital of Paraná State in Brazil, to evaluate the noise pressure levels and indicate preventive and corrective measures to a food industry in the manufacture of sweet pop-corn.

In this productive process, the prepared corn, without the external peel, now called “canjica”, is placed inside of expansion machines, known as cannons. This expansion machines seems like pressure cookers. The cannons are then heated till they achieve certain temperature and pressure, so they are opened by the operators one by one. The sudden depressurization provokes the expansion of the corn turning it into a pop-corn. The opening of these pressure cookers generates a impact noise which sounds like a cannon. Each 10 minutes is done a new series and all of the cookers are refilled with corn to be expanded. In average, this industry uses 45 bags of 50 kg of corn to daily production of pop-corn.

The researched industry has 16 cannons operated by two men. Both men are the corn expansion machine operators and their daily working day is 08 hours. When necessary they work extra hours, in average 3 extra hours per day and on Saturdays they work half day. The cannons operators have used earplugs for 08 years when the company started to give it to them.

2.1. Noise measurements

The noise occupational measurements were done in April and November of 2007, August of 2010 and March of 2011. They followed the methodology and procedures established in the Occupational Hygiene Standard - NHO-1 from

Fundacentro/ Ministry of Labor and Employment and the legal criteria established by Brazilian legislation. The threshold value for continuous noise is 85 dB(A) for 08 hours and for impact noise is 130 dB(Linear) or 120 dB(C).
The instrument used for the measurement was a integrating sound level meter, type 1, (Bruel & Kjaer, type 2230), which conformed to the American National Standards Institute S1.4 (1983; R2006) specification. The equipment manufacturer recommended procedures were used. An engineer from Fundacentro conducted the measurements in the room where the expansion machines are and outside of the room. The model 2230 integrating sound level meter was handle by the engineer and held next (~150 ± 50 mm) to the worker's ear, in the horizontal plane of the ear canal. Measurements were done for both ears and the result from the side where the sound pressure level was higher was recorded. The position of the engineer and the measurement equipment in relation to the worker was taken into consideration to cause minimum perturbation in the acoustic field. The direction of the microphones considered the type of acoustic field and the specific response characteristics of the equipment's microphones.
The equipment was calibrated before data collection. Field calibrations were conducted before and after measurements using a type 4230 sound level calibrator from Bruel & Kjaer. The measurements were taken with the use of a windscreen. The noise exposure metrics provided by the instruments and reported in this study are A-weighted, equivalent continuous sound level based on a 3-dB exchange rate, operating in the exponential averaging: slow. The impulsive noise was measured with the sound level meter, using C-weighted, exponential averaging: fast, and linear-weighted.
The measurements taken in April and November of 2007 and August of 2010, it was used the sound level meter equipped with a 1/2" prepolarized condenser microphone Type 4155, operating in the range 24 to 130 dB. However, it was observed that the levels were next to the maximum value of the range. So it was decided to use the supplied 20 dB Attenuator ZF 0020 which gives a measuring range from 30 to 150 dB.

2.2. Audiological Assessment

The audiological assessment followed the legal criteria established by Brazilian legislation and meets the requirements of American National Standards Institute S 3.1 (1991) for audiometric testing environments. The audiological tests were conducted by certified audiologists.
Before testing, it was confirmed with each worker that he had been away from noise exposure for at lest 14 hr, which was a condition for the testing. According to the legislation, the hearing thresholds were considered as normal if they were less or equal 25 dB HL in the frequencies from the 0.5 to 8 kHz range. It is considerate noise induced hearing loss (NIHL) when the audiogram, in the frequencies 3 or 4 or 6 kHz shows hearing threshold above 25 dB HL in the test by air and bone conducted in one or both ears.
The audiological assessment was done by the Audiology Laboratory from Tuiuti University of Paraná with the workers of the industry since 2007.
The following procedures were done:
a) Anamnesis with questions to investigate about medical, personal and professional history, including the research about extra-auditory effects of noise; b) Inspection of external ear canal to investigate the presence of earwax or foreign body material; c) Pure-tone audiometry and high frequency audiometer in acoustic booth. The equipment used was the AC40 audiometer with TDH-39 earphone for conventional audiometry and Koss HV/PRO – digital for high-frequency audiometry calibrated following the ANSI S3,6 standard. The frequencies evaluated by air conducted were from 250 Hz to 16 kHz and if the hearing threshold exceeded 25 dB, bone conduction testing was performed for the affected frequencies in the range of 0.5 to 4 kHz; d) The results of the audiometric thresholds group comparisons were analyzed using a Mann-Whitney test; e) Otoacoustic emissions were done using the Otodynamics LTD ILO96. The primary frequencies selected for evaluation were the geometric means of F1 and F2 at 1, 1.5, 2, 2.5, 3, 4, 5, and 6 kHz, using primary levels (L1/L20 of 65/55 dB SPL and a primary ratio (F2/F1) of 1.22.

3. RESULTS AND DISCUSSION

The noise measurements, continuous noise and impulsive noise, are showed in table 1. The measurements were done in 2007, 2010 and 2011, and the room in the industry was kept the same through the years, except by the number of the expansion machine which were increased in four new ones in the beginning of 2011, making a total of 16 expansion machine installed. However this fact did not increased the noise levels but the number of impact because each machine is operated separately, one by the time. The workers sometimes have to work extra hours, so they can be exposed even to more impacts depending on how much they have to work, because they are the only ones who operate the expansion machines.

Table 1 – Occupational noise measurements

Corn expansion section	Impulsive Noise		Continuous Noise dB(A) Leq	Number of impacts in 8 hours
	Linear	dB(C)		
Worker exposition in 2007	136.8	130.7	90	288
	136.6	131	89.9	288
	137.2	130.8	89.9	288
Outside of the room in 2007		103.6		
Worker exposition in 2010	136.6	130	89.2	288
	136.8	131.2	89.1	288
	137.4	130.6	88.7	288
Outside of the room in 2010		104.4		
Worker exposition in 2011	155.7*	155.4*	92.7	450
	155.6*	155.5*	92.6	450
Outside of the room in 2011		104.0		

It can be observed in the 2011 measurements that the noise levels are higher than the other years because this year it was decided to use the supplied 20 dB Attenuator ZF 0020, which proved the noise levels are really higher than it seemed. Even so, the levels are next to the sound level meter's maximum level, so the measurements are still underestimating.

The impulsive noise in the corn expansion room achieved the following levels: 155.7 dB (linear) and 155.5 dB(C); the continuous noise is TWA = 92,6 dB (A) to 8 hours of work day. These levels are above the limited values established by Brazilian Occupational Legislation considering continuous noise and impulsive noise and they are also above the levels of the technical standards by Fundacentro, the NHO 01 – Occupational Hygiene Standards.

The noise control procedure adopted by the industry has been the use of hearing protector till the collective control procedures turns feasible. However, even using the hearing protector there is the chance of having noise induce hearing loss (Gerges, 2000; Berger, 2003 and Starck *et al.*, 2003), seen in the worker's hearing findings. One of the control procedures proposed to the industry was the use of double hearing devices, one shell headset and one earplug, which seems to minimize the risk, according to Gerges (2000), as well as a Hearing Conservation Program – PCP, mainly to avoid the worsening of the workers` hearing loss, which will enclose the self protective advices, audiologic evaluation, educational practices related do hearing protection and studies to reduces the exposition of the workers to the noise, considering the work time.

The worker "A" from the researched industry is 41 years old and has been working for 30 years in the pop-corn company, 22 years only in the expansion machinery, called cannon. Nowadays, he wears double hearing protection device, a plug type with NRRsf of 13 dB and shell headset type with NRRsf of 22 dB. He doesn't have a history of acoustic trauma or any other chronic hearing problem such as infection, pain, otorrhea, nor has done any hearing surgery. He mentioned to feel hearing impairment, auricular plenitude sensation, and bilateral tinnitus with acute characteristic (like a cry) on the left ear. He has neurossensorial hearing loss on both ears with losses mainly in higher frequencies (hearing "notch" at the frequencies of 3000, 4000 e 6000Hz), type "A" tympanometry curve (normal) and acoustic reflexes present until 2000 Hz. The results of the otoacoustic emissions showed the absence of a bilateral response beginning at 2000 Hz.

The worker "B" is 32 years old and works 13 years in the expansion machine section. He wears hearing protective device shell headset type with NRRsf 22 dB; and like worker "A", doesn't have any history of acoustic trauma or chronic problem in his ears such as infection, pain, otorrhea, nor has done any hearing surgery. He complained about tinnitus, and his test showed that he has hearing thresholds according to the regular pattern until 8000 Hz, although a hearing "notch" is observed at the frequencies of 3000 and 4000Hz. He also presents a type "A" tympanometry curve, (normal) and present otoacoustic reflexes in all tested frequencies. On the other hand the results of the otoacoustic emissions showed the absence of a response bilaterally. Considering the acoustic immitance results, the tympanometry curve found was a type "A" and the acoustic reflexes consistent with the hearing thresholds. The results of the OAE show the bilateral absence of otoacoustic emissions begin at 2 kHz, for all the tests done.

In the table 2 and 3, there are the audiometric results from worker "A" and worker "B", in the frequencies 250 to 8000Hz.

Table 2** – Audiometric results from right ear (RE) and left ear (LE) from worker **"A"
(Frequencies from 250 to 8000 Hz) according to the years they were done.

Hz / Ano	250 RE LE	500 RE LE	1.000 RE LE	2.000 RE LE	3.000 RE LE	4.000 RE LE	6.000 RE LE	8.000 RE LE
2006	10 15	5 10	10 15	20 40	35 45	60 75	85 85	80 80
2007	5 5	5 10	10 10	20 45	40 45	60 60	80 90	85 75
2008	0 0	5 0	5 15	15 45	35 35	65 70	80 80	75 85
2010	5 0	0 5	15 10	20 45	35 40	65 70	80 85	75 80
2011	15 15	5 10	10 20	30 45	45 55	70 70	85 85	90 80

*Significant change in the auditory threshold according to standards.

Table 3** - Audiometric results from right ear (RE) and left ear (LE) from worker **"B"
(Frequencies from 250 to 8000 Hz) according to the years they were done.

Hz / Ano	250 RE LE	500 RE LE	1.000 RE LE	2.000 RE LE	3.000 RE LE	4.000 RE LE	6.000 RE LE	8.000 RE LE
2007	5 5	0 5	5 5	10 5	25 5	25 5	0 5	0 15
2008	0 -5	-5 0	5 0	0 -5	25 5	25 25	5 15	10 10
2010	5 5	5 5	0 0	25* 5	30 25	30 25	0 5	5 0
2011	10 5	10 10	0 5	0 10	20 20	25 30	10 10	15 10

- Significant change in the auditory threshold according to standards

The cannon section workers audiological evaluation suggest hearing alteration of cochlear origin more likely caused by the simultaneous exposition to continuous and impulsive noise.
According to the anamnesis, the audiological complains referred by the workers in this study are also found in other studies involving workers exposed to continuous noise and impulsive noise, considering tinnitus and difficulty in speak comprehension the most frequent, followed after by dizziness and pain (Korbes *e cols*, 2009; Guida *et al*, 2010).
Analyzing the hearing threshold results through the periodically audiometry – realized annually since 2007 – it was not observed significant change of thresholds according to Brazilian legislation. Others authors also describe the relation between the hearing loss and impulsive noise (Morata e Dunn 1995; Plontke *et al*., 2002; Starck, 2003; Weckl, Fantinel e Silva, 2003; Silva *et al*., 2005; Blanino e Garcia, 2006). Comparing 2007 and 2008 exams, the reflexes are still absent in 4000Hz and in 2008 the worker "A" presented the right contralateral acoustic reflex absent for every frequency. According to Palma (1999) the normal acoustic reflex is between 80 and 90 dB to the frequency of 500 to 4000Hz; and as the hearing threshold decreases the acoustic reflex threshold increases between 2000 and 4000Hz frequency until it total absent, being directly related to difficulty in speak comprehension.
The DPOAE confirm a cochlear alteration which characterizes changes caused by noise. The worker "A" results revel the bilateral absence of otoacoustic emissions beginning at 2kHz for all the testes done all the years. This result corroborate with Konopka study et al (2005) which analyzed the effect of impulse noise in the hearing of 93Polish military by the otoacoustic emission exams and noticed a decreasing of amplitude of OAE, mainly at 2, 3 and 4kHz of frequency. Another authors Balatsouras et al (2005) searched 13 Greece militaries realizing otoacoustic emissions mainly in 3000Hz frequency.
The table 4 and 5 presents the otoacustic emissions results from right ear and left ear of worker "A" and worker "B" on the years 2007, 2008, 2010 and 2011.

Table 4** – Otoacoustic emissions result from right ear and left ear in worker **"A"

a. result from 2007

Frequency	Amplitude RE	Amplitude LE	Signal/Noise Ratio RE	Signal/Noise Ratio LE	Result RE	Result LE
1.000	5.5	10.2	- 2.0	20.3	absent	present
2.000	-25.3	-4.6	-2.3	14.7	absent	absent
3.000	-32.6	-31.3	-2.2	-1.2	absent	absent
4.000	-37.9	-29.7	-11.0	-0.4	absent	absent
6.000	-24.5	-26.0	-2.2	-0.4	absent	absent

b. result from 2008

Frequency	Amplitude RE	Amplitude LE	Signal/Noise Ratio RE	Signal/Noise Ratio LE	Result RE	Result LE
1.000	11.5	3.5	11.1	-3.3	present	absent
2.000	-19.0	-17.3	- 15.9	4.1	absent	absent
3.000	-22.8	-25.1	- 8.1	- 11.7	absent	absent
4.000	-29.4	- 22.7	- 13.7	- 17.6	absent	absent
6.000	- 12.2	-17.7	- 1.4	- 3.2	absent	absent

c. result from 2010

Frequency	Amplitude RE	Amplitude LE	Signal/Noise Ratio RE	Signal/Noise Ratio LE	Result RE	Result LE
1.000	58.3	- 0.2	15.4	8.5	present	present
2.000	-14.1	-29.8	-0.9	-15.6	absent	absent
3.000	-30.3	-24.6	-8.4	-1.2	absent	absent
4.000	-20.5	-20.0	-9.4	-1.7	absent	absent
6.000	-13.1	-8.4	6.6	7.2	present	present

d. result from 2011

Frequency	Amplitude RE	Amplitude LE	Signal/Noise Ratio RE	Signal/Noise Ratio LE	Result RE	Result LE
1.000	8.3	- 0.2	15.4	8.5	present	present
2.000	-14.1	-29.8	-0.9	-15.6	absent	absent
3.000	-30.3	-24.6	-8.4	-2.5	absent	absent
4.000	-20.5	-20.0	-9.4	-1.7	absent	absent
6.000	-13.1	-8.4	6.6	7.2	present	present

Table 5 - *Emissões otoacústicas produto de distorção results from right ear and left ear in worker* ***"B".***

a. result from 2007

Frequency	Amplitude RE	Amplitude LE	Signal/Noise Ratio RE	Signal/Noise Ratio LE	Result RE	Result LE
1.000	- 0.8	- 0.8	-12.9	-12.9	absent	absent
2.000	- 7.1	- 9.2	-15.1	-15.1	absent	absent
3.000	-21.0	-10.1	-12.0	-12.0	absent	absent
4.000	-10.3	-20.5	-14.1	-14.0	absent	absent
6.000	-5.4	-8.1	-16.7	-16.7	absent	absent

b. result from 2008

Frequency	Amplitude RE	Amplitude LE	Signal/Noise Ratio RE	Signal/Noise Ratio LE	Result RE	Result LE
1.000	12.9	10.6	21.6	20.6	present	absent
2.000	-3.7	0.6	0.69	15.3	absent	absent
3.000	-2.8	-6.0	1.03	8.1	absent	absent
4.000	-1.2	-2.3	1.16	1.51	absent	absent
6.000	2.7	-4.1	10.0	0.9	absent	absent

c. result from 2010

Frequency	Amplitude RE	Amplitude LE	Signal/Noise Ratio RE	Signal/Noise Ratio LE	Result RE	Result LE
1.000	10.8	9.6	12.6	11.6	present	present
2.000	10.2	2.0	17.1	10.8	present	present
3.000	-6.8	-9.0	8.5	7.9	present	present
4.000	-3.2	-8.2	6.6	-7.5	present	absent
6.000	3.3	-3.6	7.8	6.7	present	presen

d. result from 2011

Frequency	Amplitude RE	Amplitude LE	Signal/Noise Ratio RE	Signal/Noise Ratio LE	Result RE	Result LE
1.000	-21.1	4.0	1.3	8.0	absent	present
2.000	-9.5	-26.7	-14.4	-5.7	absent	absent
3.000	-34.3	-40.5	-15.5	-15.7	absent	absent
4.000	-49.0	-10.6	-22.7	7.3	absent	present
6.000	-17.9	3.1	0.6	11.3	absent	present

4. CONCLUSION

The impulsive noise inside the room in the industry has reached the followed measures: 155,7 dB (linear) and 155,4 dB(C); the continuous noise reached TWA = 92,6 dB (A) for a 8 hour daily working day, exceeding the limits of tolerance established by legislations not only for the continuous noise but also for impact or impulsive noise.

The cannon section workers audiological evaluation suggest an hearing alteration of cochlear origin more likely caused by the simultaneous exposition to continuous and impulsive noise.

It is suggested reduction of the sound pressure level in the source as collective measure, meaning by that the popcorn expansion machine – cannon – because they are small-sized companies without a safety and occupational health service with significant number of workers operating the equipment not only in Brazil but also in another countries.

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The Night Splint in Carpal Tunnel Syndrome: Impact on Functionality and Quality of Life

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ABSTRACT
The Carpal Tunnel Syndrome (CTS) is a neuropathy compression of the median nerve at the level of radio-ulnar joint. Characterized physiologically by increased of pressure on the carpal canal level which triggers the reduction of nerve function at that level. In people with CTS symptoms interfere with functionality to perform their occupational roles and, concomitantly, the Quality of Life (QOL). Thus, this study aims at verifying how the application of a resting night splint in mild and moderate cases, influences these two concepts. To this end, a sample of 46 patients (22 in the control group and 24 in the experimental group) was used to apply the Boston Carpal Tunnel Questionnaire (BCTQ) and the SF-36. In the group that used the splint, the results showed a significant decrease in symptoms ($p = 0.000$) and a significant increase in functional status ($p = 0.000$), as well as an improvement in the perception of General Health ($p = 0.032$) and a decreased level of Bodily Pain ($p = 0.000$). We can conclude that the use of night splints is justified for, at least 6 weeks, in individuals with mild and moderate CTS.

Keywords: Carpal Tunnel Syndrome; Splint; Quality of Life; Functionality

1. INTRODUCTION

The CTS has a higher incidence of neuropathy in the upper limb and consists in the compression of the median nerve within the carpal tunnel, causing motor and sensory deficits. It is defined by patients as causing numbness, tingling, pain in the hand and arm and muscle dysfunction. This disorder is not limited to age, gender, ethnicity or occupation, although it is estimated that the incidence in women is 3.8 times higher than in men and prevalence in the general population is 5% for women and only 0.6% for men (Aroori & Spence, 2008; Keith et al., 2009; Luchetti & Amadio, 2002).

The etiology of CTS in most cases is not identified (called idiopathic), but may be also anatomic, systemic, or occupational (Luchetti & Amadio, 2002; Schnetzler, 2008). When the etiology is anatomy, the CTS is due to changes that occur within the carpal canal, such as tumors or lymph nodes that occupy the space, causing an increase in interstitial fluid pressure (Cranford et al., 2007; Luchetti & Amadio, 2002). When the CTS is the result of systemic factors it may be associated, for example, to obesity, diabetes, thyroid disease, rheumatoid arthritis, pregnancy, lumbrical muscle hypertrophy, among others (Cranford et al., 2007; Luchetti & Amadio, 2002). When the etiology of CTS is occupational, it is strongly related to the use of repetitive movements and extreme ranges of flexion and extension of the wrist and fingers, the use of tools with vibration, repeated impacts on the palm and strong holds (Cranford et al. 2007; Gorsché, 2001, Hunter et al., 2002; Roquelaure et al., 2008; Watts & McEachan, 2006). Regardless of the etiology, the main factor triggering the disease is explained by the decrease in the carpal tunnel space (due to the position of the wrist) or by increasing the volume of their structures, which in turn increases the pressure, conditioning it in a significant way (Werner & Andary, 2002).

As any disease, treatment is recommended whenever the symptoms interfere with the patient's daily activities. Over the past decades, scientific studies have been developed, but there is no consensus regarding the most appropriate conservative treatment in mild and moderate cases. However, according to the recommendations of the American Academy of Orthopaedic Surgeons, the use of night splint is considered a procedure with a reasonable level of evidence, except in severe cases (Aroori & Spence, 2008; Burke et al., 2003; Keith et al., 2009; Sevim, 2004). The resting night splint is made in order to immobilize the lower radio-ulnar joint in neutral position, thus maximizing the available space in carpal tunnel, which minimizes the compression of the nerve, causing symptomatic relief (Bardak, Alp, Erhan, Paker, & Onal, 2009; Hunter et al., 2002; Piza-Katzer, 2003; Premoselli et al., 2006).

It is particularly useful in recent cases of CTS, when the patient wakes up several times during the night with pain and paresthesias, but less effective when the symptoms are continuous (Bakhtiary & Rashidya-Pour, 2004). Studies show that this is effective from 2 to 12 weeks, but there are no long term conclusions (Gravlee & Sleep, 2007; Keith et al., 2009). Patients who wear the splint have a 37% relief of symptoms compared with those who do not receive any treatment (Bland, 2007; Gerritsen et al., 2003).

Normally, the splint is used at night to prevent symptoms, but can also be used during daytime to keep the lower radio-ulnar joint in a neutral position when performing any sort of activity (Gorsché, 2001; Luchetti & Amadio, 2002). However, both follow the same principle: to prevent the execution of movements of dorsi-flexion and palmar flexion (Burke et al., 2003; Cranford et al., 2007; Luchetti & Amadio, 2002).

Regardless of therapeutic approach that is adopted in the CTS, the ultimate goal is always to encourage improvements in the functioning and the patient's QOL. With an understanding of the conceptualization and application methods, QOL is an extremely important concept for Occupational Therapists as a direct result of measuring and monitoring the effectiveness of their therapeutic intervention through occupational performance (Pedretti & Early, 2001).

2. METHOD

2.1. Aims
This work aims at examining how the use of night splint influences the functionality of the individual with CTS, and at defining what are the benefits and impact on QOL of using the night splint. To this end, we used an experimental study with pre- and post-test (6 weeks apart).

2.2. Participants
We used a sample of 46 patients of the Centro Hospitalar Entre Douro e Vouga, E.P.E. As quality criteria, we defined: (1) diagnosis of mild and moderate CTS (Gorsché, 2001); (2) aged between 18 and 50 years; (3) able to answer to questionnaires, in Portuguese; (4) followed in the appointments of the Center Hospital Entre Douro e Vouga - Santa Maria da Feira.
Were excluded from the study all patients: (1) subjected to any treatment to the CTS; (2) with a history of trauma or surgery to the wrist; (3) with diabetes mellitus, obesity, thyroid dysfunction; (4) pregnant; (5) with clinical signs or symptoms of others neuropathies; (6) with severe thenar muscle atrophy (Bos et al., 2006).

2.3. Instruments
As a strategy for data collection, we chose to use the BCTQ and SF-36. The former consists in two scales, which are intended to assess the severity of symptoms (SSS) and functional status (SFS) (Levine et al., 1993).
The SF-36 evaluates the quality of life in relation to eight areas: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional and mental health (SF-36 Health Survey, Ware & Gandek, 1993).

2.4. Procedures
The interviews began with informed consent, followed by the collection of socio-demographic data, and the completing of the SF-36 and BCTQ. Participants in the experimental group were made the splint. The splint is used for resting at night and made in turbocast punched 2mm. The mold was made for each participant and ranges from the 2/3 of the forearm to the distal palmar crease. The wrist was positioned with 10° of dorsiflexion and without lateral deviation (figure 1). It´s to be used in palmar and set at the level of the forearm, wrist and metacarpophalangeal with velcro elastic (Sevim et al., 2004).

Figure1 – Resting night splint.

During the making of the splint, each participant received a flyer with instructions for use, the occupational therapists contact and a calendar to record the daily use of the splint, after handing him the second time of evaluation, ie, 6 weeks after the first evaluation and early use of the splint (Bos et al., 2006; Sevim et al., 2004). The same assessment instruments were given in the review. After data collection, they were introduced and analyzed using the Statistical Package for the Social Sciences (SPSS) version 17.

2.5. Characterization of the sample
The sample was composed exclusively of women aged between 22 and 50 years. With regard to qualifications, the majority of the sample has the 1st cycle, representing 41% of respondents, followed by the 2nd cycle with 24% and the 3rd cycle with 22%. Regarding marital status, there is a predominance of married participants (76%).
As for jobs, it seems that groups with larger numbers of individuals are found in occupations that are less skilled and manual, and the profession of vamper (worker that applies the upper part of a shoe or boot) is the most common (n = 18), followed by corker (n = 6) and housekeeper (laborer) (n = 3). It should be underlined that participants with active work, continued to do their job during the course of the study.

3. RESULTS AND DISCUSSION

With regard to the socio-demographic variables, statistical tests showed that we cannot say that these are associated with the group to which the individual belongs, which favors the equivalence between the two groups.
For the BCTQ (Table 1), with respect to symptom severity (SSS), there was a significant decrease (p = 0.000) in the experimental group, whereas a maintenance of the same (p = 0.101) was found in the control group, after using the splint for 6 weeks. As for the functional status (SFS), a significant decrease was found in the experimental group (p = 0.000), whereas there was an increase in the control group, but not significant (p = 0.111). This leads us to say that after 6 weeks of using the night splint, individuals with mild and moderate CTS, had a significant improvement in their functional status, compared with those who did not wear the splint.

Table 1 – Characterization of BCTQ in both groups.

BCTQ			Median	Desviation interquartile	p value
SSS	Experimental	Evaluation	2,54	0,49	**0,000***
		Reavaluation	1,81	0,32	
	Control	Evaluation	2,81	0,47	0,101
		Reavaluation	2,81	0,53	
SFS	Experimental	Evaluation	2,40	0,45	**0,000***
		Reavaluation	1,88	0,50	
	Control	Evaluation	2,33	0,58	0,111
		Reavaluation	2,76	0,75	

* p<0,05

We consider the use of night splints to relieve the symptoms arising from the CTS, which does not collide with the literature that states that the use of night splints to avoid continued movements of flexion and extension of the wrist during sleep can reduce the severity of symptoms and improve the conduction velocity of the median nerve (Keith et al., 2009; Gorsché, 2001; Sevim et al., 2004; Burke, 2003; Muller, 2004; Premoselli, 2006).
The data on functional status, does not go against the other works mentioned, stating that the CTS leads to a gradual loss of function in daily life activities and that is when using the splint decreases the symptoms (Sevim et al., 2004, Burke, 2003; Muller, 2004; Premoselli, 2006) and consequently improves the functionality.
As for the SF-36 (Table 2), Bodily Pain shows a lower score (less than 40 in both groups at the time of assessment) which means a low perception in this domain, but it is also the one that increases the most. For this reason, it seems that the improvements in this area are significant between the two evaluations (p = 0.000, in the experimental group, p = 0.022 in the control group) in both groups, and in the case of the experimental group, also the General Health domain (p = 0.032).

Table 2 – Characterization of SF-36 in both groups.

SF-36			Mean	Standard desviation	p value
Physical functioning	Experimental	Evaluation	68,38	5,95	0,844
		Reavaluation	67,50	5,57	
	Control	Evaluation	63,86	5,25	0,285
		Reavaluation	66,82	5,16	
Role-physical	Experimental	Evaluation	81,25	5,27	0,063
		Reavaluation	90,63	2,94	
	Control	Evaluation	68,18	6,19	0,859
		Reavaluation	68,18	6,41	
Bodily pain	Experimental	Evaluation	38,75	2,27	**0,000***
		Reavaluation	58,00	4,31	
	Control	Evaluation	38,23	3,48	**0,022***
		Reavaluation	46,9	3,69	
General heath	Experimental	Evaluation	66,46	3,44	**0,032***
		Reavaluation	71,46	3,22	
	Control	Evaluation	57,27	4,02	0,055
		Reavaluation	55,32	3,80	
Vitality	Experimental	Evaluation	61,67	4,45	0,119
		Reavaluation	57,29	3,99	
	Control	Evaluation	52,27	4,61	0,521
		Reavaluation	51,14	4,16	

Social functioning	Experimental	Evaluation Reavaluation	86,98 89,58	3,32 2,68	0,500
	Control	Evaluation Reavaluation	86,93 86,93	3,72 3,44	1,000
Role-Emotional	Experimental	Evaluation Reavaluation	90,28 88,89	5,11 5,18	0,750
	Control	Evaluation Reavaluation	95,46 93,94	2,49 3,56	1,000
Mental health	Experimental	Evaluation Reavaluation	57,33 56,00	4,48 3,71	0,923
	Control	Evaluation Reavaluation	48,18 49,82	5,19 5,05	0,197

* p<0,05

The results obtained in the Bodily Pain domain, suggest that in this study, this is the domain where there was a lower perception of health. This contradicts the literature referred to as the Vital area that has lower values (Ribeiro, 2005). We do not know whether this result is due to the small number of individuals, reflecting individual differences, or if it has to do with cultural issues of the geographical area where the study was carried out. As regards the comparison made according to each group, the results are inconclusive regarding the use of splint because it turns out that both occur in significant improvements in the field Bodily Pain, despite being more significant in the experimental group. We can suggest that these results are due to the fact that some of the individuals reported that during the course of the study, the researcher allowed them to express the feelings the disease causes them, helping in the perception of bodily pain, being this fact more significant than the use of the splint, because the improvement occurred in both groups.

As for the General Health domain, after the intervention, this area presents significant differences in the experimental group, which may suggest that the application of the splint takes effect in terms of the perception that the participant has. Thus, the results obtained allow us to speculate that the occupational performance in the individual, after the intervention has improved. In the other domains, no significant results are shown between the two groups, which may be due to the fact that the QOL assessment tool is very general, although often used in the studies.

4. CONCLUSIONS

After the completion of this study, we think that the use of night splint in individuals with mild and moderate CTS can be an approach to be used while awaiting surgery, since it reduces symptoms, improves functional status and has a positive impact on QOL.

As limitations of the study, we refer the possible existence of variables that may have influenced the results, as the small number of our sample that relates to a specific geographical area, which therefore do not allow us to generalize the results to the population with pathology of CTS.

We recognize the importance to carrying out further studies with indicators for other factors, including the use of the splint as a preventive of CTS as well as the application of the study in a male population.

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Situations of serious and imminent danger: proposal of a methodology for preparedness in campsites

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ABSTRACT
Camping parks are work, recreational and leisure locations of high risk when facing situations of serious and imminent danger, especially during peak season, not only due to higher climatic temperatures but also due to an increase in visitors, motorized vehicles and diverse materials and equipment. During this season a large number of undifferentiated personnel have to be contracted and employed in order to deal with the increase in work load caused by increased demand. These parks generate employment although only with seasonal characteristics. Within this view of prevention, the objectives of this study concentrates and centers itself on the evaluation of a work place in relation to risks leading to situations of serious and imminent danger as well as the elaboration and development of preventive and protective measures. So as to substantiate those objectives a thorough analysis of the current legislation was performed in order to identify the deviances to the norms which have been verified for this specific location of study. These deviances resulted not only from direct observation but also from the analysis of documentation, the map of the park as well as direct contact with management and staff. This research was established with the support of an observation guide and accompanied by photographs of some of the situations. A management system is proposed through which the vulnerability of all the visitors is reduced by devising organizational measures as well as informational and training sessions for the employees and visitors. The preventive measures proposed try to respond in accordance with the regulatory requirement of the employees' rights of access to information and training in relation to health risks and safety as well as the interventional measures in case of situations of danger and emergencies.

Keywords: Risk, Serious and Imminent Danger, Emergency, Prevention

1. INTRODUCTION
Camping, especially in summer, is a popular and highly sought out activity in Portugal, not only by the Portuguese population but also by numerous foreigners attracted to Portugal due to its climate and beauty in order to rest and relax.
Licensing for these touristic ventures must take into account the legal requirements, such as site location in order to safeguard people and possessions when faced with a possible natural or technological disasters as stated in article 5 in Act no. 39/2008, the 7th of March.
According to the Tourism Board of Portugal, in the year 2009 there were 225 camping parks actively working over an area of 1166 hectares and with a capacity of lodging 179 thousand campers. Privately owned camping parks account for 62% of the total, with 18% belonging to Federations and Clubs and 20% to local Governmental agencies.
In this context a large number of visitors concentrate in these areas over a very short period of time looking for an escape from their mundane, everyday life and as a result oblivious to all the possible dangers. With the concentration of these visitors and at the same time there is also an increase of motorized vehicles and other materials and equipment, some of which highly inflammable (tents) and others potentially explosive (camping gas bottles).
Camping parks in the sense of workplaces represent a very specific reality characterized by being seasonal and consequently the fluctuating employment of undifferentiated personnel. Due to these facts there is an increasing need to maintain staff up-to-date and highly trained in the area of safety.

Table 1 – Situations of Serious and Imminent Danger vs. Technological Risks

Act no. 102/2009		
Prevention		Function (Camping Parks)
Situations of Serious and Imminent Danger		Technological and Social risks
Training/Information	Employees (article 19)	Sudden increase in employment of non qualified employees during peak season (seasonal)
Organization of the preventive measures	Third Parties (article 15)	Sudden increase of campers in summer (Peak Season)

Act no. 102/2009, 10th of September, regulates the promotion and prevention of health and safety in the work place in accordance with what is foreseen in article 284 of the Labour Code regarding to prevention. Table 1 identifies the most relevant aspects of this Law in regards to this paper and study.
Apart from this problematic diversity, the reaction to situations of serious and imminent danger has to be quick, defined and adapted to the context of that moment. The main objective of this paper and study mainly centers itself in the

preventive spectrum, proposing to analyze these work and leisure locations, with a view to suggest corrective measures that will allow the necessary preparation for a rapid and effective reply to eventual emergency situations.

2. METHODOLOGICAL APPROACH

2.1. Materials and Methods

The methodology adopted was a case study when, besides consulting management and employees of the camping park, an investigation in two principal areas was carried out:

- On the one hand, an extensive analysis of legislation and regulation in force in Portugal, both specific and related, technical norms, text books and investigations carried out relating to the subject in study.
- On the other hand, an analytical observation of the site involved in this study, internal regulations, documented registers of visits, maps of the fire safety installations and documented photographs of some of the critical situations, with the aim of identifying those that could be the potential causes for accidents (Almeida, 2011).

3. RESULTS AND DISCUSSION

With the information and materials obtained from the camping park subject of this study an evaluation of the preventive measures and preexisting measures of combat in situations of serious and imminent danger was performed, identification of the deviations relating to the legislative orientations and evidence of good practices was carried out and finally proposals of promotional alterations for better management of prevention in case of serious and imminent danger were given so that they could be put into practice by Higher Technician of Work Safety and Hygiene in the work place or by someone responsible for safety .

In order to obtain more reliable results, various registered documents were studied that permitted the gathering of data relating to the year 2010, namely the rate of occupation, number of cars, tents, trailers and camp sites during each month of the year.

3.1. Characterization of Case Study

Concerning the rate of occupation, the Campsite show the months of July and August are the months of higher demand, while January and December the months of reduced demand. On the limit, the difference between the maximum and minimum occupation rate sits on a ratio of 112 to 1, as shown in Figure 1.

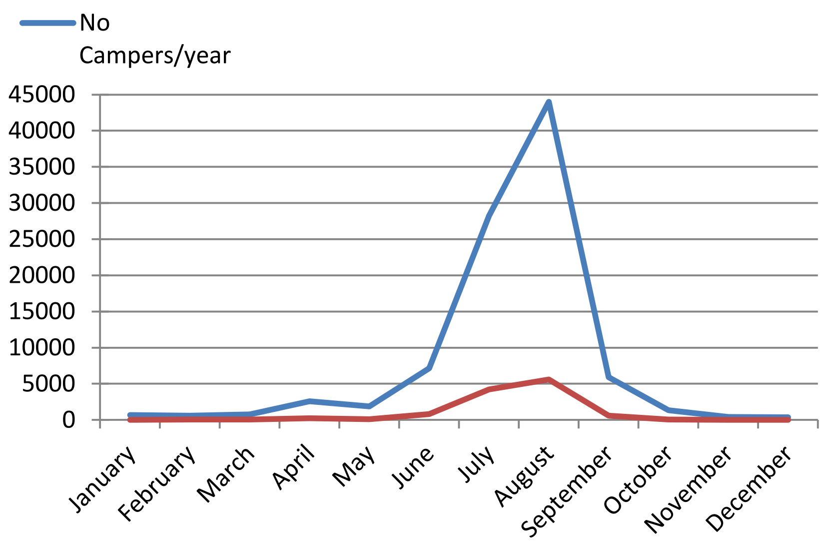

Figure 1 – Occupation for the year 2010

The data obtained from this touristic camping park shows the existence of two distinct phases, high season and low season, confirming the figures for the national tendencies in relation to data obtained from the Portuguese Tourism Board for the year of 2009.

In what concerns the occupation of the individual camp sites, many of these individual camp sites are occupied by so called resident campers which keep their caravans there all year round. During peak season, a significant increase in the number of vehicles and tents is seen, which in relation to vehicles, the number totals 15142, giving an average of 450 vehicles per day. Figure 2 shows these numbers.

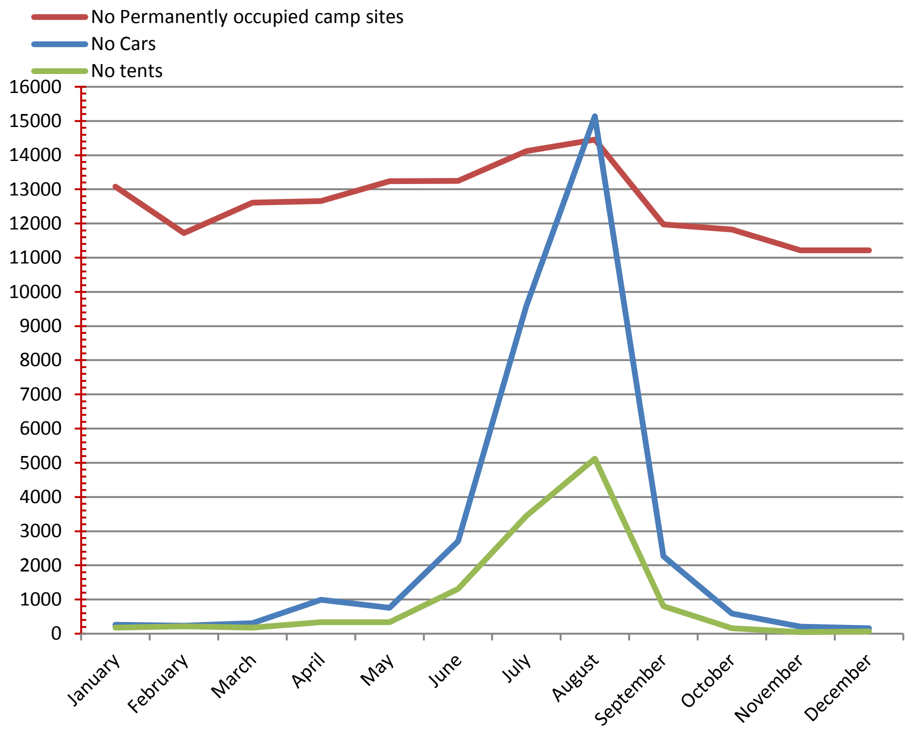

Figure 2 – Number of installed materials and equipment

This high concentration of materials and equipment, especially during peak season, generates on the one hand an increase of situations of serious and imminent danger and on the other hinders the access of emergency vehicles in a situation of crises.
The safety issue in situations of serious and imminent danger is the preoccupation and responsibility of all citizens (Delicado & Gonçalves, 2007). So, as for this, it is the target of particular attention by responsible entities and by the State. The possibility of these situations occurring is permanently present.
An analysis of the conditions and means of evacuation and possible situations due to landslides (The fall of rocks or stones, cracks in the floor) depending on the location of the camping park are equally taken into consideration /DECO, 2006).
Bearing in mind the fire safety legal framework for buildings and sites, regulated by law decree no. 220/2008, publishing the "Legal policy of security against fire in buildings (RJ-SAFB) and Ordinance no. 1532/2008 of 29th December approving the Technical regulation against fire in buildings (RT-SAFB)", the data analysis performed allowed for the visualization of these sites as well as to better understand the risk factors.
In accordance with article 198, foreseen in article 21 of the law decree no. 220/2008: "Achievement of the auto protective measures" of the RT-SAFB, the auto protective measures asked for by law are the safety records, the procedures in cases of emergency, raising awareness, training in SAFB and simulations.
The provisions contained in the safety regulation of electrical installations for camping parks and marinas approved by law decree no. 393/85, of 9th October and through Ordinance no. 1320/2008, of 17th November, establishes the requirements for installation and functioning of camping parks allowed for the analysis of irregularities pertaining to this domain.
From the analysis of the data, a number of potentially dangerous situations were verified which could lead to situations of serious and imminent danger that compromises a better management of action and prevention, namely:
•Non- compliance of the fire safety installations, signage and measures of auto protection;
•Non-compliance of the internal regulation on the part of the employers/site license holders relating to fire and the safety rules against the risks of fire (Bontempo,2006);
•Non-compliance relating to circulation and parking of vehicles, hindering the access of emergency vehicles in situations of crisis.
From the results obtained concerning risk evaluation it shows a necessity of implementing effective preventive measures for the protection and safety of the employees and the employers, namely:
•Analysis and presentation of a plan for the reorganization of the fire safety installations and safety signage;
- Definition of a method for the placement and distance between trailers and tents;
- Proposal of corrective measures for the users: problems with the individual utilization and placement of camping gas bottles in the exterior of trailers and tents;
- Definition of emergency procedures, in case of "missing people" considering the high rate of occupation.

•Elaboration of proposals for better training and information awareness:
- Conception of flyers with instructions related to prevention of situations of serious and imminent danger directed at employees;

- Conception of flyers about action to be taken in case of emergency situations directed at campers;
- Elaboration of chips with the action procedures, allowing for easy and rapid reading on the part of the executors (Cruz,et al,2010).

In this case study and in accordance with the current legislation the fire safety system must guarantee the coverage of all the occupied areas, which is not present in the particular camping park. The fire safety installation is undoubtedly insufficient, covering only 9% of the total area of the camp site. This rate is considered extremely low. Also, the length of the hoses is not sufficient for water to reach the entire camp sites. For this reason a proposal is given for the reorganization of the fire safety system as well as for the division of the park into sectors destined for each type of equipment, with maximum limits of occupation in conformity with no. 1 of article no. 281, ordinance no. 1532/2008: 20 camping tents; 20 caravans and auto caravans, in this way guaranteeing access to water points in all areas.
The access roads and internal circulation between sectors should have a minimum distance of 3,5 metres so as to guarantee the accessibility of rescue units. In each sector two reels with hoses of 20 metres each should be installed, as shown in figure 3.
In this perspective, all the camp sites would be covered by the hoses in the reels, guaranteeing in this way a better efficiency in the prevention of the spread of a fire.

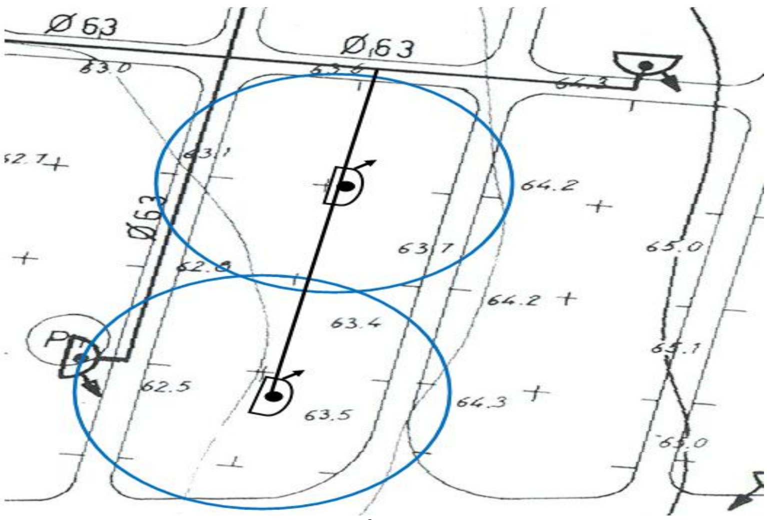

Figure 3 - Reorganization of camp sites in a sector X

In order to carry out a decision made in a situation of fire an emergency algorithm of easy and intuitive reading is suggested, where the various procedures are outlined, as shown in figure 4

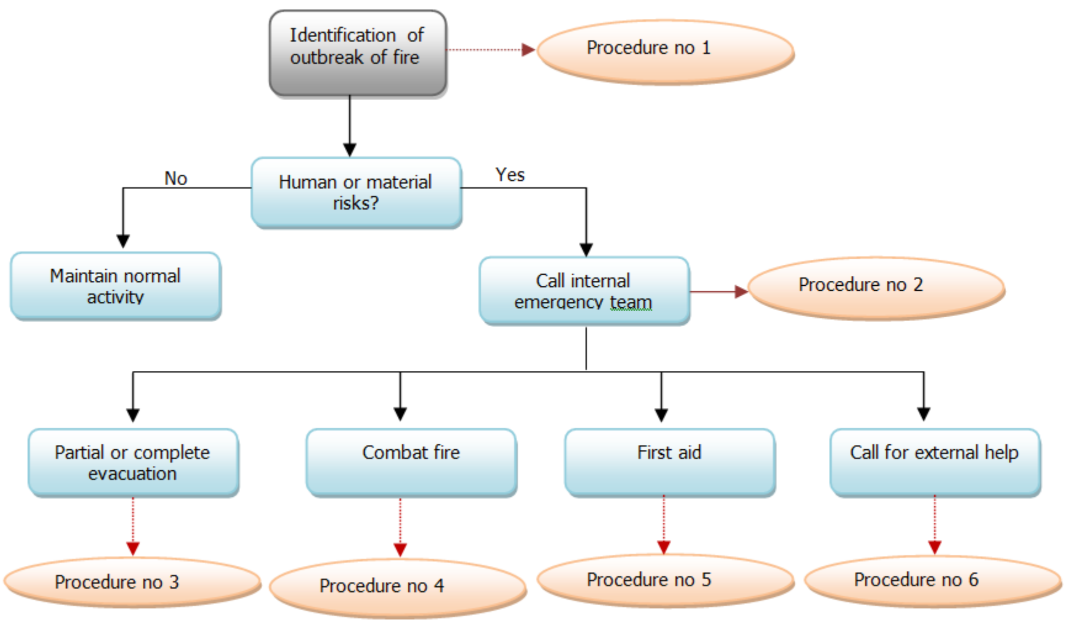

Figure 4 – Decision making algorithm

In the algorithm various procedures are listed in order to be worked on by the Higher Technician of Work Safety and Hygiene. In figure 5, used as an example, shows procedure no. 1.
It is a card, with the sequence of steps to be taken, included in the action protocol, allowing for easy and rapid reading by the executors.

Acampar

PROCEDURE Nº 1
Safety against fire

Ficha 2/10

When alarm is triggered in the security guard´s quarters, proceed in the following way:

1. **Perform a rapid analysis of the location;**
2. **Use fire extinguishers or hose reels for fire;**
3. **Inform the Safety Manager (SM) who must act in conformity with the predict-able advancement of the fire;**
4. **Proceed with the electrical cut of the affectected area, ordered by the SM;**
5. **Check if there are people in danger and inform the SM;**
6. **Check and clear all emergency exists, if necessary;**
7. **Seal off the área ordered by the SM;**
8. **Evacuate the area ordered by the SM.**

DONE BY	VERIFIED	AUTHORISED

Figure 5 – Card with procedure no.1

In accordance with ordinance no. 1532/2008, article 288 refers that "The internal regulations of camping parks should include the preventive and auto protective measures against fire and in turn issued to each camper". As a result of this, it is essential to have informative flyers which are given to campers when checking into the park. Two types of flyers are suggested: The first, a simple but insightful flyer that will help patrons in using the correct protective measures as shown in figure 6, the second, a flyer whose objective is to orientate and guide the patrons in situations of a fire outbreak, indicating how to trigger the alarm, security measures to be taken and how to initiate and combat the fire, as shown in figure 7.

Fire Prevention

Extreme care with fire, never use any type of fire in insecure conditions, take into account all the preventive measures to avoid an outbreak.

Only use the barbecues available;
Do not light fires, except for cooking equipment previously authorised in accordance with the Park´s internal regulation and meets all the safety requirements for the type of equipment in question ;
The area betwen the tents must be kept clean and clear of only objects at all times;
Do not use lit coal in or near the tents;
Always obey the signage and the orders of the person responsible for the park;
Set up your equipment within the area allocated so as to maintain the minimum distance of 2 metres between the other campers;
Maintain the area destined for camping and for the equipments clean and in good conditions of conservation and hygiene.

Figure 6 – Fire prevention Flyer

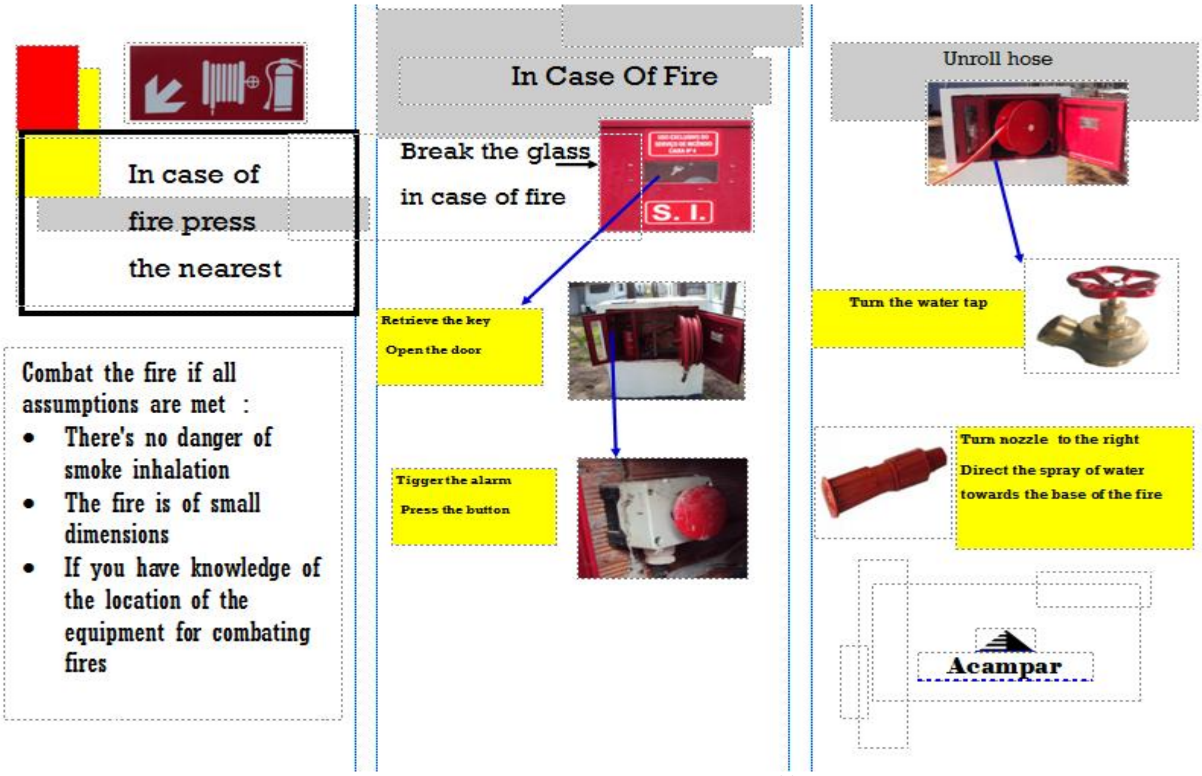

Figure 7 – Flyer indicating procedures in case of fire

All the proposed measures are in conformity bearing in mind the classification and methodology previously presented. In this context, the intervention of a Higher Technician of Work Safety and Hygiene for the work place whose responsibility it is to evaluate and assure the organization of an effective prevention plan is justified. This plan must contain the organization of the fire network, auto protection measures including information and staff training, instructions and measures to be adopted in case of situations of serious and imminent danger for a wide range of possible risk factors. This intervention is of the utmost importance due to the fact that in peak season a large number of people are employed many of which unqualified and also due to the exponential increase of visitors to the park.
Bearing in mind the good practices in terms of prevention and action to be taken in situations of serious and imminent danger and the main areas of health and safety in the work place, foreseen in article 98 of the law decree 102/2009, interventional strategies are presented so that they can be developed by a Higher Technician of Work Safety and Hygiene in the sense of which measures to adopt. The preventive measures proposed take into account better preventive management, namely, the necessity of information and training so that better decision making can occur (Fernandes, R.C, 2009), the organization of the fire plan network, signage and identification of the deviances of the auto protective measures in cases of emergency.

4. CONCLUSION

The preventive measures proposed try to respond in accordance with the regulatory requirement of the employees’ rights of access to information and training in relation to health risks and safety and also the interventional measures in case of situations of danger and emergencies. In this sense, they can be an important auxiliary resource that will permit strengthening of these organizations with the necessary means for a more effective reply in situations of serious and imminent danger always remembering the high numbers of visitors concentrated at certain times of the year.
The importance of camping parks amongst all the different touristic offers gains higher importance due to the current situation, besides not generating high rates of employment and the quality of employment being unstable (significant ratio of precariousness in this area of business compared to employment of 3 to 4 months but with a legal and binding term contract). Never the less, with new social awareness regarding nature, these parks could become factors of quality and development.
Simultaneously, as a consequence of the increase of visitors and workers temporarily employed during the summer months and in order to respond to the abrupt increase of the percentage of occupation of the parks, the necessity of contracting a Higher Technician of Work Safety and Hygiene justified in order to coordinate the measures to be adopted in case of situations of serious and imminent danger as well as assure the organization and management of a preventive plan for a wide range of possible risks.
In the future it would be interesting and useful to see a comparison of the various different types of existing parks depending on their locations (beach, urban, forest and mountain), seeing that they reveal different social and economical

realities due to the different social status of visitors, employment that they generate, the ambient in which they are located and the preventive risk measures both professionally as well as environmental (Almeida,2011).

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Integrated management systems – quality, environment and health and safety: motivations, benefits, difficulties and critical success factors

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ABSTRACT
Following the process of economic globalization and increasingly competitive markets, many organizations have implemented wider management systems, as distinctive factor against competition. However, with the increasing standards organizations found themselves needing to integrate management systems aiming the expertise and resources optimization. As a result of that integration a maximum performance of the management system can be achieved. It was defined as this study aim the assessment of critical success factors for implementing an integrated management system, and what were the difficulties felt by organizations during the integration process. The type of sampling was non-probabilistic by convenience. The sample was composed with four organizations with certified management system of quality, environment and occupational health and safety. The type of study was descriptive and exploratory level I. To collect data semi-structured interviews were conducted with management system managers, where the entire integration process was examined. It can be concluded that the integrated management system contributes positively to the studied organizations, leading to benefits at the organizational processes, cost reduction, efficiency gains, among others. It can also be concluded that the involvement of top management, the existence of human and financial resources, training, as well as the employee motivation involvement, clear goals and meeting deadlines, are factors that can lead to successful systems integration. The change on both organization structure and behavior of employees was the most outline difficulty felted by organizations.

Keywords: Management system; integration; success factors; integrated management systems

1. INTRODUCTION

With technological advancement, rampant global growth and the growing prospects of human life, the concept of industrial development has changed. This change, along with the economic globalization process and increasingly competitive markets, has led many organizations to extend their business area, making it more comprehensive and differentiated in comparison with their competition (Billig and Camilato, 2008 and Ferreira, 2009). The "quality assurance" led to international efforts in order to develop quality management systems that must work as a guarantee regarding the performance, methods and control procedures, materials, technical specifications and guidelines for production and inspection (Michael and Dias, 2009). According to Sampaio and Saraiva (2010), management systems can be defined as a set of interrelated business processes, which use different resources to achieve the established organizational goals. Additionally, they allow the organization to recognize the effort to assure compliance of its products and/or services, customer satisfaction and continuous improvement (Pojasek, 2007).

With the industrial revolution, the idea of progress becomes imperative, being the natural resources seen as raw material for generating new products, resulting in the degradation of the natural environment (Smith, 2006). The integration of environmental issues (including environmental protection and pollution prevention in the management of organizations through the implementation of an environmental management system) allow acquiring a deep insight of the most important environmental aspects associated with its activity, and identifying the processes that need to be improved through the implementation of effective environmental measures (Fresno and Engelhardt, 2004).

Also the issues of health and safety at work have been increasingly recognized as an important factor, not only for employees, but also for the organizations, assuming themselves the occupational health and safety management system as a guarantee to reducing risks and costs associated with repairing accidents. This management system proves to be just a tool that, when properly implemented, allows the organization to obtain data, objectively, on its performance in health and safety in all its aspects, allowing improvements based on facts (Ramos and Almeida, 2008).

As a result of this framework, the implementation of management systems and the increase of their certification led to the need to integrate them into a holistic system (Asif *et al.*, 2010). The idea arising from this concept, which involves the integration of various management systems is, as far as possible, that organizations can manage their operations through a single management system, instead of several management systems (Rasmussen and Jørgensen, 2007). This holistic management avoids wasting resources and increasing organizational efficiency and profitability (Abrahamsson *et al.*, 2010).

2. MATERIALS AND METHOD

The data collection for this study was based on case studies, since the results of case studies can have a significant impact in terms of research, leading to new discoveries and development of new valid and useful theories for professionals

(Voss *et al.*, 2002). Meredith (1998) adds that, this method of study helps the understanding why certain characteristics are met in target-cases.
The case studies were based on semi-structured interviews (based on guidelines adapted from Sampaio and Saraiva, 2010) for managers of integrated management systems of each of the organizations targeted. The aim of this interview was to know how the integrated system was implemented and what were their contribution to the organization, as well as knowing what were the critical success factors for implementation.

- Q 1. Which year did the organization decided to integrate the management system?
- Q 2. What was the sequence of implementation/integration of the management system?
- Q 3. Why your organization decided to integrate the management systems? What were the real motivations?
- Q 4. The organization adopted a specific strategy to the integration of management systems? If yes, which and why?
- Q 5. Which were the main obstacles that the organization faced during the integration process?
- Q 6. On a scale of 1 to 5 (1 - lowest level of integration ... 5 – highest level of integration), how would you classify the integrated management system in your organization? Why?
- Q 7. The integrated management system in the organization is recognized as an asset? Why?
- Q 8. Which are the main benefits that resulted from the integration of management system?
- Q 9. If the organization had not implemented an integrated management system, what would be the level of performance compared to the current reality (1 - lower than the current time | 2 - equal to the current time | 3 - higher than at current time)? Why?
- Q 10. How would you classify the integration of the existing standards - quality, environment and occupational health and safety (1 - very difficult integration…5 - easy integration)? Why?
- Q 11. How many levels of integration of management systems do you consider to exist, and what distinguishes each one of these levels?
- Q 12. What factors do you consider relevant to the successful integration of management systems?

For the case studies were selected four organizations with integrated management systems (environment, quality and occupational health and safety). As a reference, in this selection was used the number of target organizations in other studies with similar research methodology (Fresno and Engelhardt, 2004, Rasmussen and Jørgensen, 2007; Karapetrovic and Casadesus, 2009; Grael and Oliveira, 2010), as well as theories presented in scientific articles on research of case studies (Voss *et al.*, 2002; Meredith, 1998). The selected organizations had management systems with different levels of integration. The selection and classification of organizations has taken in account the information gathered from certification entities, auditors and consultants who audit or assist in the organizations under study. Thus, organizations were classified as high level of integration and low level of integration depending on, whether they showed, respectively, an "all-in-one" system or a system with a document integration only (Karapetrovic, 2002; Bernardo et al., 2009).
After data collection, the steps suggested by Eisenhardt (1989) and Voss *et al.* (2002) were followed. Initially the collected information was analyzed and, at a later stage, tried to identify possible patterns in different case studies, comparing the features of organizations with high and low levels of integration.

3. RESULTS AND DISCUSSION

The chosen organizations belong to the following economic sectors: mining, wholesale trade and construction. Only one of the organizations belonged to NUT II of Norte, and the other ones from the Centro. The average number of organizations employees is 78, ranging from 15 to 150. With regard to the system manager, responsible for the integration, it was found that in organizations with high level of integration, average age tends to be lower ($\bar{x}$ = 31 years), a higher level of academic skills and a professional experience time lower when compared to organizations with a lower level of integration (Table 1). By performing an analysis of the socio-biographical data, can be verified, despite the small number of case studies, these factors may be influential for a better integration of management systems.

Table 1 - Comparison of system managers and the level of integration

n = 4	High level of integration	Low level of integration
Qualifications	Graduation	High school
Age (years)	$\bar{x}$ = 31	$\bar{x}$ = 48,5
Time of service in the organization (years)	$\bar{x}$ = 6	$\bar{x}$ = 18

When asked upon which year the organization decided to integrate the management system and the sequence of that implementation/integration, three organizations reported having gone to the implementation and integration of the occupational health and safety management system simultaneously with the environmental management system, based on the quality management system. However, two of the four organizations only integrated some procedures and documentation. In terms of duration of the integration process, organizations with high level of integration decided to integrate the systems five years after the implementation of quality management system. In organizations with a lower

level of integration, one of them implemented the three systems simultaneously, to certify during the following year, thus revealing little maturity of the systems. Organizations have resorted to consult companies and the recruitment of more resources and staff training, in order to proceed with the integration of systems. One of the organizations (with a low level of integration) chose to check the documentation for common systems and compile it into single documents.
Given the motivation that led the organization to integrate the management systems, like Karapetrovic *et al.* (2006) and Santos *et al.* (2011), managers claimed image improvement as a marketing tool and improved relations with stakeholders, as well as the optimization of processes, reduction of documents and improving internal organization, as the main motivations for integrating management systems (Table 2). It is noticeable the difference between the two groups of organizations. The group that presents a higher level of integration, points out as main motivations the system optimization and efficiency improvement. Despite the other group of organizations indicating the improvement of internal organization, the motivations were very limited, turning more outward than for the system itself. The reduction of documents, similar to that referred by Sampaio and Saraiva (2010) and Santos *et al.* (2011), seems to be the major motivation for these organizations, which is reflected in difficulties at the operational field.

Table 2 - Motivations for the integration of management systems.

	High level of integration		**Low level of integration**	
Marketing tool / image improvement	X	X	X	X
Internal process optimization	X	X		
Marketing differentiation	X			
Give response to customers with specific demands	X			
Improve effectiveness and control of systems	X			
Top management decision		X		
Economic support for investment projects		X		
Cost reduction associated to resources involved		X		
Customers and suppliers relationship improvement			X	
Internal organization improvement			X	
Documents reduction			X	X

During the integration of management systems, organizations have faced difficulties, especially those organizations with high level of integration (Table 3). These difficulties, also identified by authors such as Santos *et al.* (2011) and Sampaio *et al.* (2008), occurred mainly at the level of internal restructuring and employee's behavior change. Organizations with low level of integration have not identified obstacles so far, due to the fact that only integrated documentation, continuing the subsystems operating in parallel.

Table 3 – Obstacles during the integration of management system

High level of integration	**Low level of integration**
▪ Behaviour and procedures change by some employee's, mostly those who were in the organization for more time. ▪ Organization restructuration.	▪ Did not experience significant obstacles until this moment, since they only integrated documentation, keeping the subsystems separated.
▪ Lack of experience of the consulting organization in management systems integration. ▪ Changes in the organization structure.	▪ Lack of local consultants. ▪ Lack of partners with integrated management system for benchmarking effects. ▪ Financial investment.

When asked about the level of integration of management systems (Table 4), organizations with high level of integration believed that their systems are well integrated, meeting "all in one" system, referred by Karapetrovic (2002). These organizations can distinguish four levels of integration, beginning with the policy, from the integration of documentation, the definition of objectives and goals and finally, the alignment of management tools. Other organizations felt that their level of integration was reduced because it only reflected at a documentation level, remaining separate processes, i.e., an integration classified as partial, according to Bernardo *et al.* (2009). It was notorious the difference between organizations with high and low levels of integration, in that the first ones had already referred to different levels identified by Karapetrovic (2002), and the other ones had failed to identify these levels, reflecting the low level of integration existing in them.

Table 4 – Integration levels (1 - lowest level of integration ... 5 – highest level of integration)

High level of integration	Low level of integration
▪ [4] Systems find themselves well integrated. However, there are improvements to be done. ▪ Identified levels: 1 – Policy 2 – Documentation support 3 – Objectives and goals 4 – Operational control / management tools	▪ [2] Integration only at the documentation level. As far as operational control concern, there is still an independent approach, at the quality, environment and safety level. ▪ Identified levels: 1 - Documentation 2 – Policy and objectives
▪ [5] Even having the notion that it can be improved, a maximum level of integration was considered. It was also considered that it was still in a growing stage where the integration with other management systems will be easier. ▪ Identified levels: 1 - Policy 2 – Documentation support 3 - Objectives and goals 4 - Operational control / management tools	▪ [1] Only integrated at documentation level. ▪ Identified levels: 1 – Documents integration

It was noted that the integration of management systems is an asset for organizations with high level of integration, since it provides an improvement of indicators and better control procedures. These gains have a positive effect of the motivations cited by organizations, particularly in terms of improving the efficiency and control systems and the response to some customers with specific requirements. Organizations with a lower level of integration do not see the management systems integration as a positive gain, especially in operational terms. In fact, the motivations indicated do not correspond to internal motivations in its true sense, since they are merely aspects of marketing, improving the relationship with customers and suppliers, leaving missing a whole host of reasons that reflect improvements and add value to the system and consequently the organization.
The main perceived benefits for organizations with high level of integration were at the level of organization of processes, improving the functioning of the organization due to behavior change and a better definition of responsibilities. Organizations with a lower level of integration essentially felt benefits in the reduction documentation (Table 5).

Table 5 – Benefits of the integration.

	High level of integration		Low level of integration	
Interested parties relationship improvement	X	X		
Procedures organization	X			
Behavior changes at environmental and safety levels	X			
Responsibilities definition improvement	X			
Documentation reduction	X		X	X
Indirect cost reduction	X			
The integrated systems allow the global vision of the organization		X		
Better work and organization		X		
Employee's communication improvements		X		
Effectiveness and efficiency gains		X		
Systematization and procedure speed increase			X	

With these benefits, organizations with high level of integration said that if the organization had not implemented/integrated management systems, the level of performance would be lower than the current one. In organizations with high level of integration this process was undoubtedly a way to improve their performance. Both organizations are found in possession of a level of superior performance compared to the situation preceding the integration. On the other hand, organizations with low levels of integration had recognized improvements in documentation, but not enough to consider being a higher level of performance. These results suggest that, in fact, only with a fully integrated management system, they can have gains and the benefits that this integration entails, and which are mentioned in the literature. This way, organizations see their performance improve, thereby increasing the effectiveness and efficiency of the system and consequently the organization.

Regarding the easiness of standards integration, organizations with high level of integration consider them of being quite easy to integrate, particularly ISO 14001 and OHSAS 18001, by the fact that they are more similar. On the other hand, organizations with low level of integration experience some difficulty in integration, not by the lack of standards compatibility, but especially for the current organizational structure. The organization that felt more difficulties in the integration of standards was precisely the one who choose to implement the three management systems simultaneously in an integrated manner.
Salaheldin (2009) defines critical success factors as critical areas that the organization should consider for successful integration. When asked about the success factors associated with the integration of management systems, organizations have identified the set of factors described in Table 6.

Table 6 - Critical success factors to the integration of management systems.

	High level of integration		**Low level of integration**	
Top management involvement (makes every employee involved in it)	X	X	X	X
Financial resources	X		X	X
Human resources	X		X	
Training	X		X	
Employees motivation	X			
Well defined objectives	X			
Persistency	X			
Employees involvement (they are the ones who more contribute to the audit process)		X		X
Consultants with integration experience		X	X	
Compliance with deadlines set for the project (indicators monitoring)		X		
Learning spirit of the teams		X		
Objectivity		X		

Based on the critical success factors identified by the organizations, the following should be highlighted as being most important:

- Top management involvement;
- Financial resources;
- Human resources;
- Training.

In fact, it is clear the importance of the involvement of top management for the success expected to arise during the integration of management systems. This commitment, besides being able to influence the alignment of management systems with the organization's business plan (Teo and Ang, 1999), can lead the rest of the organization also to commit themselves, as well as allow top management to demonstrate their commitment to the strategy (Salaheldin, 2009). According to Teo and Ang (1999), this commitment may even raise the status of the organization's management and consequently lead to an approach between the management and the various departments which, in a phase of implementation and maintenance of integrated management systems, can be very positive.
The commitment of top management is a major factor in the initial phase of management systems implementation (Nah *et al.*, 2001), facilitating the allocation of human resources and financial resources necessary to implement/integration of management systems (Teo and Ang, 1999). Without this commitment, the successful integration of management systems is compromised. Awan *et al.* (2008) reported the importance of creating synergies between the functional areas of business, including human resources, finance, marketing, among others, and the remaining functional areas of the organization, to be assigned responsibilities in the implementation of practices relevant to the system.
Training, particularly in areas where scientific and technical progress is constant, is a key factor for the system to operate without any nonconformities. The standards of quality, environment and occupational health and safety, report that training is important to assign responsibilities to employees, stressing the need to evaluate their effectiveness.
Yusof and Aspinwall (2000) and Salaheldin (2009) also identified human and financial resources, as well as education and training as critical success factors to systems implementation. Salaheldin (2009) also notes that these factors have a strong impact on the operational control.
The organizations under study also identified other factors that are considered as secondary:

- Motivation;
- Persistency;
- Clear objectives;

- Employees involvement;
- Compliance with deadlines in the project.

The motivation and employee involvement are essential to achieve certification and maintain effective management systems (Cheng and Tummala, 1998). These authors described the employees as managers, supervisors and operators and emphasize that the attitude and behavior of people working in organizations are critical to achieving the systems certification and its maintenance, since they are those that most contribute to the results of audits.

Among the strategic factors responsible for successful implementation/integration of management systems, a clear definition of objectives is, according to Salaheldin (2009), one of the most important. Harry and Schroeder (2006) and Trad and Maximiano (2009) point out that the successful implementation does not happen without an active leadership with clearly outlined and communicated objectives to employees. Pande *et al.* (2000) also points to the need of the projects are based on the needs and objectives and strategy of the organization.

The resources allocated to the system for the development of strategies and operational components, are important and necessary for meeting deadlines previously set for the project. This factor is critical and can be compromised if the top management is not compromised as well (Teo and Ang, 1999). The development of a monitoring plan of indicators is very important to meet the deadlines.

It is also worth mentioning that other factors, not being the most important ones, allow to take some elations:

- Spirit of learning of the teams;
- Objectivity;
- Consultants with integration experience.

Salaheldin (2009), about the spirit of learning of the employees, states that the higher this is, the greater its influence on the operational performance and, consequently, the greater the probability of a successful implementation/integration of the management systems.

For the other factor, it is important that organizations be objective in the projects that they propose to develop, particularly in terms of systems integration. This is a feature by which organizations must adhere to not stray from the main objective.

Another factor identified as critical, to the success of management systems integration, was the existence of consultants with experience in the integration of management systems. In fact, this factor relates to the difficulties experienced by the organizations that have adopted a strategy of integration hiring an outside consultant and that this one proved to be inexperienced in management systems integration. Again, the training factor being highlighted as critical to the success of systems integration. Although not being an employee of the organization is a service provider and as such, an employee of the organization, so this one also needs to be equipped with specific skills to the functions it performs.

4. CONCLUSIONS

The adoption of an integrated management system is, nowadays, a strategic decision of great importance for the competitiveness and sustainability of organizations. The successful integration of the management system is significantly related to the true motivations that lead to integration organizations. To achieve this efficiency level of integration and an "all-in-one," organizations need to comply with a number of factors that will lead to successful integration and better control systems.

With the integration of the management systems, and according to the organizations that collaborated on this study, it is possible to identify a set of benefits and gains associated. These reflect the initial motivations and, in practical terms, brought positive changes, including restructuring the organization in general and the system in particular, especially in terms of processes, documentation, communication and employees responsibility. Despite the benefits that integration earned to the organization, some difficulties were identified by them in this process, namely the level of behavioral changes and procedures, as well as the organizational structure and the initial financial investment required.

The observed level of integration can be influenced by the order of implementation and integration of standards, pointing out the conclusions of this study that the order of implementation follows, in most situations, the order of publication of the standards. This can be a key factor to the extent that organizations implement OHSAS 18001 and ISO 14001 after the quality management system implemented and embedded.

Can also be concluded that there are several factors indicated as critical to the success of the integration of management systems. Since not everyone is put on the same level of importance, based on the literature and in this study, were considered to be more important the involvement of top management, financial and human resources and training.

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Nanotechnologies are Safe? New Demand for Standardization

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ABSTRACT
The ability to understand and control matter at the nanoscale is leading to a "revolution" in technology and industry. Many products containing nanoparticles are already in the market. Negative impacts on public health, safety or the environment are often not yet known. Standardization is considered as essential to make a certain regulation in the market and avoid future problems. In this paper an overview of the present situation and foreseeable evolution of the standardization related to Nanotechnologies is presented, with emphasis on the situation at European level.

Keywords: Nanotechnology; Standardization; Health and Safety

1. INTRODUCTION

The rapid development of nanotechnology has led to the emergence on the market of several products containing nanoparticles. The risks to health, either for workers who handle nanoparticles, and for consumers, by inhalation, ingestion or skin contact are still often not really known.

According to the NNI (National Nanotechnology Initiative, launched in 2000 in the USA) by 2015, it is expected that nanotechnologies will be responsible for 2 million jobs and about 1 trillion USD production. Other estimates are even more optimistic: 1.5 trillion EUR in 2015 and even 2.6 trillion USD already in 2014. This most optimistic scenario would imply that the market for nanotechnology-based products would be larger than the prospected information and communication technology market and would exceed the future biotech market by ten times.

What is sure is that nanotechnologies are already almost everywhere, with more than 1500 products containing nanoparticles in the market today.

Knowledge of the exposure to, or effects of, engineered nanomaterials on human health and safety in occupational environments is limited and does not allow reliable assessment of risks of these materials on workers' health. Anyhow, there are already several studies concerning exposure to engineered nanomaterials, which have been associated with a number of health effects including pulmonary inflammation, genotoxicity, carcinogenicity and circulatory effects (Savolainen 2010). There is therefore an increasing concern of regulatory authorities concerning nanotechnology.

Philippe Busquin, European Commissioner for Research, has written the following text as a forward of the publication "Towards a European Strategy for Nanotechnology" (CEE 2004) which clearly presents the position of the European Commission regarding nanotechnology:

"Nanotechnology is expected to contribute towards improving our quality of life, in particular, for sectors such as materials sciences, healthcare, information technology and the environment. Many products have been enhanced by nanotechnology to provide improvements and are already on the market e.g. heart-valves, coatings, scratch-free paints, tires, sport equipment etc. At the same time, we should be vigilant in addressing any drawbacks of nanotechnology and to ensure that research is carried out in a responsible manner. Any negative impacts on public health, safety or the environment must be addressed upfront and as an integral part of the technological development process. Such an integrated approach should also help to ensure a high-level of confidence from investors and consumers".

Both the Economic and Social Committee and the European Parliament have highlighted the importance to be attached to standardization as a means to accompany the introduction of nanotechnologies and nanomaterials on the market, and a means to facilitate the implementation of the European regulation.

Recently the European Commission has published a recommendation concerning the definition of nanomaterial (European Commission 2011). The definition is the following:

"Nanomaterial means a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm-100 nm. In specific cases and where warranted by concerns for the environment, health, safety or competitiveness the number size distribution threshold of 50 % may be replaced by a threshold between 1 and 50 %. (…). Fullerenes, graphene flakes and single wall carbon nanotubes with one or more external dimensions below 1 nm should be considered as nanomaterials".

This detailed definition is an important basis for regulatory purposes, namely in aspects related to potential health, safety and environmental risks in relation to nanomaterials. As can be seen from the definition, a special concern is given to certain materials which can be more harmful namely for health and safety.

The following paper tries to make a summary of the present situation of standardization related to nanotechnologies, especially in Europe. Nevertheless, il must be emphasized that the concern about the lack of standards related to nanotechnologies is not only European. For instance, in the USA a lot of effort is also being done, in relation to regulations (see for instance Yokel and MacPhail, 2011).

2. CEN/TC352 – NANOTECHNOLOGIES

2.1. Creation

In 2006, within CEN (European Committee for Standardization), the Technical Committee CEN/TC352 has been created, to develop standardization in the field of nanotechnologies. This includes the preparation of standards for classification, terminology and nomenclature, basic metrology, measurement and characterization (including procedures for calibration), health, safety and environmental issues. The primary aim is «understanding and controlling materials and processes at the nanoscale, particularly below 100 nanometers in one or more dimensions (...)». The business plan of CEN/TC 352 emphasis that the Technical Committee will seek to develop and maintain relevant and up to date standards, which will meet the needs of industry and support relevant legislation over years (Almeida 2011).

2.2. Published standards

A first standard document has been adopted in 2008 and published in 2009 (CEN ISO / TS 27687:2009 - Nanotechnologies - Terminology and definitions for nano-objects - Nanoparticle, nanofibre and nanoplates). This standard clearly specifies that a nanomaterial is a material with one or more external dimensions, or an internal structure, on the nanoscale (e.g. having one or more dimensions of the order of 100 nm or less), which could exhibit novel characteristics compared to the same material without nanoscale features. Novel characteristics might include increased strength, chemical reactivity or conductivity. This standard presents several definitions that are included in the official European definition of nanomaterial (agglomerates, aggregates, fullerenes, graphene flakes and carbon nanotubes. Some measuring techniques are also presented. It also distinguishes the different types of nano-objects:

- Nano-particles (with three outer nano-sized dimensions)
- Nano-fibres (with two outer nano-sized dimensions)
- Nano-plates (with one outer nano-sized dimension)

The standardization program of CEN/TC352 is ongoing, in cooperation with the corresponding international committee (ISO/TC229). The following standards have already been published:

- EN ISO 29701:2010 – “Endotoxin test on nanomaterial samples for in vitro systems – Limulus amebocyte lysate (LAL) test”. This standard describes the application of a test using Limulus amebocyte lysate (LAL) reagent for the evaluation of nanomaterials intended for cell-based in vitro biological test systems. The test is suitable for use with nanomaterial samples dispersed in aqueous media, e.g. water, serum or reaction medium, and to such media incubated with nanomaterials for an appropriate duration at 37 ºC. The test is restricted to test samples for in vitro systems, but the methods can also be adapted to nanomaterials to be administered to animals by parenteral routes.
- EN ISO 10801:2010 – “Nanotechnologies - Generation of metal nanoparticles for inhalation toxicity testing using the evaporation/condensation method”. This standard gives requirements and recommendations for generating metal nanoparticles as aerosols suitable for inhalation toxicity testing by the evaporation/condensation method. Its application is limited to metals such as gold and silver which have been proven to generate nanoparticles suitable for inhalation toxicity testing using the technique specified.
- EN ISO 10808.2010 – “Nanotechnologies - Characterization of nanoparticles in inhalation exposure chambers for inhalation toxicity testing”. This standard specifies requirements for, and gives guidance on, the characterization of airborne nanoparticles in inhalation exposure chambers for the purpose of inhalation toxicity studies in terms of particle mass, size distribution, number concentration and composition.

The following documents are under approval:

- CEN ISO/TR 11811 – “Nanotechnologies - Guidance on methods for nanotribology measurements”
- CEN ISO/TS 13830 – “Guidance on the labelling of manufactured nano-objects and products containing manufactured nano-objects”. This standard is intended to provide guidance on the format and content of voluntary labelling for manufactured nano-objects (MNOs) and products, preparations and mixtures containing MNOs. It also provides guidance on the use of the term “nano” in product labelling.

This important document on “nano” labeling has been submitted to a ballot in the beginning of 2011 and it has not been approved, both at ISO and at CEN level. At CEN level, 15 members supported the ballot whereas 4 rejected (66 %.weighted votes agreed while 71 % is required for approval). Due to the CEN weighted voting system, if one major member would change its negative vote to a positive vote, the project could be accepted. There are a lot of arguments in favor and against a specific labeling system for “nano”; probably this could raise among consumers a movement for the rejection of nano, as it happened with GMO (genetically modified organisms). Anyway, the document will be improved according to the suggestions received, and later submitted to a second ballot.

2.3. Mandates from the European Commission

A first approach of the European Commission to CEN/TC352 has been made in 2007, through a mandate Ref. M409 asking for the identification of a work programme for the development of standards in the area of nanotechnologies and nanomaterials. Following the feed-back of CEN/TC352, in 2010 the European Commission sent jointly to the three European Standardization bodies (CEN, CENELEC and ETSI) a second mandate (Ref. M461) specifically asking to develop standards for testing methods and tools for the characterization, behaviour and exposure assessment. The exposure takes into account not only aspects of health and safety of workers but also consumers and the environment itself. Some 20 technical committees in several European areas have been identified, which should be involved in work that is expected to be coordinated by CEN/TC352.

Mandate M461 identifies four areas for standards development:

- Methodologies for nanomaterial characterization in the manufactured form and before toxicity and eco-toxicity testing.
- Sampling and measurement of workplace, consumer and environment exposure.
- Methods to simulate exposures to nanomaterials.
- Health, safety and the environment.

Following the acceptance of mandate M461 «Nanotechnologies and nanomaterials», a roadmap has been established which identifies 45 standardization projects (leading to TS – Technical Specifications or TR – Technical Reports) in the field of «characterization of and exposure to nanomaterials» and «health, safety and environment».

The following developments are especially important in terms of health and safety:

- Guidance on measurement techniques relevant to different exposure routes: inhalation, ingestion, skin exposure.
- Guidance on detection and identification of nano-objects (in all media types).
- Guidance on how to address background issues in different exposure settings.
- Guidance on sampling, particularly to determine exposure to and from environmental sources.
- Guidance on metrics to be used for the exposure measurements of nanomaterials (nano-objects and nanostructured materials) such as mass concentration, number concentration and surface area concentration, with recommendations for relevance to specific toxicological end-points.
- Guidance on simulation approaches and models for the specific prediction of workplace exposure to manufactured nanoparticles taking especially into account possible but representative uses, worst case scenarios, accuracy, comparability, reproducibility, repeatability and predictability of the real situation.
- Guidance on safe handling of manufactured nanoparticles and other manufactured nanoscale entities (including selection of PPE – Personal Protective Equipment).
- Guidance on containment, trapping and destruction of nanoparticles and other manufactured nanoscale entities.
- Guidance on dosimetry and exposure determination in occupational settings relevant to manufactured nanomaterials.
- Methodology to determine effectiveness of filtration media against nanomaterials (PPE and general air filtration).
- Methods to assess emissions from handling, or machining of nanomaterial containing products.
- Protocols for determining the explosivity and flammability of nano-powders (for transport, handling and storage).
- Guidance on detection and identification of nanoparticles and other nanoscale entities.
- Protocols for the characterization of manufactured nanoparticles from aerosols and from environmental sources, including sampling, sample stabilization, agglomeration, aggregation, etc.
- Guide to the management of waste and the disposal of nanomaterials.
- Nanocomposites - guidance on ageing / particle release.

The development of standard documents concerning the above mentioned topics is foreseen within the development of Mandate M461 and will involve different Technical Committees within CEN and also ISO. Financial support from the European Commission is expected in the development of the studies that will lead, in a time horizon of 3 to 6 years, to the publication of the corresponding standard documents.

The involvement of the following CEN/TCs are worth mentioning, as they are more related to health and safety issues:

- CEN/TC 137 Assessment of workplace exposure to chemical and biological agents
- CEN/TC 162 Protective clothing including hand and arm protection and lifejackets
- CEN/TC 195 Air filters for general air cleaning

2.4. ISO standards

The technical committee ISO/TC229 (Nanotechnologies) has developed several other standard documents which are not included in the CEN/TC352 programme which have been recently published (21 standards since 2008) The following two standards are relevant in the area of health and safety (apart from CEN/ISO documents presented in 2.2):

- ISO/TR 12885:2008 – "Nanotechnologies - Health and safety practices in occupational settings relevant to nanotechnologies".

The use of the information in this technical report can help companies, researchers, workers and other people to prevent adverse health and safety consequences during the production, handling, use and disposal of manufactured nanomaterials. This advice is broadly applicable across a range of nanomaterials and applications.

- ISO/TR 13121:2011 – "Nanotechnologies -- Nanomaterial risk evaluation".

This Technical Report describes a process for identifying, evaluating, addressing, making decisions about, and communicating the potential risks of developing and using manufactured nanomaterials, in order to protect the health and safety of the public, consumers, workers and the environment. It offers guidance on the information needed to make sound risk evaluations and risk management decisions, as well as how to manage in the face of incomplete or uncertain information by using reasonable assumptions and appropriate risk management practices. Further, ISO/TR 13121:2011 includes methods to update assumptions, decisions, and practices as new information becomes available, and on how to communicate information and decisions to stakeholders. This Report suggests methods that organizations can use to be transparent and accountable in how they manage nanomaterials. It describes a process of organizing, documenting, and communicating what information organizations have about nanomaterials.

Other ISO and IEC technical committees are also indirectly involved in nanotechnologies. The following standard, developed by ISO/TC146/SC2 (workplace atmospheres) is also relevant for health and safety:

- ISO/TR 27628:2007 – "Workplace atmospheres -- Ultrafine, nanoparticle and nano-structured aerosols -- Inhalation exposure characterization and assessment".

This Technical Report contains guidelines on characterizing occupational nanoaerosol exposures and represents the current state-of-the-art, with an emphasis on nanometre-diameter particles. Background information is provided on the mechanisms of nanoaerosol formation and transportation within an occupational setting and on industrial processes associated with nanoaerosol exposure. Exposure metrics appropriate to nanoaerosols are discussed, and specific methods of characterizing exposures with reference to these metrics are covered. Specific information is provided on methods for bulk aerosol characterization and single particle analysis.

There are under development 23 other standard documents in the work programme of ISO/TC229, only two of which in parallel with CEN/TC352 (see section 2.2). The following six can be more relevant in terms of health and safety:

- ISO/DTS 12901-1 – "Nanotechnologies - Occupational risk management applied to engineered nanomaterials -- Part 1: Principles and approaches".
- ISO/NP TS 12901-2 – "Nanotechnologies - Occupational risk management applied to engineered nanomaterials -- Part 2: Use of the control banding approach".
- ISO/DTR 13014 – "Nanotechnologies - Guidance on physico-chemical characterization of engineered nanoscale materials for toxicologic assessment".
- ISO/NP TR 13329 – "Nanomaterials -- Preparation of Material Safety Data Sheet (MSDS)".
- ISO/AWI TS 16195 – "Nanotechnologies - Generic requirements for reference materials for development of methods for characteristic testing, performance testing and safety testing of nanoparticle and nanofibre powders".
- ISO/NP TR 16197 – "Nanotechnologies - Guidance on toxicological screening methods for manufactured nanomaterials".

2.5. OECD publications

In 2006, OECD (Organization for Economic Co-operation and Development) decided to establish Working Party on Manufactured Nanomaterials (WPMN) as a subsidiary body of the OECD Chemicals Committee. This programme concentrates on human health and environmental safety implications of manufactured nanomaterials (although limited mainly to the chemicals sector), and aims to ensure that the approach to hazard, exposure and risk assessment is of a high, science-based, and internationally harmonised standard. This programme promotes international cooperation on the human health and environmental safety of manufactured nanomaterials, and involves the safety testing and risk assessment of manufactured nanomaterials. Since then OECD has published 29 documents under the series of Safety of Manufactured Nanomaterials. Below a list of the most relevant publications is presented. All are freely available at OECD website:

- No. 10 - ENV/JM/MONO(2009)15- "Identification, Compilation and Analysis of Guidance Information for Exposure Measurement and Exposure Mitigation: Manufactured Nanomaterials".
- No. 11 - ENV/JM/MONO(2009)16 – "Emission Assessment for Identification of Sources and Release of Airborne Manufactured Nanomaterials in the Workplace: Compilation of Existing Guidance".
- No. 12 - ENV/JM/MONO(2009)17 – "Comparison of Guidance on Selection of Skin Protective Equipment and Respirators for Use in the Workplace: Manufactured Nanomaterials and Dosimetry for the Safety Testing of Manufactured Nanomaterials".
- No. 28 - ENV/JM/MONO(2010)47 – "Compilation and Comparison of Guidelines Related to Exposure to Nanomaterials in Laboratories".

As it has been previously mentioned, a close cooperation with OECD is expected in the development of the programme of standardization of CEN/TC352.

2.6. Other Relevant Standard Documents

There are several other publications related to standard documents which are relevant for nanotechnologies, namely at national level, with special emphasis to USA, some of which serving as a basis to the development of ISO standards. It is nevertheless worth mentioning the PAS (public available specifications) and PD (public documents) published by BSI

(British Standards Institute), which have also served as a basis to the development of CEN and ISO standards. The following two documents are particularly relevant:

- PD 6699-2 "Guide to safe handling and disposal of manufactured nanomaterials".
- PD 6699-3 "Guide to assessing airborne exposure in occupational settings relevant to nanomaterials".

3. NANOTOXICOLOGY

There are at present a lot of activities and research related to the so called "nanotoxicology". In fact, products can be much more harmful at nanoscale when compared to "macro" scale, as they can penetrate in the body of humans and in all living organisms. The European Commission has recently launched several REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) Implementation Projects on Nanomaterials which are also expected to contribute in the development of test methods related to the exposure of humans and the environment to nanoparticles. This will also help to support the registration of nanomaterials within REACH system (Borges 2011).

The restrictions concerning animal testing (e.g. in testing cosmetics) has increased the importance of the development of appropriate alternative *in vitro* testing. Hartung and Sabbioni (2011) have recently published a complete survey about this topic in nanomaterial toxicology. The need for standardized tests is obvious, namely for regulatory purposes.

4. CONCLUSIONS

Standardization is an essential tool for the development of nanotechnologies. A lot still needs to be done. The European Commission is putting efforts not only in the development of research related to nanotechnologies but also to address any negative impacts on public health, safety or the environment.

The development of standards is essential for market regulation, supporting in this way industry, trade and will be useful to protect the workers, the consumers and the environment.

The European Integration and Innovation Platform «Nanofutures» has also recently identified, after a survey made with more than 50 European Technology Platforms, the importance of Standardization in promoting Safety and Sustainability of Nanotechnologies. The following short term target (up to 2015) has been suggested: "evidence based proportionate standards to support the evaluation and management of health and environmental risks", while at medium term (up to 2020) the target is the establishment of "harmonized technical and regulatory European Standards".

Standardization can be an important tool to the so-called "nano-responsible development", including integration of risk and benefit assessment in the production, marketing and use of nanotechnologies, nanomaterials and/or products incorporating nanomaterials.

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Manual therapy in chronic bursitis shoulder in workers of a productive sector of an industry in brazil

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ABSTRACT
Skeletal muscle problems are among the most serious affecting workers worldwide. The neural mobilization technique has been used in patients with musculoskeletal disturbs recuperation. Our general objective was to study the immediate effects of two techniques of manual therapy in the range of movement and pain modulation in patients with occupational chronicle bursitis. This study was characterized as experimental through clinic randomized (*randomized clinical trials*), of quantitative and descriptive approaching. The population was formed by workers of a productive sector in a factory unity in Campina Grande-Pb with shoulder chronicle bursitis. Two groups were formed with 5 participants: control (G1) were submitted to the conventional rehabilitation protocol and experimental (G2) received also a neural mobilization technique of ULTT1 in the opposite limb. The masculine sex was absolute in the sample (100%). The predominant marital state was married with 80%, followed by the single one with 20%. The age varied of 20 to 40 years, with greater percentile between 36-40 years (50%). Regarding to the weight, 40% had 71-80 kg while 60% had 1,66-1,70 m, obtaining a percentile relative to body mass index (BMI) varying between 26-30, corresponding to about 60% of the population. The intervention in G2 for movements of flexion, abduction, external and internal rotation presented, apparently, better results than the intervention in group G1. As the reduction of pain, it was verified that both protocols were efficient for immediate pain reduction, being the group G2 showed a more expressive pain reduction. The two types of intervention showed apparent improvements in range of motion of the individual with chronicle bursitis. The neural mobilization was superior to the conventional technique for reducing pain in addition to showing a trend toward better recovery of range of motion movements for the flexion, abduction, internal and external rotations.

Keywords: Chronic bursitis; health worker; Manual therapy.

1. INTRODUCTION

The musculoskeletal injuries are nowadays, the more frequent health problems related to the work in all countries, despite of the industrialization level (BRANDÃO, 2005)

The painful shoulder is the second more injured body region because of musculoskeletal disturbances, getting behind of back pains. One of the diseases that cause injuries to the worker shoulder that is exposed to repetition movements is the bursitis. Many causes can affect human being normal function, among them are limited joint movements, muscle atrophy, soft tissues shortening, increase or reduction of muscular tonus, sensitivity variation, cognitive and perception restrictions. Last years, some physiotherapists with orientation to orthopedics, mentioned other cause to limited function, that is movement restriction through nervous system, called *neural tension* or *adverse mechanics*. (NTA or MTA). In other words, the nervous system movement or flexibility deficiency can lead to symptoms from its own tissues.

Normal nervous system mechanics and physiology during body movements tested through the *slump test*, developed by Geoff Maitland, and *Neural Tension Tests*, introduced in clinical practice by Robert Elvey, permitted a greater recognition of the fact that, if the nervous system movement and flexibility is damaged, more frequently can occur dysfunction in the nervous system itself or in musculoskeletal structures that receive its innervations (SMANIOTTO & FONTEQUE, 2004)

One of the main nerves biomechanical characteristics is their capacity to move forward, isolately or together with the structures around. If the nerves are with their movement limited because of the mechanical interface, it might be produced adverse neural tension signals during the neural tension test. The main characteristics will be: movement range reduction and reproduction of various types of symptoms (BUTLER, 2003).

The neural mobilization technique has been used in patients with musculoskeletal disturbs recuperation. Ekstron and Holden (2002) used her during the rehabilitation of patients with epicondylitis, being successful. Nevertheless, according to these authors, there isn't yet any result for patients with musculoskeletal disturbs, presenting deficit in range of movement, using this technique of getting the not central nerve free for the movement.

Our general objective was to study the immediate effects of two techniques of manual therapy in the range of movement and pain modulation in patients with occupational chronicle bursitis.

2. MATERIAL AND METHODS

This study was characterized as experimental through clinic randomized (*randomized clinical trials*), of quantitative and descriptive approaching.

The population was formed by workers of a productive sector in a factory unity in Campina Grande-PB with shoulder chronicle bursitis. To compose the sample, we used the accessibility criterion, being of a non probabilistic type. Ten patients with close diagnosis of shoulder chronicle bursitis, whose diagnosis had been done through the clinical exam with help of ultrasound results that had confirmed the diagnosis and accepted to participate of the study signing a free consent term were included in this study. Those patients that presented any extra neural damage as well as chirurgic antecedents in shoulder or upper limb that could turn confuse the study variables were excluded. This way, were excluded patients with tendinitis, not central nervous damage, and by the imminent risk of manipulating the nervous system, individuals with diseases that could affect secondarily the peripheral nervous system, for example: rheumatic arthritis, systemic lupus, diabetes.
For data collection was used a universal CARCI® goniometer to measure the movement range of the following movements: Flexion, extension, abduction, external and internal rotation of the shoulder with bursitis. More over, was used the Pain Numerical Scale (PNS) for pain intensity measure. To analyze the population profile was used semi structured questionnaire with personal and anthropometrical data applied to each participant.
This research was carried out in the physiotherapy sector of a industry in a brazilian city. Arriving to the industry, the patients responded to a questionnaire, secondarily considering the previous defined criterions to the sample composition, and were included in the study.
This study had as experimental units the patients with close medical diagnosis of shoulder occupational chronicle bursitis. To a greater similarity between the groups (Control and experimental) and this way guarantee that the study wasn't intentional, the units was organized in blocks, (random experiments in block), before the treatments choose. This way, were formed 5 blocks compounded by two experimental units according to the similarity or proximity of the age. From this point, the treatments choose was done in each block. Of the two units, one received the experimental treatment, while the other received the conventional treatment. Two groups were formed with 5 participants: control (G1) and experimental (G2). The way of driving the treatment to the experimental units was a random process, where all of them were submitted to the conventional rehabilitation protocol, but, the experimental group received also a neural mobilization technique of ULTT1 in the opposite limb. The proposal of conventional treatment consisted of 5 minutes of Ultrasound (KLD Biosistemas Equipamentos Eletrônicos Ltda, Avatar III, TUS-0203) and joint mobilization through the glenohumeral joint anterior and posterior sliding techniques and glenoumeral traction (10 repetitions each technique), all of them in the damaged shoulder.
After the application of just one session, the collected data were analyzed through the simple descriptive statistic, being presented through graphics and tables. After the Shapiro-wilk test for verifying data normality, the student t test was used for comparing the average related to pain intensity, establishing in 5% ($p<0,05$) the significance level to reject the nullity hypothesis.

3. RESULTS AND DISCUSSION

Table 1 shows the sociodemographic profile of the studied population, resulting in a total of 10 workers in a fabric industry of Campina Grande, with clinical diagnosis of subachromial bursitis, detected by US. The gender wasn't inserted in table data, once the masculine sex was absolute in the sample.(100%). The predominant marital state was married with 80%, followed by the single one with 20%. The age varied of 20 to 40 years, with greater percentile between 36-40 years (50%). Regarding to the weight, 40% had 71-80 kg while 60% had 1,66-1,70 m, obtaining a percentile relative to body mass index (BMI) varying between 26-30, corresponding to about 60% of the population.

Table 01: Characterization of the sample

VARIÁBLE	FREQUÊNCY	%
Marital State		
married	8	80
single	2	20
Age		
20 – 25	2	20
26 – 30	0	0
31 – 35	3	30
36 – 40	5	50
Weight (kg)		
50 – 60	2	20
61 – 70	1	10
71 – 80	4	40
81 – 90	1	10
91 – 100	2	20
BMI		
15 – 20	2	20
21 – 25	1	10

26 – 30	6	60
31 – 35	1	10
HEIGHT (m)		
1,60 – 1,65	2	20
1,66 – 1,70	6	60
1,71 – 1,75	1	10
1,76 – 1,80	1	10

Source: Research data (2011).

The age is in concordance with literature findings, affirming that DORT incidence is greater among young workers. Many authors told that the musculoskeletal symptoms are predominant in the age group with more than thirty years. Nevertheless, regarding to gender, the research data are opposite to what was said. According to authors, . the women are more damaged, mainly the age group of 20 to 39 years. Otherwise, in the sample studied there was a prevalence of 100% in masculine gender. (WALSH et al., 2004). In this sense, the function assumed by the sample individuals can justify this result, once, according to Coury et al., (2002), the number of damages in women can be related more to the type of activity that was done than to the gender, once the women did tasks (of risks) different from the ones did by men. Other preponderant factor in the research was the fact that more then a half of the population present BMI between 26 and 30. According to the Health World Organization (WHO), this group is classified as overweight and above 30 is considered as obesity I. Authors showed that the obesity is considered a risk factor for loosing the work capacity. The overweight causes a negative impact by affecting the musculoskeletal and cardio respiratory capacity favoring the increase of morbid tax by chronicle diseases.

Table 02 shows the gains of a group for each movement, at the end of the intervention.It was observed that in G2 the movements of flexion, abduction, external and internal rotation presented , apparently, better results than the intervention in group G1. In G1, the extension and horizontal adduction were the movements that pointed out greater gains in comparison to G2.

Table 02: Percentage of gains for shoulder movements

Movement	G1 (%)	G2 (%)	G2 – G1 (%)
Flexion(0-180°)	13,44	17,11	3,67
Abduction (0-180°)	10,45	18,89	8,44
External Rotation (0-90°)	4,89	14,44	9,55
Internal Rotation (0-90°)	3,55	6,22	2,67
Extension (0-60°)	7,34	1,66	5,68
Horizontal Adduction l (0- 75°)	11,73	3,73	8

Source: Research Data, 2011.

Table 03shows the comparison of the averages of pain indexes told by the participants. These averages were compared in each group to verify if the treatment caused an effect in participants pain reduction followed by an average comparison after the protocols execution among the studied groups. It was verified that both protocols were efficient for immediate pain reduction, being the conventional protocol associated to neural mobilization the one that showed a more expressive pain reduction.

Table 03: Presentation of pain intensity averages before and after the treatment in each group studied.

G1 – Before	G1 – After	G2 - Before	G2 - After
6,2 ± 0,78	4,4 ± 0,s 96[a]	6 ± 1,05	2,8 ± 11,3[b,c]

[a]p<0,05 after the t student test application comparing the averages G1 – After and G1 – Before.
[b]p<0,05 after the t student test application comparing the averages G2 – After and G2 - Before'
[c]P<0,05 after the t student test application comparing the averages G2 – After and G1 – After
Source: Research data, 2011.

In the literature various studies point to the efficiency of neural mobilization in range of movement recuperation. The increase of flexibility, when used the neural mobilization is related to movement restoration and to the nervous system flexibility, promoting, this way, the return to normal functions. Fonteque et al. (2005), compared the nervous system mobilization with passive stretching and concluded greter efficacy of neural mobilization in range of movement gain, of the hip considering the passive stretching. In the study of Santos and Domingues (2008), was verified that the neural mobilization increased in average 22,5% the range of movement for hip flexion. According to literature findings, the present study showed range of movement gains for Flexion, abduction, internal and external rotation. Otherwise, it was

noted that the gain was lower regarding to the one reported in the literature and this fact can be associated to the pathological process chronicle characteristic in which was the participants shoulder. In the chronicle situation of a pathological event, with casual relation to occupational activities is frequent the morphological change of joint structures and the neural mobilization hasn't any effect in their decrease, its performance stays in the mechanical interface, permitting that occur an improvement of of the nerve sliding that reduces the pain and consequently increases the range of motion.
The data of this study confirm the ones of the literature, detaching the efficacy of neural mobilization as an instrument of pain reduction when compared with the conventional treatment (table 03). In a study carried out with 26 patients with ages between 21 and 72 years was used the neural mobilization and obtained significant gains in pain state. In Coppieters et al. (2003) studies with 20 patients presenting neck pain, was done a neural mobilization and obtained significant improvements. The evidences are justifiable because of the neural mobilization capacity to restore the axoplasmic flux, searching for a better vascular and oxygen intake of the involved structures, reverting the physiologic and mechanical changes coming back the function to the nervous structures, restoring the electrical conduction, avoiding the bad inference passage, closing the pain gate and improving the vascular intake. (LOPES, 2010).
It is known that many musculoskeletal disturbances in shoulder area are related to the range of motion and movements repetition, causing an overload in this joint due to the tendon stress, as well as the probable lack of oxygen. The soft tissues (muscles, tendons and nerves) respond to the mechanical stress caused by the repetition and physical overload with inflammatory signs that, in the clinic, appear as pain and possible mobility and strength limitation, damaging the function and causing incapacity (LANCMAN; SANTOS, 2008).

4. CONCLUSIONS

The two types of intervention showed apparent improvements in range of motion of the individual with chronicle bursitis. Besides these few clinical evidences, and even with these two forms of intervention reducing the pain state, the neural mobilization was superior to the conventional technique for reducing pain in addition to showing a trend toward better recovery of range of motion movements for the flexion, abduction, internal and external rotations.

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Effects of mismatched school furniture and morphological adolescent characteristics within different maturation levels on the prevalence of back pain

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ABSTRACT
Back pain in children and adolescents has increased in recent years, the school environment being a privileged environment for influencing this phenomenon. This study aims to examine the effect of mismatch between the school furniture dimensions and morphology of adolescents with different maturity levels on the prevalence of back pain. A cross-sectional study was conducted, involving 138 students of both genders, aged 12 to 15 years-old. Pain assessment of three segments of the spine was performed by "Adolescents and School Bags" questionnaire adapted for Portuguese Language. Anthropometric measurements were collected according to the standards of the International Society for the Advancement of Kinanthropometry (ISAK) and Pheasant criteria. The bone age determination was performed by the Tanner-Whitehouse III method. Finally, physical activity was evaluated by the Actigraph® GT1M accelerometer during 7 consecutive days. Data analysis was done using the multifactorial logistic regression (Backward Conditional Method) with PASW 18.0 software. The prevalence of back pain was 58%. The results showed a statistically significant association between girls and back pain (OR = 4.06; 95% CI 1.31-12.60). Adolescents with a more advanced bone age were more prone to have neck pain ($p = 0.035$) and dorsal pain ($p = 0.015$). Bigger differences between the desk and the elbow height increase the likelihood of adolescents experiencing back pain (OR = 1.39; 95% CI: 1.08-1.79), mainly for girls (OR = 2.32; 95% CI: 1.27-4.26). In contrast, the difference between the desk and the eye height showed to be protective for the back pain in girls (OR = 0.55; 95% CI: 0.35-0.87) and for the total sample (OR = 0.81 95%CI; 0.67-0.98). These results highlight the importance of studying the school environment in order to establish preventive programs for back pain in children and adolescents.

Keywords: Back pain, Adolescents, Maturity, Backpacks, School Furniture, Physical Activity

1. INTRODUCTION

Back pain is a common problem among adults and has been increasing in the youth population. A surprising number of school aged children and adolescents, reported having regular episodes of back, neck and headache pain. There are several evidences that back pain in childhood could be a possible risk factor for back pain in adulthood (Brattberg, 2004; Feldman, Shrier, Rossignol, & Abenhaim, 2001; Harreby, Neergaard, Hesselsoe, & Kjer, 1995; Hestbaek, Leboeuf-Yde, Kyvik, & Manniche, 2006; Hong & Brueggemann, 2000; Salminen, Erkintalo, Pentti, Oksanen, & Kormano, 1999).

Concern about this phenomenon is not recent. Different studies have been conducted for understanding the etiology and the risk factors of back pain. Children and adolescents are exposed to specific risk factors, different from the adults, but also, with negative effects for their musculoskeletal health. Children and adolescents spend a big part of the day at school and remain in a sitting position for long periods of time. Taking this into consideration, it is important to study the first and the largest workplace of all of us during infancy and adolescence- the school.

The research undertaken for understanding the risk factors associated with back pain, showed that age, is one of the most commonly considered factor among children and is highly correlated with low back pain (Grimmer & Williams, 2000; Salminen, 1984; Watson et al., 2002). Gender has been similarly associated with back pain, with girls reporting pain more often than boys (Balague et al., 1995; Salminen, 1984; Troussier, Davoine, de Gaudemaris, Fauconnier, & Phelip, 1994).

The findings concerning the association between backpack use and back pain have been ambiguous. Several authors have reported a positive relationship between backpack weight and back pain (Murphy, Buckle, & Stubbs, 2007; Negrini & Carabalona, 2002; Viry, Creveuil, & Marcelli, 1999; Whittfield, Legg, & Hedderley, 2001), other authors reported the opposite, the lack of association between backpack weight and back pain (Goodgold et al., 2002; Jones, Watson, Silman, Symmons, & Macfarlane, 2003; van Gent, Dols, de Rover, Hira Sing, & de Vet, 2003; Watson et al., 2003).

Vigorous physical activity levels and participation in sports, have found to be factors associated with low back pain (Grimmer & Williams, 2000), particularly when adolescents participate in competitive sports (Balague, et al., 1995; Harreby et al., 1999; Sjolie, 2004). On the other hand, physical activity, like regular walking and cycling, prevents the occurrence of low back pain in adolescents (Sjolie, 2004).

While students spend most of their time sitting during school time, it is important to take the furniture design into account for it may reflect the postures adopted by the children during class. The mismatch between anthropometric measurements and furniture design may induce fatigue and discomfort and therefore result in poor posture habits as well as neck and back pain (Parcells, Stommel, & Hubbard, 1999). Several authors found a mismatch between the dimensions of school furniture and anthropometric characteristics of schoolchildren (Parcells, et al., 1999; Saarni, Nygard, Kaukiainen, & Rimpela, 2007). Other authors have reported that desks and chairs are too high in relation with children's anthropometric characteristics (Gouvali & Boudolos, 2006; Panagiotopoulou, Christoulas, Papanckolaou, &

Mandroukas, 2004; Parcells, et al., 1999; Saarni, et al., 2007), whereas Bruynel et al. (1985) showed the opposite findings.
It is important to understand the risk factors associated with the onset of back pain in order to implement preventive actions to control/reduce the prevalence of back pain among children.
The aim of this study was to examine the effect of the backpack weight and the mismatch between the school furniture dimensions and morphology of adolescents with different maturity levels on the prevalence of back pain.

2. MATERIAL AND METHODS

2.1. Sample

A cross-sectional study was conducted, involving 138 students (72 boys and 66 girls), attending the 7th to 9th grades (aged 12 to 15 years-old). This study was carried out in two secondary schools in Oeiras, Portugal. Students participated voluntarily in the study after the informed consent of their parents.

2.2. Methods

2.2.1. Self-report questionnaire

Pain assessment of three segments of the spine was carried out by means of a self-administered questionnaire - "Adolescents and School Bags" - adapted for the Portuguese Language. The prevalence of back pain, in the last three months was determined by using a body map question where the students must indicate each region of the body where they experienced pain. The intensity of the pain was also assessed through Visual Analog Scale included in the same questionnaire.

2.2.2. Backpacks

The backpack weight was measured using a digital electronic scale. Each bag was weighed individually on the day the students carried more weight. The day was chosen considering the perception of the students and the confirmation from one of the teachers. On the day of the data collection students were asked to bring their backpacks for weighing with the books and materials they typically carried to and from school.

2.2.3. Assessment of physical activity

Physical activity was assessed using the accelerometer Actigraph® GT1M. The students wore the accelerometer in an elastic waistband on the right hip during day time, except while sleeping, bathing and during other aquatic activities. Accelerometers provide a measure of frequency, intensity and duration of movement, allowing data to be analyzed over user defined intervals (epochs). In this study, the epoch duration was set at 15 seconds. The data was analyzed according to Freedson' cutoffs (Freedson, Melanson, & Sirard, 1998). Specially written software MAHUFFE (version 1.9.0.3) was used for data analysis.
The participants were asked to wear the accelerometer during seven consecutive days and the inclusion criteria was set as: at least two weekdays and one weekend day of recording and with a minimum of 10 hours registration per day. These criteria were used according to Troiano et al. (2008).

2.2.4. School furniture

The desks and chairs dimensions were obtained by direct measurement, in classrooms of both schools by one researcher, without the presence of students. The following dimensions of classroom furniture were measured with an anthropometer (DKSH) to the nearest of 0.1 cm:

- <u>Desk height</u>: the vertical distance from the floor to the top of the front edge of the desk.
- <u>Desk clearance</u>: the vertical distance from the floor to the bottom of the front edge of the desk.
- <u>Desk depth</u>: the horizontal distance between the front edge and rear edge of the desk.
- <u>Desk width</u>: the horizontal distance between the lateral edges of the desk.
- <u>Seat height</u>: the vertical distance from the floor to the highest point on the front of the seat.
- <u>Seat depth</u>: the horizontal distance of the sitting surface from the back of the seat to the front of the seat.
- <u>Seat width</u>: the horizontal distance between the lateral edges of the seat.

2.2.5. Anthropometric and maturation measurements

Anthropometric measures, weight, height and sitting height, were collected according to the standards of the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones et al., 2006) and the remaining measures (shoulder height, eye height, elbow height, popliteal height, buttock-popliteal length, buttock-Knee length, free space for the legs and hip width) were taken by Pheasant criteria (Pheasant & Haslegrave, 2006).
BMI was calculated as weight in kilograms divided by height in squared meters.
Bone age was estimated by the TW3 method (Tanner et al., 2001) with an X-ray to the left hand-wrist using a portable X-ray equipment (Ascott model). As a maturational level indicator we used the difference between the bone age and the decimal age (BA-DA).

2.3. Statistical analysis

For the data treatment, in a first step, a descriptive analysis to determine the parameters of central tendency (mean, standard deviation and median) and frequencies (absolute and relative) was carried out. The association of risk factors and the different outcomes was carried out using the chi-square statistical techniques (for nominal variables) and t-student test (for continuous variables). When normal distribution or homogeneity of variances was not observed (through the Kolmogorov-Smirrnov and Levene tests, respectively) nonparametric Mann-Whitney technique was used.

To determine the associations among demographic, anthropometrics, maturation, physical activity and mechanical parameters with the symptoms prevalence in different body segments considered, we used unifactorial logistic regression analysis (Enter method), for each estimators of the risk factors and a multifactorial logistic regression analysis (backward conditional method), including as factors, the variables that had statistically significant associations in previous models. We calculated significance tests and confidence intervals from the maximum likelihood estimation of the coefficients and their standard errors. In each model, the polychotomous parameters were transformed into "dummy" variables in order to determine the odds ratio in relation to the reference category of each of these variables. Data was analyzed with PASW for Windows version 18.0 (SPSS Inc., an IBM Company, Chicago). For all tests, statistical significance was set at $p<0.05$.

3. RESULTS AND DISCUSSION

This study aimed at determining the effect of the backpack weight and the school furniture's dimensions mismatch of in relation to morphological characteristics of adolescents with different levels of maturity and the prevalence of musculoskeletal symptoms in the spine.

Our results showed that approximately 60% of adolescents experience back pain during at least one day in the last 3 months. The prevalence for back pain was found to increase with age, in both genders. The highest prevalence value was found for the neck and upper-back pain (37.2%), followed by low back pain (32.2%) (table 1). Girls have a higher prevalence of pain when compared to the boys, independently of the back segment considered. These results are similar to those reported by Salminen et al. (1999) although with lower values. Other studies have also revealed a higher prevalence of pain in girls (Balague, Dutoit, & Waldburger ,1988; Brattberg, 1994; Viikari-Juntura et al., 1991). Our results also showed that boys and girls experienced pain in different back segments simultaneously.

Table 1 – Prevalence of pain in the three segments of spine by gender and total sample

Location of pain	Boys n (%)	Girls n(%)	Whole sample n(%)
Neck	29 (28.4)	39 (44.8)	68 (37.2)
Dorsal	32 (31.4)	36 (41.4)	68 (37.2)
Low back	23 (22.5)	36 (42.4)	59 (32.2)
All back segments	47 (46.1)	59 (67.8)	106 (57.9)

Regarding the sample characteristics by gender (table 2), it could be seen that girls presented higher values for weight, BMI and sedentary physical activity levels, while boys showed higher values for height and light and moderate-vigorous physical activity levels. Boys mature later than girls who show earlier maturation levels. Differences in morphology and maturation were also important in the deviation regarding the furniture's dimensions, namely for the relationship between popliteal height and seat height, hips' width of the and seat width and buttock popliteal length and seat depth.

Table 2 –Descriptive statistics of demographic, anthropometrics, furniture and physical activity parameters and its association between genders

	n	**All sample** mean±sd	**n**	**Boys** mean±sd	**n**	**Girls** mean±sd	**Z(p)**
Demographics							
Decimal age (years)	113	13.5±1,0	63	13.4±1.1	50	13.5±1.0	-0.370 (0,711)
Bone Age (years)	113	13.4±1.9	63	12.8±1.7	50	14.2±1.9	-0.995 (0.320)
BA-DA (years)	113	-0.03±1.5	63	-0.6±1.4	50	0.7±1.2	**-4,379 (<0.000)**
Weight (kg)	138	50.6±10.0	73	49.9±10.8	65	51.5±9.1	-1.148 (0.251)
Height (cm)	138	159.9±8.7	73	160.5±9.4	65	159.3±7.8	-0.689 (0.491)
BMI (kg/m^2)	138	19.7±2.9	73	19.2±2.8	65	20.3±2.8	**-2.489 (0.013)**
Furniture vs anthropometry							
Desk height-sitting height (cm)	138	15.6±4.8	73	15.3±5.3	65	15.9±4.1	-0.815 (0.415)

Desk height-elbow height (cm)	138	-8.8±4.1	73	-9.1±4.1	65	-8.5±4.0	-0.375 (0.707)
Desk height-eye height (cm)	138	42.1±6.1	73	41.1±6.7	65	42.1±5.3	-0.08 (0.935)
Seat height-popliteal height (cm)	138	-0.9±2.5	73	-0.3±2.4	65	-1.5±2.6	**-2.575(0.010)**
Buttock/popliteal length-depth seat (cm)	138	5.1±3.2	73	4.6±3.1	65	5.6±3.1	**-1.967 (0.049)**
Seat width-Hip width (cm)	138	-9.3±4.5	73	-10.6±4.2	65	-7.7±4.3	**-3.539 (<0.000)**
Physical activity							
SPA(min per day)	95	597.0±73.0	51	576.1±71.2	44	621±2±68.0	**-3.034 (0.002)**
LPA(min per day)	95	205.7±41.3	51	216.5±71.2	44	193.1±33.6	**-2.814 (0.005)**
MVPA (min per day)	95	45.0±21.1	51	53.8±23.0	44	34.9±12.6	**-4.303 (<0.000)**

BA-DA= difference between bone age and decimal age, BMI = Body Mass Index; SPA= sedentary physical activity; LPA= Light physical activity; MVPA = moderate vigorous physical activity

An analysis of risk factors associated with the prevalence of pain in the spine show the role of the maturation level, the practice of physical activity, the maladjustment of school furniture, as well as the female gender. Notwithstanding this analysis having been carried out per back segment we will only present the results that were statistically significant, i.e., for upper back and all back segments together.

Figure 1 shows the furniture dimensions related to anthropometric characteristics with significant association to dorsal pain. Boys did not present any association, whereas girls had a significant association with the difference between desk height and elbow height (OR = 2.32 95% CI: 1.27-4.26) and the difference between desk height and eye height showed to be a protective factor for dorsal pain (OR= 0.55 CI95% 0.35-0.87). These results are according to the ones found by Gouvali & Boudolos, (2006), Panagiotopoulou et al. (2004), Parcells et al.(1999) and Saarni et al. (2007).

On the other hand, the difference between the desk height and the eye height were identified as a positive association with the occurrence of back pain, both for the total sample (OR = 0.81; 95% CI: 0.67-0.98) and for the female gender (OR = 0.55, 95% CI: 0.35-0.87). This association can be explained by the increased distance between task and eye height reducing the likelihood of experiencing back pain independently of the segment considered, as the trunk flexion’s angle decreases it leads adolescents to adopt proper postures.

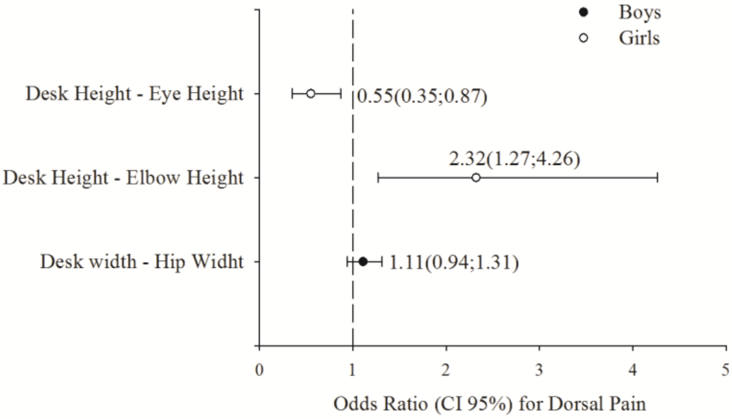

Figure 1 – Odds Ratio (and 95% Confidence Intervals) for the differences between furniture dimensions and anthropometric measurements, for both genders. Data was analysed by logistic regression and included all significant variables associated with dorsal pain.

Regarding back pain symptoms (Fig. 2), we observed that there were no significant statistical associations between low back pain for boys and physical activity levels, furniture dimensions and anthropometric characteristics. Besides the girls’ sedentary levels pattern, it should be carefully analysed due to the fact that the odds ratio was close to 1 (OR = 0.97, 95% CI: 0.94-0.99). On the other hand, as we have noted, neither the boys nor the girls performed active physical activity patterns, i.e, the practice of at least 60 minutes per day of moderate to vigorous physical activity (table 2), as established by the WHO recommendations (2010). For these reasons it is not surprising that the determinant factor was the sedentary life style.

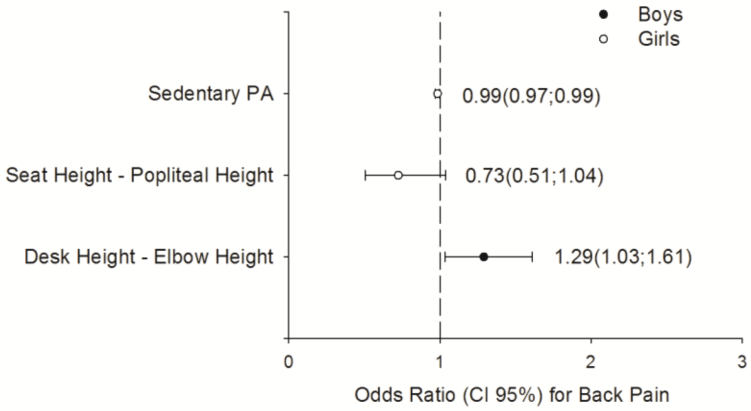

Figure 2 – Odds Ratio (and 95% Confidence Intervals) for significant variables with associated to back pain (3 segments). Data was analysed by logistic regression.

For the overall sample, the female gender showed a significant association with back pain anywhere (OR = 4.06 95% CI: 1.31-12.60). This result is supported by others studies (Balague, Dutoit, & Waldburger, 1988; Brattberg, 1994; Salminen, 1984).

The difference between desk height and elbow height showed to be significant associated with dorsal pain (OR = 1.39 95% CI: 1.08-1.79), while the difference between desk height and eye height reveals to be a protective factor for the same segment of the spine (OR = 0.81 95% CI: 0.67-0.98).

The role of backpack weight is unclear. In the current study there was no significant association between backpack weight and back pain, as reported by Jones et al. (2003), van Gent et al. (2003) and Watson et al. (2003). Nevertheless, we found that backpack weight of our students was within the safety thresholds (10-15% of body weight) proposed by Brackley & Stevenson (2004). In the future it will be important to consider backpack characteristics, time spent and how a backpack is carried to school.

BMI results were found to be within the normal values (Cole, Bellizzi, Flegal, & Dietz, 2000), therefore there was no significant association with back pain and BMI. Considering that this study sample was made up of adolescents it should be considered important to include anthropometric measures for expressing the disproportion of body segments. The late maturing adolescents tend to have greater leg lengths and shorter trunk length than the earlier ones (Malina & Bouchard, 1991). These characteristics may be related to higher mismatched school furniture than BMI and consequently increase the likelihood of experiencing back pain.

5. CONCLUSION

This study found a 58% prevalence of back pain values. Girls showed a higher prevalence than boys, 69% and 48%, respectively.

The results showed an association of back pain anywhere and the female gender. Higher differences between the desk height and elbow height increased the likelihood of adolescent’s experiencing upper back pain. On the other hand, the difference between the desk height and eye height showed to be protective for upper back pain. Adolescents with higher bone age were more prone to have neck pain

These results highlight the importance of studying the school environment in order to establish preventive programs for back pain in children and adolescents**,** not only in health terms, but also in terms of school education.

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Postural Stability Assessment during Manual Material Handling Tasks – Case Study

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ABSTRACT
Human body is a system of segments connected by joints; any voluntary motion of the body causes internal perturbation of balance. Manual handling of loads such as load lifting may increase these perturbations. In a bi-manual whole body lifting task, the grasp of a load and pick it up from the floor induces a forward shift in the position of the centre mass, challenging the dynamic balance regulation while simultaneously impending the ongoing extension movement. In order to compare the disturbance of balance both in back lifting or leg lifting of a frontal load a laboratory-based case-study was performed through the simulation of lifting tasks. A twenty-eight male worker frontally lifted a box from the floor. Two experimental conditions were applied: the participant used leg lift (straight back, bent legs) or back lift (straight legs, bent back) with combinations of two different weight materials. Through the application of the Index of Proximity to the Stability Boundary it was found that both techniques adopted for load lifting seem to equally influence postural balance control. In addition, it was concluded that manual lifting of heavier loads may jeopardize postural balance increasing the occurrence of falls.

Keywords: Lifting loads; Postural balance; Postural Stability Index; Falls; Centre of Pressure

1. INTRODUCTION

The Human trunk is the segment with largest body mass and is located two-thirds above the ground (Winter, 1995; Van der Burg, 2003). On the other hand humans are bipeds and have the ability to locomote (Winter, 1995). Due to these facts, as well as, the fact that human body is a system of segments connected by joints, any voluntary movement will initiate an internal perturbation which may cause considerable displacements of the body Center of Mass (COM) (Van der Burg, 2003). These displacements may endanger the control of whole body balance which is more pronounced as the COM reaches the limit of the base of support of the human body.

In order to maintain postural balance a control system must be continuously acting which involves voluntary or involuntary activation of muscles (Winter, 1995; Van der Burg, 2003; Pan et al., 2003).

According to Toussaint el al (1998) lifting an object from the ground involves forward bending of the trunk while reaching for the load, grasping the load, lifting the load to desired end position and, finally establishing a new static equilibrium which correspond to three distinct phases – reaching phase, grasping phase and lifting phase (Toussaint et al., 1998). In bi-manual whole body lifting, the task to perform a relatively fast voluntary movement is accompanied by the task to maintain dynamic balance in the field of gravity (Toussaint et al., 1997a). When the load is grasped in front of the body, the mass of the load is added to the lifter (Toussaint et al., 1998). Consequently the position of the COM of the system of the lifter plus load will shift forward in the grasping phase (Toussaint et al, 1997b).

The shift in the position of the COM relative to the base of support, when performing a bi-manual whole body lifting task, disturbs the equilibrium (Toussaint el al., 1998). Roberts (1995), Kollmitzer et al. (2002) and Pan et al. (2003) open this concept to the generic manual material handling tasks by stating that this tasks increase body sway which contribute to the occurrence of postural instability. In this context greater muscular force, involving more muscles and higher activation levels, are needed to counteract the shift of the COM to reach equilibrium (Kollmitzer et al., 2002; Pan et al., 2003).

The performance of a goal-directed voluntary is the result of internal forces from muscle contraction that also act on the body segments supporting the movement and disturb their position given the geometrical configuration and inertial characteristics of these segments. In a bi-manual whole body lifting, the task to perform a relatively fast voluntary movement is accompanied by the task to maintain dynamic balance in the field of gravity (Toussaint el al., 2007a).

A study was held by Toussaint et al. (2007b) in order examine the disturbance of balance both in back lifting (straight legs, bent back) or leg lifting (straight back, bent leg) of a frontal load and that lifting technique had a significant influence on the pattern of COM adjustments. These authors concluded that albeit of the lifting technique applied by the subject it seems to be crucial that COM displacement should maintain inside the base of support in order to keep postural stability. These authors also found that leg lifting of a frontal load is more unstable than back lifting of a frontal load.

Considering that ergonomic research studies point out that tasks involving frontal lifting of loads should be performed through a leg lifting technique to prevent musculoskeletal disorders, it was found to be relevant to clarify how this technique disrupts postural balance and its contribution to the occurrence of falls.

Thus, in order to compare the results obtained by Toussaint et al. (1997b) this study aims to examine the disturbance of balance both in back lifting or leg lifting of a frontal load through the application of postural stability indexes namely the Index of proximity to the stability boundary (IPSB) suggested by Bagchee et al. (1998). The index of proximity to stability boundary allows quantifying the factors responsible for postural stability. An increase in the postural stability will occur if at any particular instance the CP lies very close to the FSB.

2. MATERIALS AND METHOD

A twenty-eight healthy male worker participated in this study. The participant was informed that he was to perform a series of lifting tasks, in which an object was to be lifted. The true propose of the experiment, however, was not revealed to the participant.

The participant was required to undergo a health-history screening before joining the study, so it was clear that the participant didn't have any of the following conditions: history of dizziness, tremor, vestibular disorders, neurological disorders, cardio pulmonary disorders, diabetes, chronic back pain, chronic knee pain, chronic joint pain and any fall within the past year resulting in any injury with days away from work.

An informed-consent procedure was conducted prior to the collection of the trial data.

The complexity of motor mechanisms of postural balance maintenance process cannot be limited to a simple analysis of one variable. The search for these mechanisms needs precise and valid methods. The Index of Proximity to Stability Boundary (IPSB) is defined based on how closely the CP approaches the functional stability boundary (IPSB). This is due to the fact that postural instability increases when the centre of pressure is close to the FSB. The calculation of IPSB is based on the equation (1) (Bagchee et al., 1998). Where P represents the minimum distance between the CP trace and the FSB and Rmax is the distance between the origin and the FSB along the line joining the origin and the minimum distance point.

The ratio of P to Rmax provides the value of IPSB. When the CP reaches the FSB, the value of P approaches zero, and corresponding IPSB value becomes zero. The postural stability deteriorates as IPSB approaches zero. Thus larger IPSB values are always desirable, as they are indicative of a better postural stability (Bagchee et al., 1998).

$$IPSB = \frac{P}{Rmax} \qquad \text{Equation (1)}$$

According to Bagchee et al. (1998) the Functional stability Boundary (FSB) is the region in which a person can balance while performing a task, without the possibility of a loss of balance.

The construction of the FSB was constructed on the basis of the measured forward CP displacement during a voluntary fall in the forward direction as proposed by Bagchee at al. (1998).

The participant stood on the force platform (RSSCAN) with heels together and the toes pointing outward at a 30º angle, with the origin of the plate being at the middle of the feet. For the forward test a sheet of paper was placed between the participant and the platform. The outline of the feet was than traced on the paper, as it can be seen in Figure 1. The FSB was then determined on the basis of a forward fall through the leaning of participant's body using, as rotating axis, the ankle joint. The forward limit of the FSB was obtained when the vertical force registered in the platform suffered a rapid drop, which corresponds to Rmax. This provided the extreme point of displacement for the CP, at a distance Rmax forward from the origin, as shown in Figure 2. The FSB was then determined on the basis of this fall forward test data (Bagchee at al., 1998).

A line drawn through the Rmax parallel to the line joining the calcaneus of both feet constitutes, according to Bagchee et al. (1998), a reasonable approximation of the FSB.

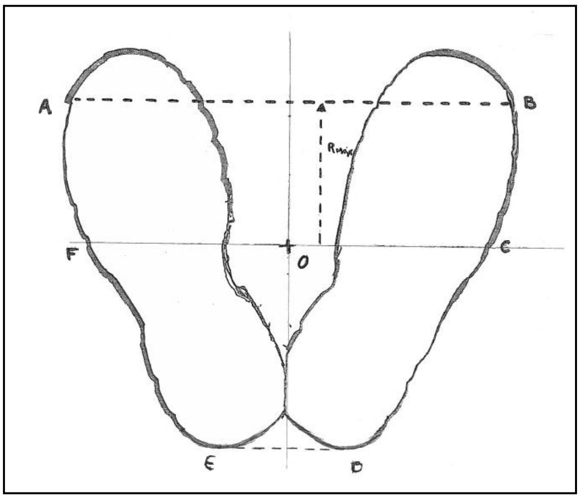

Figure 1 – Outline of the feet where A,B,C,D,E,F,A are the functional stability boundary based on the maximal forward reach (Rmax).

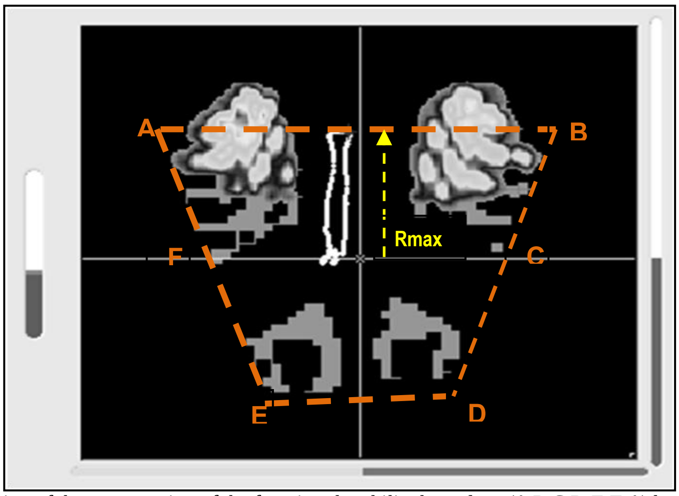

Figure 2 – Schematic representation of the construction of the functional stability boundary (A,B,C,D,E,F,A) based on the maximal forward reach (Rmax).

The participant was standing in front of a box, and at a sign from one author he flexed forward grasped the box, lifted it to return to an upright position with the box at acromion height. Two experimental conditions were applied: the participant used leg lift (straight back, bent legs) or back lift (straight legs, bent back). In each condition the participant performed three trials.

For each trial six tasks were performed by the participant:

- Back bending without object lifting;
- Leg bending without object lifting;
- Back lift of a 5 Kg box;
- Leg lift of a 5 Kg box;
- Back lift of a 15 Kg box;
- Leg lift of a 15 Kg box;

In order to avoid anticipation process and minimize the learning process by the participant, the boxes had the same shape and colour and the trials were performed randomly.

The IPSB was then calculated for each trial. To compare the effect of lifting technique in the IPSB values an ANOVA analysis was performed completed with the post Hoc test HSD Tukey.

3. RESULTS AND DISCUSSION

Higher values of IPSB indicate lesser proximity to the FSB and hence the least potential for compromising postural stability.

Results obtained for IPSB for the different trials are presented in Table 1 as well as the mean values of IPSB and standard deviation obtained for each group of trials.

Table 1 – Range of values for IPSB obtained during the diferente trials performed by the participant

	Back Lift			Leg Lift		
	No load	**5 kg load**	**15 kg load**	**No load**	**5 kg load**	**15 kg load**
Trial 1	586.21	965.51	293.10	603,45	577,59	112,07
Trial 2	500.00	433.96	245.28	537,74	339,62	198,11
Trial 3	288.29	612.61	216.22	702,70	540,54	333,33
Mean	458.17	670.69	251.53	614,63	485,92	214,50
SD	153.3	270.49	38.82	83,05	128,04	111,54

Results from univariate ANOVA on the IPSB values (Table 2) revealed the existence of significant differences between the tasks performed by the participant ($p < 0.05$)

Table 2 – Univariate ANOVA on the IPSB values

	Sum of squares	df	Mean square	F	Sig.
Between groups	516028,569	5	103205,714	4,624	0,014
Within groups	267815,259	12	22317,938		
Total	783843,827	17			

Post Hoc HSD Tukey test results revealed the existence of two homogeneous groups. Tasks involving lifting of heavier loads had significantly lower mean IPSB values than tasks involving lighter loads. These differences can be clearly observed through the analysis of the Boxplot graph shown in Figure 3.

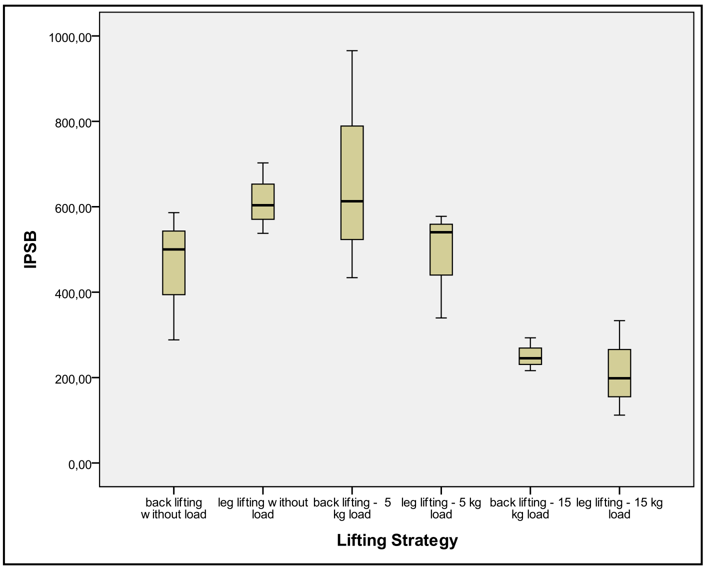

Figure 3 – Boxplot graph for the mean values of IPSB for the six trials performed by the participant

Results of Post Hoc HSD Tukey test also revealed that mean IPSB values obtained for leg lifting technique did not have significant differences from those obtained for back lifting

4. CONCLUSIONS

A comparison of the Mean IPSB values obtained for the two lifting techniques (leg lift and back lift) revealed the inexistence of significant differences. Thus it can be concluded that both techniques adopted for load lifting seem to equally influence postural balance control.

In a biomechanical point of view it can be stated that the risk of falling is not influenced by the technique adopted for load lifting, these results contradict those obtained by Toussaint et al. (1997b). However, the results obtained in this study are in accordance with the major recommendations of the Official Organizations, Occupational doctors and Ergonomists which recommend that manual lifting of loads should be performed adopting a leg lift technique (back straight and bend leg).

In addition it was detected that tasks involving lifting of heavier loads had significantly lower mean IPSB values than tasks involving lighter loads. It can be concluded that manual lifting of heavier loads may jeopardize postural balance and increase the occurrence of falls.

A few limitations ought to be considered as a result of the implemented methodology. Although they were consciously accepted, they affect the final results, thus requiring special attention in the interpretation and generalization of the results. Among these limitations one stands out: the fact of the experiment involved a case study which results reveal the behaviour of a subject. It must also be said that the present study took place in a laboratory which does not recreate, in full, the environment of a job task.

This study is now being developed involving the use of a sample of larger dimension.

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Work safety management on vertical transportation equipments in the construction industry

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ABSTRACT
This study aims is analyzing elevators and cranes used in work sites, so that work safety indicators can be developed in order to systematize the safety actions and maintenance equipments. For so, an protocol was elaborated to be applied on construction sites of the state Pernambuco/Brazil, in 2010. It was adopted as reference, the "Evaluation and Risk control Method" elaborated by Barkokébas Junior, in 2004. The inspection protocol, grounded by the safety legislation and occupational medicine, is divided into three parts: I. Documentation, II. Material as swell as personnel movement and transport; and, III. Cranes. With data collected in the sites, graphic were generated that reflect quantitative, qualitative and economic indicators. It was found the necessity to improve the equipment's documentation in the construction site, emphasizing the crane's loading plan. There was the need for attention in the elevators, in relation to the winch operator and drum bearing without cage. The cranes showed disagreements in relation to work in inclement weather, as well as lack of identification of the manufacturer on the lifting devices or technician responsible for lifting devices. This work shows, through the generated indexes, the importance of the relation between the production and the mechanical engineering sector, which are qualified professionals which permit the use of transport equipments in a construction site. It is concluded that, the integrated deeds between the mechanical engineers, civil engineers, work safety engineers and every intervening person of the sector must be intensified so that the civil construction environment can become safer, with equipments in a good shape of work and optimizing the activities performances.

Keywords: Work safety. Construction industry. Vertical transportation equipments.

1. INTRODUCTION

In Brazil, the Social Security Ministry (2011) indicates that during 2009, 723.452 work-related accidents and diseases were registered among the insured workers of the Social Security. Within these registrations, the number of work-related diseases added up to 17.693 and part of those accidents and sicknesses resulted in 623.026 workers withdraws due to the temporary incapacity (302.648 to 15 days and 320.378 with absence upper 15 days), 13.047 workers victims of permanent inability and 2.496 citizens' deaths.

According to Sinduscon/PE (2010), in 2006, the construction sector was accounted for 5,75% of the working accidents in a total of 1.003 accidents registered. The construction industry is the 7th among various sectors, thus conversion industry got the 1st position with 30,49%, followed by the commercial sector, automobile's reparation, personal and home objects with 13.1%, real state activities, rents and services rendered to companies with 7,96%, transport, storage and communication with 7,96%, agriculture, breeding livestock, forestry and forest exploration with 7,84% and health and social services with 7,09%.

The construction industry distinguish since it is a sector with nomadic character of production according to Barkokébas et al (2008) .Moreover, it poses a high workforce turnover and also a diversity in the construction types, introducing, even, a large range of activities , machines and equipments along the process.

By reason of the fact that the cranes and elevators of work are too big tools and that they move people and heavy freights in different ways, a high potential of risk for the occurrence of serious and fatal accidents is characterized, leading to a greater concern of the professionals who work in the construction industry (PORTO apud SANT'ANNA, 2007).

A preventive campaign to combat the working accidents in the Civil Construction Industry of Pernambuco visited 568 construction sites only in 2008, according to the Civil Construction Industry Union of this State – Sinduscon/PE (2010). So that, the elevators for material presented 4.23% in nonconformity, the elevators for people totalized 1.94% in nonconformity and the cranes, 0.88%. Having the main indentified problems as the lack of indicative signs of maximum capacity allowed in the elevators for material, the absence of a safety device which avoids the gate opening when the lift isn't on the ground and when it comes to the cranes, the biggest number of registers are related to the inexistence of register of specific fields for the cranes loading and unloading.

The aim of the study is analyzing elevators and cranes used in work sites, so that work safety indicators can be developed in order to systematize the safety actions and maintenance equipments.

2. THE CONSTRUCTION INDUSTRY

According to the Brazilian Institute of Geography and Statistics – IBGE (2010), in 2007, the gross investment on fixed assets, by the companies, in the sector added up to around 5,1 billion (Table 1). The purchasing of machines and equipments was the main investment and it represented 44.2% of the total invested. Hereupon, the expenses came with means of transportation, which corresponded to 23.1% of the amount invested, land and building purchases (21,3%) and other acquisitions (furniture, computers and tools), which represented 11,4% of the total.

Table 1 – Value of the acquisitions in the Construction industry regarding the tangible goods – Brazil – 2007

Tangible Goods	Value of the acquisitions in the construction industry	
	1.000.000 R$	Total Percentage (%)
Total	5.120	100,0
Machines and equipments	2.263	44,2
Means of transportation	1.181	23,1
Land and buildings	1.092	21,3
Other acquisitions	584	11,4

Source: IBGE, 2010

According to Brazilian Civil Construction Board – CBIC (2010), 2009 started under high apprehension, since the announced data during the first quarter confirmed a strong job downturn and technical recession revelation. However, Brazil presented a positive result in the 3rd quarter of 2009 (the GNP of the period revealed an expansion of 1.3% in comparison to the 2nd quarter).

The same resource declares that, for 2010, the projections indicate the growing level of 6% originating over 1.8 million job posts and an inflation within the target (4.5%).

The perspective for the sector in the next years is big because great projects are already expected or confirmed, such as My House, My Life (Minha Casa, Minha Vida), Growing Acceleration Program (Programa de Aceleração do Crescimento – PAC), the 2014 world cup and the 2016 Olympic Games in Rio de Janeiro, with some arena constructions, ports, airports and urban mobility. To that, it is necessary to invest on a construction productive chain and so it will cause impacts on the income and job generation.

3. VERTICAL EQUIPMENTS OF TRANSPORT IN THE CIVIL CONSTRUCTION

According to Barkokébas et al (2010b), the equipments of transport in the civil construction constitute indispensable elements for its product accomplishment, due to the need of its use in the vertical and horizontal distribution of material and people. Such a fact makes the efficiency of the materials and components transport, in the construction site of a multistory building, essential to reduce costs and to meet deadlines.

The vertical movement of load and passengers in work sites and work fronts, along the years, has been receiving various equipments for that purpose, such as freight elevators, personnel elevators, rack elevators, winches, traveling cranes and a variety of cranes types (ANTONIO, 2004).

According to Gehbauer (2002), some equipments such as the cranes, elevators and forklifts can be considered as “Keys” to any business because they are about to represent up to 80% of the construction activities.

Therefore, the most employed types of elevators (freight, personnel, freight and personnel/mixed and column) as well as cranes (stayed with steady and variable towers and mobile too) in the construction site will be presented as the following:

3.1. Elevators

Elevators are equipments responsible for transporting people and load transport in the construction sites of vertical buildings. They are basically composed of: basement, winch and components, cabin and the tower, where the cabin moves vertically (FARIAS FILHO, 2007).

Source: MECAN, 2010

Figure 01 – Cable traction elevator basic project

According to Farias Filho (2007), elevators have been used in vertical construction for over 50 years in Brazil, and they are ruled by the statutory standard No.18, which regulates the work conditions and environment in the construction industry. The statutory standard No.18 settles safety conditions and devices that aim to preserve the workers’ lives and limbs.

As for the type of transport, the elevators can be:

a) Personnel elevators

These are used to transport passengers. However, the simultaneous transport of people and material is prohibited. This kind of elevator might reach all the building extension from the 7th slab execution of buildings, in construction, with 8(eight) or more floors according to the statutory standard No.18 (BRASIL, 2011).

b) Grain elevators

According to the sub-item 18.14.22.1 of the standard 18 (BRASIL, 2011), in this kind of elevator the transport of passengers is not allowed. Moreover, there should be inside the grain elevator cabin a sign containing the indication of its capacity and another with the passenger transport prohibition. The control of the elevator is made out of the cabin and the job post must follow the minimum requirements of comfort, according to the statutory standard No.17 - Ergonomics.

c) Personnel and material Elevators (Mixed)

They are used to transport passengers and material, but not simultaneously. This kind of elevator must reach all the building extension from the 7th slab execution of buildings in construction, with 8 (eight) or more floors and it must have an external activation system in case of material transport need, according to the standard 18 (BRASIL, 2011).

As for the lifting system, the elevators can be:

a) Pinion-rack elevators

The rack elevators, according to Montarte Group (2011), is an equipment which uses the pinion-rack system, activated by a speedy brake motor for the cabin lifting, where the uprising occurs through the cabin sustenance on a tower made of a lattice structure (module).

This kind of elevator aims both load and passengers transport, under the condition that it can not happen simultaneously and that the maximum weigh capacity specified has to be strictly followed, according to the Technical Recommendation of Procedure 02 (RTP 02) of material and personnel movement and transport – Work Elevators of Fundacentro (2001).

Souece: Montarte, 2011

Figure 02 – Rack Elevator

Source: Montarte, 2011

Figure 03 – Engine set

Source: Montarte, 2011

Figure 04 – Pinion-Rack system

b) Cable traction

The transmission schema of the power of the cabin lifting system through cable traction is composed of an electrical engine which transmits movement to a speed reducer through either a direct or a conveyor connection, made up of an endless transmission system, worm, a drum - assembled on an axis connected to the reducer, where the steel cable is wrapped and finally, the steel cable and the pulleys.

c) Column winch or winch "velox"

The column winch is an equipment of hoisting, normally installed upon metallic cantilever beams, aiming the vertical freight transport up to 600 Kg (STAIDEL, 2011).

Source: Data bank LSHT

Figure 05 – Power transmission of the lifting system

Source: STAIDEL, 2011

Figure 06 – Column winch

3.2. Cranes

According to Rousselet & Falcão (1999), the crane is a hoist of horizontal arm, which is borne by a vertical metallic structure, called "tower", around what its rotary brace, called "boom", can spin. Borne by the boom, a little trolley (little car) runs where a "hook" is hung. At the boom edge a "bumper" is installed, to avoid the trolley fall.

According to Antônio (2004), the crane is an equipment used in a construction fro a long time by several works. Its greatest importance is promoting a faster development in the work execution, achieving, this way, a bigger productivity. The same source informs that some criteria to the cranes use are

- The available space on the construction site;
- Material size and weigh to be transported;
- Methods used in the work execution;

Following are the main types of cranes:
a) Stayed Crane with Constant tower
This kind of crane is generally placed out of the building, it must be balanced to the building body. To demonstrate, there must be space in the site in order to make the whole mast stay in the ground after the removal of the structure pieces, according to the figure 07.
b) Stayed crane with variable height of the tower
This kind of crane has its growth of the work height versus the extension growth of its vertical tower, by sequential insertions of this tower elements and it is called Telescoping.
The ones assembled in the shaft of the construction elevator have their tower with a constant extension and the growth of the work height occurs through the lifting of the whole group, from an anchorage platform on a construction paving to another one more raised. It is called ascensional and it can be seen in the Figure 08.
c) Mobile crane with Stayed tower
In this kind of crane, its entire structure moves along the track on wheels. The movement on the track is performed by an equipment, which is assembled upon a base with metallic wheels. The small "railway" must be anchored on the ground appropriately, according to figure 09.

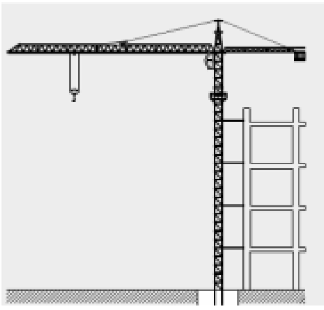
Figure 07 – Tower crane

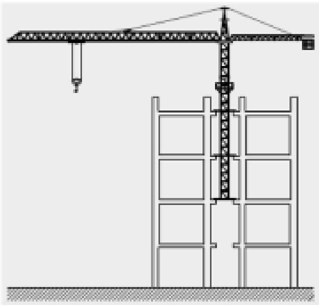
Figure 08 – Ascensional Crane

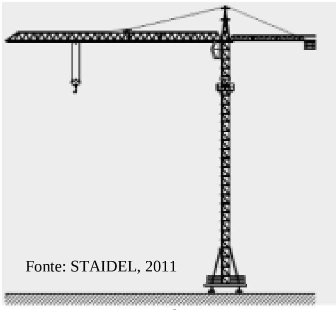

Figure 09 – Track Crane

4. MATERIALS AND METHODS
Firstly, a bibliographic and documentary proofreading through legislation and valid normalization survey such as: Statutory standards, Technical Regulation of procedure – RTP, manufacturer manuals and specific articles on the field.
In parallel, a field search was performed in three construction sites of a big company in the metropolitan region of Recife – Pernambuco/Brazil, using the "Method of assessment search and risk control in the engineering field" created by Barkokébas Junior et al. (2004).
To this, a "check-list" was made, divided in three big parts: Part I – Documentation, which comprehends the items related to the elevators documents, cranes and load projects for cranes, Part II – Movement and transport of material and people, which presents the items to be checked regarding the elevators operation and Part III – Cranes, with specific items of this equipment operation. The "check-list" was based on Brazilian Legislation of work safety and health, insomuch that 121 items were checked in each site totally and classified in: Not applied (NA), in accordance (IA), in disagreement (ID) and serious and impending risk (GIR).
NA is used when the standard is not applicable to the studied environment, IA refers the entire situation that is according to the standard, ID is every situation which conflicts with the Standards and GIR is every condition of work environment that can cause work accidents or professional diseases with serious harm to the worker's life and limb.
After a visit to the sites, a data treatment was done as well as the graphics development, which translates quantity, quality and economic index.
The quantity index presents the amount of items classified in each site, whereas the quality index presents the items which conflict and serious and impending risk qualitatively, gathered in four sections: Elevators documentation, Crane documentation, Load project of cranes and elevators. The first three ones refer to the documentation items whereas the two last ones comprehend the operation items of elevators and cranes, respectively. At last, the economic index that has, as a base, the standard No.28 – supervision and punishments, which shows the level of infraction regarding the number of workers. This index displays the fine passive of the items in conflict and serious and impending risk found in each site.

5. RESULTS AND DISCUSSIONS

Bellow, the achieved data will be presented in the field search: sample characterization, quantity index, quality index and, finally, the economic index.

5.1. Sample Characterization

The construction site A had three (3) towers and it presented the work in the structure phase, with an end prospect for September 2011 and it counted on 131 active workers. The studied equipments in this site were an ascensional crane with its setup inside the building and a freight and personnel elevator, that is, an equipment which can transport people and freight since it is not simultaneously, whose setup was performed in the shaft of the definitive elevator of the building.
The site B had 10 towers and was in the structure stage, with an end prospect for October 2011 and it counted on 250 active workers. The studied equipments were a freight elevator, a personnel elevator, installed between the two towers; and a telescoping crane localized beside the building.
The site C had eight towers. Some of them in the structure phase and others, in the finishing phase with an end prospect for February 2011 and 241 active workers in the site. The studied equipments were the column winch elevator or "winch velox"; and the mobile crane, though small and localized beside the building.

5.2. Quantity Index

Figure 10 shows the quantity index, which presents the amount of items that are not applied, that are according to the standard, in disagreement and in serious and impending risk in each site visited. We notice that site C displayed a greater number of disagreement, with an overall number of 23 (19%) in nonconformity, followed by site B with 13 nonconformities (10,8%) and two serious and impending risks (1,65%) and at last, site A with eight (8) nonconformities (6,62%) and 1 (one) serious and impending risk (0,82%).

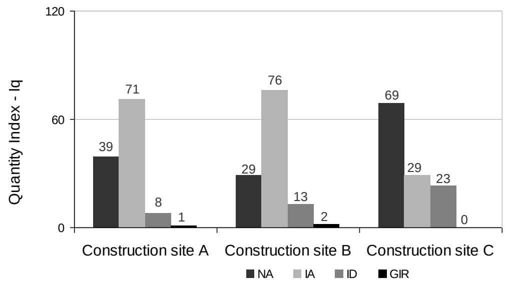

Figure 10 – Quantity index – Iqt

5.3. Quality index

Figure 11 shows the accumulated quality index of all visited works, presenting the percentage of disagreement and also of the serious and impending risk in every section studied (Elevators documentation, Cranes documentation and a Project of the load cranes, elevators and cranes), it was observed that the sectors with the greater number o items which disagrees were the ones related to the cranes – Cranes documentation (13,4%), Load crane project (40%) and the crane operation (26,7%). The only sector which presented items in serious and impending risk was related to the elevators.

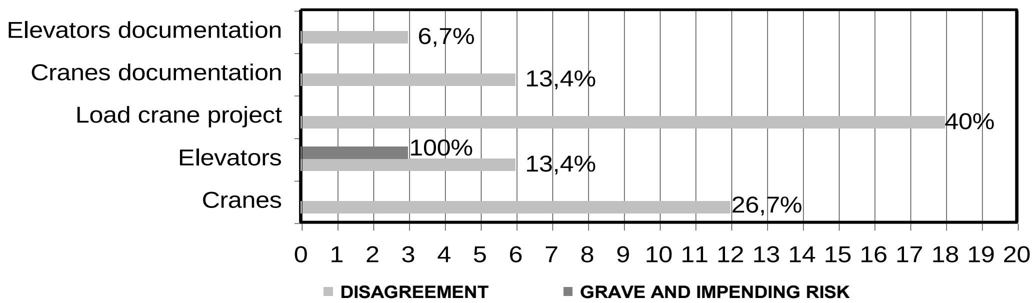

Figure 11 – Quality index – Iql

The main problems found on the elevators documentation were the ones related to the lack of course validation and experience by the professionals in charge of the elevators setup and dismantling, as well as the lack of notes on faults, irregularities and maintenance on the follow-up book register of the equipment. In the cranes documentation case, the disagreements found were related to the absence of a quotation about the load test accomplishment on the term of the technical delivery of the equipment and the lack of projects for the auxiliary devices of crane hoisting, such as boxes and dump boxes.

The load Project of the cranes was the group which presented the greatest number of disagreements related to the lack of: renting of storage areas for material, electric grid and of projection of the load range areas, with the route indications on the line drawing of where to install the crane. The lack of reflective vest used by the cranes operators and of omission of the course and practicing syllabus on their diplomas was, also, found in the construction sites visited. Regarding the elevators operation, the disagreements found were the following: operator's post with the seat ergonomically inadequate, absence of communication through the radio and shortage of signage, thus, prohibiting the workers circulation by the equipment tower. However, situations in serious and impending risk were found in this section, such as the lack of protection grating around the bearing drum of the equipment and exposure of the earthwork pole. The chief situations found which disagrees with the legislation related to the crane operation were: operator working under bad weather, boxes and dump boxes without the manufacturer and technical accountable person's identification and loading and unloading areas without signage and insulation.

5.4. Economic index

Based on the standard No.28, figure 12 presented the economic index showing that site C generated the highest passive of R$ 27.044,10, followed by site B with R$ 25.866,14 and at last, site A with R$ 14.108, 90.

Figure 12 – Economic index – Ie

6. CONCLUSION

The need for more attention to the equipments documentation in the construction sites, mainly to the load project of the cranes, was verified when the items in disagreement and serious and impending risk found on this study were analyzed. We verified that the elevators need attention regarding the winch operator post, which presented substandard conditions in the visited construction sites and the bearing drum without a protection grating too, demonstrating a high risk for the workers.

The cranes presented basically, conflicts related to the work under bad weather and the lack of a sunshade for the operators. Besides, it was verified that the hoisting device did not have a manufacturer or technical accountable person's identification.

This work shows, through the generated indexes, the importance of the relation between the production and the mechanical engineering sector, which are qualified professionals which permit the use of transport equipments in a construction site. Such equipments are considered to be essential to any vertical business.

So, an elevator, a crane with deficient maintenance and no work safety standard met can harm either a human being or the economy, due to the time lost, because of the steady equipments or accidents.

In conclusion, the integrated deeds between the mechanical engineers, civil engineers, work safety engineers and every intervening person of the sector must be intensified so that the civil construction environment can become safer, with equipments in a good shape of work and optimizing the activities performances.

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In the backstage of consumption: the risks that remain invisible in the evaluation of working conditions

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ABSTRACT
In the last few years, Portugal has been invaded by the new cathedrals of consumption: the shopping centers. Normally seen as places that combine leisure, sociability, entertainment and culture often hide situations of low salaries, precarious labour ties, strong intensification of work and atypical working schedules, which accentuate the psychosocial risks that these workers are subject to. In this sense, this study plans to identify and evaluate the main physical and psychosocial risks of the shop employees as well as the effects, less visible, of the job on their health and well-being. Therefore, the INSAT was administered at random to 48 employees of clothes shops of different labels. The results made it possible to identify the main physical and psychosocial risks of the job as well as the relation with health dimensions of NHP. In reality, the constraints and the physical and organizational characteristics have great influence on the psychological state or these workers: more than half of the employees (52,1%) complained about emotional problems and about 39,6% of problems related to sleep. These complaints seem to be related with the intensification of the job, more precisely with the atypical working schedules and the relational and organizational constraints with which these workers live with daily in their day-to-day at work.

Keywords: psychosocial risks work intensity; health and well-being.

1. INTRODUCTION

In recent years, Portugal has been invaded by the new cathedral of consumption: the shopping centers. Normally seen as places that combine leisure, sociability, entertainment and culture (Cachinho, 2000), where you can find the glamour of the grand names of fashion, beauty, youth and the health of teenagers who work in these places suggesting a satisfactory job, well-paid and with no apparent problems. However, few are the reports which reflect the true reality of the shopping center employees (Cruz, 2010). Behind the scenes of the world of glamour, some situations such as, the low salaries of the workers, precarious labor ties, intensifying work and atypical working schedules, that accentuate the psychosocial risks that these workers are exposed to, are hidden.

It is difficult to voice these problems as the embarrassment of their announcement often makes it difficult for the workers to expose them. On the one hand, we want to believe that certain aspects of the job itself, involve certain psychological characteristics, namely related to the age or gender of the workers; as such, the workers see the problems as something "inherent to the job, or even as part of the professional identity" (Sorignet, 2006, in Volkoff, 2011, pp. 120) and not something that they should expose. On the other hand, the precariousness of the job impels the worker to accept certain work conditions that they know are hazardous to their health, and prevents them from exposing certain situations due to their precarious labour ties (Volkoff, 2011), "the understanding of the working conditions and their effects is hindered in the absence of stable collective" (pp. 119) capable of denouncing as high job requirements.

2. WORK INTENSITY: THE RISKS THAT REMAIN (IN)VISIBLE

In the last few years, we have noticed job intensification due to organizing changes and the new economy requirements; these changes have increased the rhythm of the workers. Tidying the shop, folding clothes, arranging hangers, replacing merchandise, cleaning the storage-room and attending to the customers, are tasks considered to be normal functions of clothes shop employees. (Cruz, 2010).

In the commercial area, the worker is liable to be constantly interrupted by the customers while doing other tasks (such as folding clothes). These interruptions, in spite of being seen as normal of that function, establish one of the highest forms of job intensification, thus, despite being interrupted several times, at the end of the day, all the tasks have to be done. The intense cognitive load required as well as the repetitive movements are also considered aspects that contribute to the increase of work intensity (Boisard, Cartron, Gollac, & Valeyre, 2003).

In fact the intensification of the work affects its execution. Physical and organizational risks such as, doing repetitive movements, adopting painful postures, being subject to temperature variations, standing for long periods of time, working atypical schedules, having to hurry, executing various tasks at once, have consequences on the health and well-being of the workers.

The atypical schedules that the workers are subject to, constitute a physical risk, with negative repercussions on their lives at a family, physical, social and emotional level. Apart from the cardiovascular and digestive problems, they can develop fatigue and stress problems, causing alterations at an emotional and sleeping level, more precisely, anxiety, irritability and even depression disorders (Sousa et al, 2005) that, although they aren´t so visible, they have a strong impact on the individual´s health and well-being.

In fact, the psychological aspect of the work, assumes a specific importance and the psychological factors include a set of pluri-factorial dimensions such as the actual interactions with the job environment, the contents, the nature, the organization of the work, the work relations, among others (Matos-Monteiro & Barros-Duarte, C., 2010).
It seems that, if there is a tendency to relate health problems with the physical aspects of the job, associated to environmental work factors and to physical requirements developed during the activity, the aspects related to the contents and to the organization also assume a fundamental importance in the evolution and construction of health. (Barros-Duarte, Cunha, & Lacomblez, 2011).
In this sense,

> the disorders, the pain, the consumption of medication, the complaints, the difficulties, the limitations, caring for themselves, besides the diagnosis, complex or uncertain, to which these "signals" can be associated to. They indicate aspects of the state of health, sensations of well-being or not that the worker can reinforce or reduce… (Molinié & Volkoff, 2002, p.54)

Actually, the more traditional indicators, although fundamental, are not sufficient to portray the complex reality that involves the relation between health and work, masking certain difficulties of the individual that only after using other indicators (of health) can they be visible (Davezies, 2007).
The analysis of the job perspective and the use of indicators, centered on the person, as the difficulties felt at work and the analysis of the Nottingham Health Profile (NHP) makes it possible to point out other relations between health and work that, although no pathological situations have arisen, they affect the well-being of the workers and complicate their day to day life.

3. MATERIALS AND METHODS

In this sense, and in order to understand the risks that remain invisible, a report was elaborated with the aim to comprehend the non visible consequences that these work conditions cause to the workers.
The instrument used was the Health and Work Inquiry – INSAT, which is a self-completing inquiry, with a perspective centered on the person, which has as goal to analyze the conditions of the present and past jobs and their consequences on a health level and the well-being of the worker (Barros-Duarte, & Cunha, 2010). The INSAT, is composed of 7 main axes divided among the work domain and its conditions, the difficulties felt at work, the state of health and health at work. This inquiry includes the Nottingham Health Profile (NHP). The NHP is an instrument of evaluation of the quality of life, composed of 38 items based on the classification of incapacity described by the OMS, with yes/no answer format. Using an easy interpretation language, the NHP offers a simple measure of the physical, social and emotional health of the individual. The items are organized in six categories that include the level of energy (LE), pain (P), emotional reactions (ER), sleep (S), social isolation (SI) and physical mobility (PM).
The procedure used consisted on the administration of the inquiry (INSAT) in a closed envelope to a number of workers from different shops in order to ensure the confidentiality of the data. The data was coded and analyzed statistically through a SPSS version 18 program.

4. RESULTS AND DISCUSSION

The study was conducted in five shopping centres in Porto's district, with 48 employees from different stores, 12 of them were males and 36 females. We concluded that 80% of the employees were aged between 20 and 29 years, with regard to qualifications, 13% had primary educations (3rd cycle), 42% secondary education and 42% were graduated. The majority of the employees work in rotating shifts and 37.5% in mixed schedule, meaning work during day and night. The results of statistical analysis, based only on the current job of the surveyed allowed to organize data in two major groups: (i) exposure to certain work characteristics: the environment and physical constraints (table1) and the organizational and relational constraints (table2), (ii) indicators of the NHP on six health dimensions (table3).

Table 1: Environmental characteristics and physical constraints of the INSAT with values over 20%

Environment and Physical Constraints	Percentages over 20%
Heat/ Cold or Temperature Variations	28,3
Inappropriate lighting	21,7
Make gestures precise and detailed	26,1
Adopt painful postures	21,7
Long time periods standing in the same position	37,0
Long time periods standing with displacements	54,5
Going up and down very often	48,9

Table 2: Environmental characteristics and physical constraints of the INSAT with values over 20%

Organizational and Relational Constraints	Percentages over 20%
Have to depend on direct requests from costumers	41.9
Managing many things at the same time	53.3
Being frequently interrupted	34.1
Have to hurry	37.2
Dealing with situations or unexpected problems without help	49.9
Have to short a meal break or not even perform it	34.1
Have to exceed the normal working hours	39.5
Working in late shifts implying me to go to sleep after midnight	51.2
Performing pre-established tasks without controlling them	27.9

Table 3: Environmental characteristics and physical constraints of the INSAT with values above 20%

Contact with the costumers	Percentages over 20%
Deal with costumers demands or complaints	63.8
Dealing with stressful situations in relationship with costumers	60.9
Being exposed to the risk of verbal abuse from costumers	37.2
Being helpful dealing with difficulties and suffering from costumers	31.1

Of all the different dimensions measured by NHP (Table 4), we can now highlight the high frequency[1], of responses, particularly the *emotional reactions*.

Table 4. Analysis of the health dimensions of the NHP (in percentage)

Health dimensions	**At least one complaint**	**Any complaint**
Energy	20.8	79.2
Pain	29.2	70.8
Emotional reactions	**52.1**	47.9
Sleep	39.6	60.4
Social isolation	16.7	83.3
Physical mobility	35.4	64.6

In fact, the *emotional reactions* characterize a weak state of health of the psychological point of view translated by a generalized depression that seems to affect more than a half of workers in the sample (52.1%).
Besides that, *pain* (29.2%) and *physical mobility* (35.4%) complaints are referred as probably related to the characteristics and physical constraints, as confirmed by the participants, " I have to go up and down the stairs to the warehouse often, and still are plenty of stairs, which at the end of 8 hours of work cause me a lot of pain, and worse, I have to come to work in high heels"(INSAT32, Comment free, 2011).
As for sleep complaints (39.5%) they may be associated with the type of schedule practiced, that often have to extend the normal working hours which difficult managing work-life balance, affecting the sleep cycle.
In order to find some relation between work and perception of health, some connections were found between some job characteristics and values obtained in the NHP showed significant on health and welfare of the employees of the stores.

Table 5: Analysis of the connection between the NHP and the item: "In my work I am exposed to Heat/ Cold or Temperature Variations

	Chi-Square	P	Contingency coefficient	P
Pain	8.246	0.041	*0.390*	*0.041*
Energy	12.940	0.005	*0.469*	*0.005*

1 Comparing with studies conducted in France (Derriennic, Touranchet, & Volkoff, 1996; Cassou et al., 2001) with the same standards of data handling - "At least onde complaint" or "No complaint" – are shown in general, much higher.

Table 6: Analysis of the connection between the NHP and the item: "In my work I am forced to adopt painful postures"

	Chi-Square	P	Contingency coefficient	P
Physical mobility	7.300	*0.063*	---	---
Pain	11.442	*0.010*	0.446	*0.010*

Table 7: Analysis of the connection between the NHP and the item: " In my work I am forced to go up and down very often"

	Chi-Square	P	Contingency coefficiente	P
Physical mobility	11.683	0.009	0.454	0.009
Pain	15.458	0.001	0.506	0.001
Energy	7.450	0.059		

Besides the characteristics of the work related to physical constraints and physical environment that seem to interfere with the physical mobility and pain (NHP dimensions), showing a job very physically demanded, but also has consequences in terms of psychosocial dimensions in NHP (complaints about emotional disorders and energy). Furthermore, besides physical vulnerability, some organizational work components can also interfere in health and wellbeing.

Table 8: Analysis of the connection between the NHP and the item: " In my work I am forced to hurry"

	Chi-Square	P	Contingency coefficiente	p
Emotional reactions	8.200	0.042	0.400	0.042
Sleep	8.454	0.038	0.405	0.038
Energy	11.623	0.009	0.461	0.009

Table 9: Analysis of the connection between the NHP and the item: " In my work I am forced to have to deal with situations or unexpected problems without help"

	Chi-Square	P	Contingency coefficiente	p
Energy	8.633	0.035	0.405	0.035

In fact, if some significant connections can be found in work organization, more precisely in "have to hurry" and " have to deal with situations or unexpected problems without help" while analyzing psychosocial risks effects such as verbal abuse and "being helpful dealing with difficulties and suffering from costumers", significant connections found seem to indicate some consequences in health and wellbeing, also confirmed by the participants: "It is very difficult when we are alone in the store, or with a colleague, and unexpected situations arise that may seem simple and easy to resolve but actually we do not manage to solve, and we have to connect to supervisor who sometimes does not answer the phone, other times the problem can't be resolved over the telephone, so we have to have the customer come back later which sometimes causes very unpleasant situations for us "(INSAT32, Comment free, 2011)

Table 10: Analysis of the connection between the NHP and the item: " In my work I am forced to be exposed to the risk of verbal abuse from costumers"

	Chi-Square	P	Contingency coefficiente	p
Emotional reactions	12.274	0.007	0.455	0.007
Sleep	11.099	0.011	0.437	0.011
Energy	18.113	0.000	0.527	0.000

Table 11: Analysis of the connection between the NHP and the item: " In my work I am forced to be helpful dealing with difficulties and suffering from costumers"

	Chi-Square	P	Contingency coefficiente	p
Emotional reactions	12.328	0.015	0.464	0.0515

Besides the fact *emotional reactions* dimension was the most significant one (table 4), the differences found among physical, organizational and psychosocial constraints seem to justify not just the work physical demands, the content and work organization but also strong demands on the relations of work to which these workers are exposed. In fact, all these characteristics cannot be considered isolated but altogether as shown in correlations analysis and confirmed by the declarations: "Of course, only who's in my positions understands that physical exhaustion is hard, but the psychological one is harder. Physical pain is solved with a good night's sleep, psychological not. And in my case that's just what affects me the most , as well as my personal problems I have to put up with those of others, solve problems, sleep poorly, sometimes I can´t make a meal and still have to be here with a smile on my face." (INSAT32, Comment free, 2011)

Table 12: Analysis of the correlations between Job characteristics and the dimensions of the NHP

	Emotional reactions	Pain	Energy	Physical mobility	Sleep	Social isolation
Managing many things at the same time	0.321*	0.298*				
Dealing with situations or unexpected problems without help	0.298*		0.410*			0.330*
Exceed the normal working hours		0.381*		0.318*		
Exposed to situations where I have to hurry	0.319*	0.371*	0.507**			0.434*
Being helpful dealing with difficulties and suffering from costumers	0.463*					
Risk of verbal abuse from costumers	0.357*		0.556**		0.323*	

** $p \leq 0.001$; *$p \leq 0.05$

But if it was privileged some work characteristics, others - sometimes less visible - also interfere with the *emotional reactions*. Being exposed to situations of having to hurry and have to manage many things at the same time appear to significantly influence the probability that workers have problems in this health dimension, combined with the energy dimension reveal a fragile psychological state. It seems, that if there is a tendency to link health problems with the physical aspects of work, including the factors of the physical work environment and requirements developed during the physical activity of work, aspects related to is content and his organizations have also a fundamental importance in the evolution and construction of health.

This emotional discomfort evidenced by the results is still justified by those risks whose visibility is strongly influenced, not only because is manifestation requires workers to declare but also because their origins are always questioned: specifically, the risk of verbal aggression and being helpful dealing with difficulties and suffering from costumers. These are the risks that still remain dissociated in the evaluation of working conditions, and the question remains: these are effects resulting from working condition or external work factors? – and the doubt helps to keep the diagnosis in silence... And these are the risks that remain invisible in the evolution of work conditions

5. CONCLUSIONS

The results show the growing need which concerns the conditions of work and its tie to the physical, psychological and relational well-being. It is necessary to publish these risks, based on the results, which are at the moment, together with the physical requirements, contributing to the degradation of the workers` health. Considering these types of problems, which although they are not diagnosed as pathological, they influence the state of well-being. The so called infra-pathological aspects, become therefore, the only possible alternative if we want to avoid an evaluation of the working conditions that, based on what is standard and established, is unable to understand the behavior of the human being at work. The human being in the workplace can’t be seen as a machine, but as a person with feelings, fears, expectations, qualities, faults and with a family and social life. To this end, the job should have all conditions to make it easy the performance of their tasks, so they can feel good in the place of work and find a balance between personal and professional life. Therefore it is extremely important to do a job analysis taking into account all the variables related to work and then correlate them, and that's what we’ve tried to do with this study. When you do an analysis of the characteristics of work, we should make an analysis based on a comprehensive and complementary approach, that is not merely explanatory, focusing on the perspective of the worker, where we can identify their complaints, their perceptions and feelings about their work and health, so there is a recognition of the variables that remain invisible in the analysis of working conditions.

With this report we intend to establish the relation between working conditions and the impact on the personal life, having as theoretic support, the instrument – INSAT. Based on this, the INSAT can be seen as a mediator of the dialogue between the actors involved in the promotion and prevention, in the sense of an intervention in occupational health that we intend to mend (Barros-Duarte, Cunha, & Lacomblez 2011). The approach which is visible in INSAT can offer new possibilities of the reality and new opportunities of action in the working context, while conducting the inquiry, taking notes of the workers statements and establishing the priorities and the purpose given to the intervention.

This study intended to overcome the traditional risk assessments of the impact on health and safety emphasis through a personal and subjective experience, to the risks that are less visible and less referenced by the workers, specifically employees of shopping centers, because they are subjected to them on daily basis.

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Risk Assessment and Decision Support

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ABSTRACT
Typically, oil production activities contain many hazardous scenarios which could cause catastrophic disasters such as loss of asset, human fatalities or injuries and environmental pollutions. Essence of designing a safe process plant and delivering sustainable performance makes an efficient risk management plan necessary for promoting safety in hazardous industries such as oil production. Risk management activities including hazard identification and risk assessment support decision makers to manage the relevant risks and take appropriate actions to reduce the critical risks levels and contribute sustainable development.
In spite of abundant number of tools, techniques and methodologies to apply risk management, there are still some difficulties to address uncertainties associated with decision making during different phases of a project life cycle. Furthermore, in most decision making models, there isn't a clear distinguish between the key components of risk management process e.g. risk, uncertainty, hazard, and feeling threat. The aim of this paper is an attempt to present an efficient model to provide an appropriate decision making approach under the uncertain situation.
An oil field development plant is selected as a case study to apply the presented model and assess related risks and uncertainties during the basic design phase of the project in order to demonstrate the efficiency of the model. Three main categories are identified as the major causes of hazard situations in the oil field development plant which are technical causes, organizational causes, and political issues. The required considerations and appropriate actions to reduce the level of risks levels as a result of identified variables have been analyzed for the selected possible hazardous scenarios.

Keywords: risk assessment, decision making, uncertainty; process industry.

1. INTRODUCTION

Decisions made during the design phase can greatly influence the safety of the plant during the operation phase. Every decision making situation involves some degree of uncertainty and managers face with judgment regarding uncertainties. Uncertainty exists where the all possible consequences of an event are unknown, the probability of either the hazards and/or their associated consequences are uncertain, or both the consequences and the probabilities are unknown (Holton, 2004; Kaliprasad, 2006; Cleden, 2009). To move from an uncertain situation, there is a need to improve the level of knowledge about the hazard situations, their probabilities and possible impacts; this process is referred as risk assessment. The result of risk assessment is used to provide information to aid decision making on the need to introduce risk reduction measures.
The overall aims of this paper are how to address uncertainties in decision making process, and clear distinguish between the key components of risk. To fulfill the research purpose and achieve the aim of the study the researcher identified following objectives:

- Reviewing the relevant literatures including basic concepts of risk and uncertainty, risk management processes, hazard identification and risk assessment techniques, including academic journals, articles and books.
- Presenting an uncertainty decision making model to provide an appropriate decision making approach and establish an effective risk management process
- Applying the presented decision making model to risk and uncertainties associated with an Oil Field Development Project and evaluating its effectiveness

These steps enable the researcher to evaluate the effectiveness of the presented uncertainty decision making model in the real case study and find out its weaknesses and strengths.

2. RESEARCH METHODOLOGY

The research started with a general review of relevant literatures including basic concepts of risk and uncertainty, risk management processes, hazard identification and risk assessment techniques, including academic journals, articles and books. The uncertainty decision making model is presented to provide an appropriate decision making approach to support decision makers under uncertain situations. That is followed by applying the presented model to risks and uncertainties associated with an oil field development plant's case study. This enables the researcher to evaluate the effectiveness of the presented uncertainty decision making model in the real case study and find out its weaknesses and strengths.

3. THE THEORETICAL BACKGROUND

3.1. The Concept of Risk

In general, the concept of risk is defined as a combination of the probability and the consequence of an undesirable situation (Sherif, 1989; Renn, 1998; WHO, 2004; Kristensen, et. al, 2006; Aven et al., 2007; Aven, 2010).

3.2. Hazard

It is important to remember hazard is different to risk. A hazard is a situation that has the potential to cause harm, including human injury, damage to property, damage to the environment, or some combination of these (ISO 17776, 2000; AS/NZS: 4360, 2004; IEC, 2008; Sutton, 2010; Filipsson, 2011). Risk, on the other hand, is the chance that such effects will occur.

3.3. Uncertainty

Uncertainty indicates the level and quality of our knowledge about probability and consequence of an event (Willows et al., 2003).

3.4. Risk Vs Uncertainty

It is important to distinction between risk and uncertainty. *Uncertainty* exists where you don't know the all possible consequences, the possibility of subsequences are completely unknown or you don't know what the underlying distribution look like, or both consequences and probabilities are unknown (Rodger *et al.*, 1999; Kaliprasad, 2006; Sackmann, 2007; Migilinskas *et al.*, 2008). While, *risk* exits where we know the all possible consequences but we don't know which consequences will occur for sure; in addition the probability of outcomes or the underlying outcome distribution is known by decision makers (Sackmann, 2007; Migilinskas *et al.*, 2008). Figure 1 shows the relation between the level of knowledge about probability and consequence and distinction between risk and uncertainty.

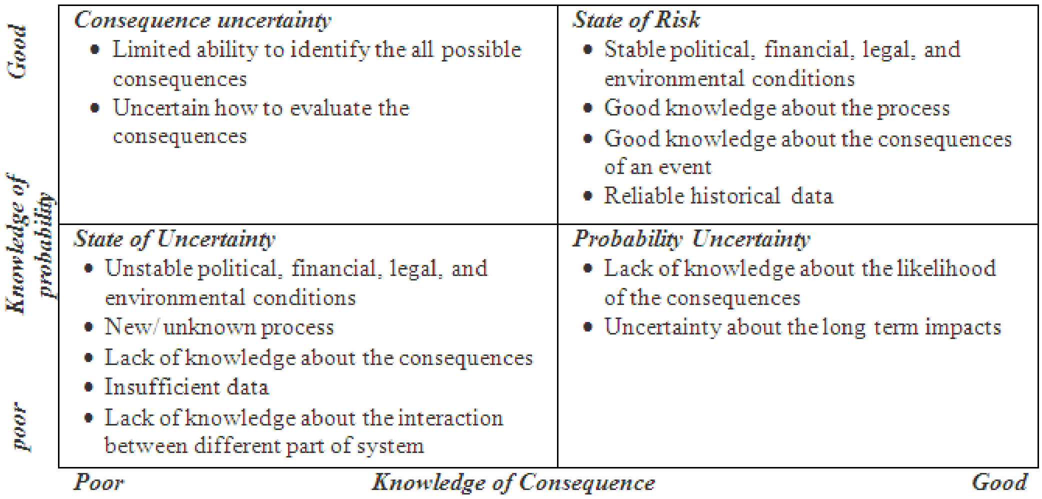

Figure 1-The relation between the level of knowledge about probability and consequence and distinction between risk and uncertainty (Adopted from Willows et al., 2003)

3.5. Risk Management Processes

There are wide ranges of literatures which are illustrated a framework for risk management process. The steps which are discussed in all of them are almost same and differences are because they are established based on different views in different industries and problem areas such as engineering, human health, and environment. According to Australian and New Zealand standard (2004), risk management process includes establishing the context, risk assessment (includes hazard identification, risk analysis, and risk evaluation), managing the risks, communication and consultation, and monitoring.

4. THE UNCERTAINTY DECISION MAKING MODEL

Figure 2 shows the decision making model under uncertain situations. Generally, there could be two different situations where one has to make a decision, either in a normal planning or in an emergency situation.

In a normal planning, decision makers set a goal to achieve the desirable outcome, for example an investment to establish a plant, or to develop a product to launch into the market. After setting the goals, all related variables which affect the defined goals should be taken into account e.g. technical, environmental, political and economical variables. It must be noted that decision maker face with variables along the project life cycle from the beginning up to the end. However, the type of variables might be changed, or new variables add to the decision making process through the project life cycle. These variables in general could cause potentials for failures (hazard situations) such as loss of capital investment, reputation, productivity, assets, human life, environmental pollution, etc. The hazard situation could in turn results in a feeling of threat and an urgency to act against an uncontrollable and uncertain situation by finding some alternatives and try to make proper decisions. Once decision makers feel threat they have to make decision and choose the best options to prevent the hazard situation. Decision makers by using their mental models analyze the received information and variables in order to identify, analyze and evaluate the alternatives. Based on the mental model the information/variables are processed in two ways, either the mental models will filter the information based on the perceptual filters or the information will change the mental models (Isenberg, 1984 in Shahriari et al. 2008). Perceptual filters are ways decision makers look at things based on expectation, assumption, and experiences. The lack of knowledge about the alternatives causes the decision makers to face an uncertain situation. To move from an uncertain situation, there is a need to improve the level of knowledge about the alternatives by quantification of uncertainties. In order to quantify the uncertainties, each alternative should be evaluated by estimating the relevant risk probabilities and consequences, calculating risk and comparing weakness and strengths of different alternatives, this process is referred as risk assessment. The result of risk assessment is feed back to the decision maker as a decision support to choose the best option among the all alternatives.

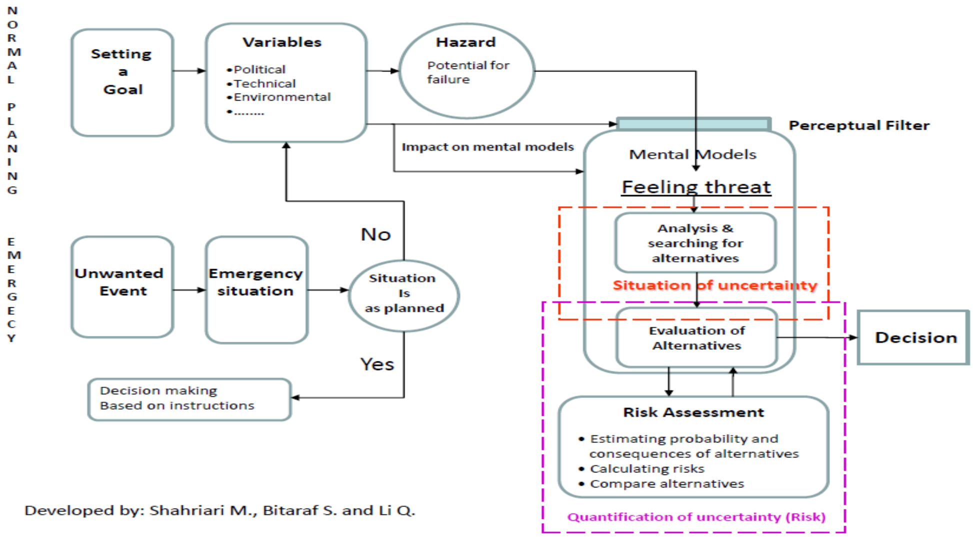

Figure 2- The Uncertainty Decision Making Model

Decision making under an emergency situation has its special characteristics which makes it different from the normal planning situation. During the emergency situation, decision makers face with an unwanted event, and they need to process large amount of data and information which are sometimes unavailable or unreliable, under time pressure. The decisions that are made in the first minutes, and hours are critical to damage control, prevention of human life and assets loss, environmental pollution, and financial costs (Kowalski-Trakofler, et al, 2001). One who is faced with an emergency situation may know what to do as it has been planned before or has no idea which action to take. Therefore, if the emergency situation is as planned, decision maker should follow the instructions e.g. evacuation instructions in the event of fire in a building. In case, there is no instruction and plan for emergency situation or the situation has turned to an unexpected state instead of being match with what has been planned, the decision will be made based on the individual experience and perceptions.

5. CASE STUDY DESCRIPTION

An oil field development plant is selected as a case study to apply the presented model and assess related risks and uncertainties during the basic design phase of the project in order to demonstrate the efficiency of the model. This case study was selected due to importance of oil field development plants after oil and gas extraction from the reservoir. Extracted fluids from wells are normally a mixture of oil, gas and water. An oilfield development plant is a unit which is constructed to apply preliminary process treatment to producing fluids from wells in order to separate major compounds and prepare them for export to the refineries.

The production hydrocarbon mixture from each well is passed through the choke valve, which reduces the flow rate and piped to a manifold via flow lines. The next facilities are 3 phase separators where separate three phases of oil, gas and water by gravity forces and density differential of compounds. Separated oil is pumped by transfer pumps to downstream facilities for producing other petroleum products afterwards. The produced water is normally piped to water testing package to separate residual oil, gas and solids prior to injection to the well for advanced oil recovery or safety releasing to the environment. The produced gas shall be dehydrated by dehydration package to reduce the water content to less than 5ppm to meet gas quality for refineries. However, gas could be transported or injected to reservoir for gas lift or used as a fuel for prime movers and power generators. The Figure 3 Shows the Block Flow Diagram of the plant.

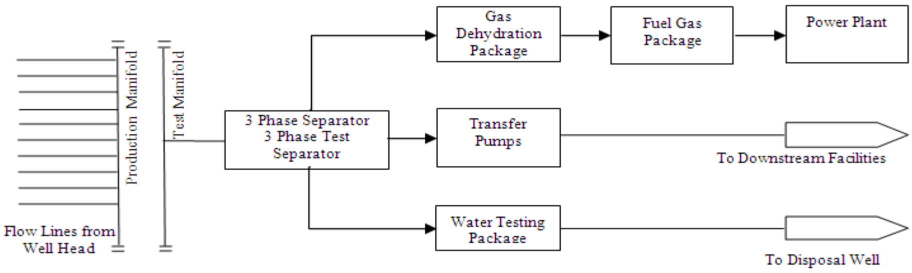

Figure 3- Block Flow Diagram of the Oil Field Development Plant

6. RESULTS AND DISCUSSION

The presented decision making model is applied in the case study to evaluate the effectiveness of the model. The main goal is to design an oil field development plant in a safe and environmental friendly manner that can be safely operated and minimize the costs of failure as well as maintenance. Therefore safety consideration shall be coupled with any decision made over the period of plant design.

6.1. The Variables

The cause and effect diagram is developed to identify all key variables which may cause hazardous scenario of fire, explosion, and toxic material release. Three major categories are identified as the major causes of hazard situation in the oilfield development plant which are technical causes, organizational causes, and political issues (see figure 4).

The historical data related to the accidents in process industry is used to identify the main causes of each defined category. There are several literatures and historical reviews and analysis about technical and organizational causes of accidents in process industry, whereas it is rare to find historical reviews and literatures about effects of political matters on safety of process industries. Therefore, for the first couple of groups, organizational and technical causes, the historical analysis of accidents in process industry is used as a source to identify the key variables which are effective on the safety of the project; and the effects of political issues on the safety of the project are identified based on the experts' judgment and experience.

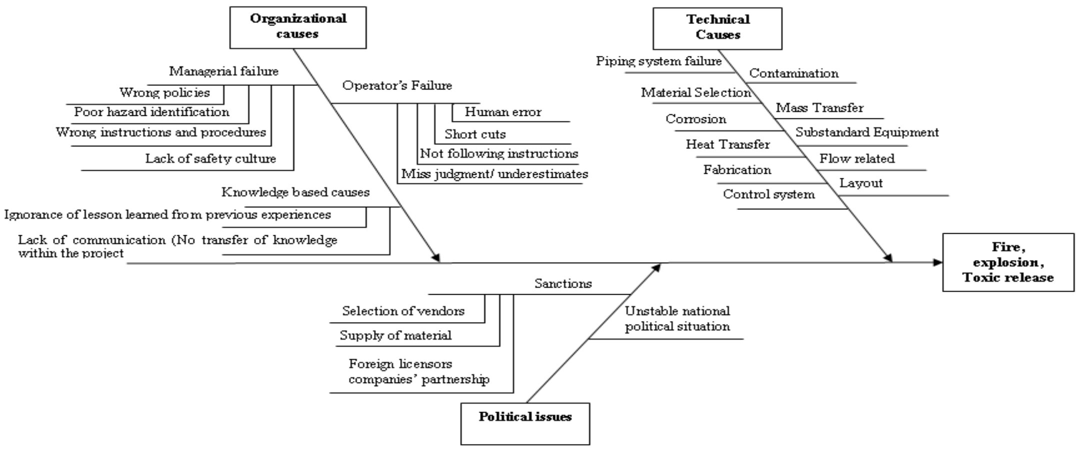

Figure 4- The cause and effect diagram of key variables which may cause hazard events

There are several historical analyses to categorize the causes of accidents in process industry. Kidam, et al, (2009) analyzed the historical data of 364 accident cases related to process industry based on the Failure Knowledge Database (Japan & Science Technology Agency). The causes of accidents are categorized into two main groups; technical and human/organizational (Figure 5). Figure 5 shows that 73% of accidents in process industry are caused by technical failures, 23% by organizational matters and 4% by unknown reasons.

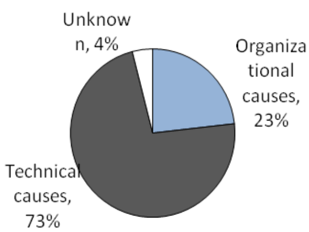

Figure 5- The general causes of accidents in process industry (adopted from Kidam, et al, 2009)

The main reasons for technical causes based on reviewing the accidents in process industry are, piping system failure, contaminations, material selection, corrosion, and heat transfer. The organizational failures are happened by poor human performance in managerial level or operator's level and also poor knowledge sharing. Moreover, main oilfields are located in unstable political areas like Middle East, Africa, and Latin America. So, this industry is very sensitive to geo-political events in hydrocarbon producing areas. Unstable political situation and sanctions affects the safety of process plants by imposing limitations on supply of required materials and facilities, selection of vendors, and avoiding foreign licensor's to be companies' joint ventures.

6.3. Hazard Identification

This hazard situation in turn results in feeling of threat to act against an uncontrollable and uncertain situation. Consequently, identification of hazards is essential at the early stage of design for assessing the safety level. Not all hazard identification methods are suitable for all phases of project life cycle. The appropriate method for each stage of project will differ in respect to the available information as well as the level of detail that decision makers need. In respect to the available information and documents at the basic design stage of the investigated case study, HAZOP study had been carried out at final stage of basic design phase to identify hazardous scenarios.

6.4. HAZOP

The purpose of HAZOP study is to review every part of process and operation to discover the deviations from the normal operation and provide the recommendations for design improvements and operating procedures. The HAZOP team review the process based on the P&IDs or equivalent, and systematically questions every part to discover the deviation which can give rise to hazards. The HAZOP procedure is described in the following paragraphs:

6.5. The Hazard Scenarios

The following hazard scenarios had been identified based on the HAZOP study results in Process Area of the plant:
Scenario 1: Fire/Explosion due to leakage of gas and crude oil as a result of damage to 1st stage separator
Scenario 2: Loss of hydrocarbon due to rupture of flow line
Scenario 3: Rupture of production tube due to High pressure on upstream of well
Scenario 4: Reduce the plant load due to less supply of gas to dehydration package
Scenario 5: Damage to export pumps due to low NPSH (Net Positive Suction Head) and as a result possible cavitations
Between the identified scenarios, the first three scenarios are chosen for further analysis and risk assessment. These scenarios are chosen between other identified scenarios due to their high likelihood or their major consequences. The first two scenarios are chosen, since their consequences are so sever once the incident happen. The consequence of the scenario 3 is pretty low, but the probability of this scenario is high.

6.6. Probability and Consequence Estimation

Once the hazard scenarios are identified based on the HAZOP study; the fault tree analysis is developed for each hazard scenario in order to estimate the probability of undesirable scenarios. The consequence analysis for each investigated scenario should be developed to estimate the impact of the hazards on health, safety, environmental, and economical consequences. In this study the qualitative consequence analysis is developed to estimate the impact of hazard scenarios. According to the estimated number in probability estimation and consequence estimation, the risk level is developed based on the semi-quantitative risk ranking matrix.
The result of risk evaluation shows risk level of scenario I & III are at unacceptable risk level, and Scenario II is acceptable but is required more investigation to reduce the level of risk to the tolerable level. The management team should develop required modification to reduce the risk level either by decreasing the probability or consequences. Furthermore, there are some uncertainties due to different variables (technical, organizational, and political) which may affect the risk level considerably. The required considerations and appropriate actions to reduce or mitigate the associated uncertainties due to the key variables are explained in the next section in detail for each hazard scenario.

6.7. Required Considerations to Reduce the Effect of Variables

There are some uncertainties due to different variables (technical, organizational, and political) which may affect the risk level considerably. The required considerations and appropriate actions to reduce or mitigate the associated uncertainties due to the key variables are explained in the following Sections:

Technical Causes

To prevent the hazard scenarios due to technical causes, the following considerations should be taken into account during the design phase:

- Following codes and standards by designers apart from limitations arisen from sanctions and economical crises;
- Appropriate design and material selection to meet technical requirements in spite of imposed sanctions and consequent cost impacts;
- Regular audit plans and inspection schedules during the operation phase to obtain sustainable safety;

- Appropriate control and safety systems implementation to detect the possible deviations from safe operation conditions;

In addition to the general aspects which are mentioned above, the following considerations should be taken into account in design of 1st stage separator to reduce the risk level of scenario 1:

- Studying the necessity of demulsifiers and corrosion inhibitors to increase separation efficiency and corrosion attack risk mitigation respectively;
- Considering mercaptans (components with sulfur contents exists in crude oil which are extremely corrosive) effect on material selection in separator as well as other equipment in process area;
- Installation of level controllers to prevent operational problems such as carry over and blow-by;
- Antifoam injection in separators to prevent mixing gas and water in their surface contacts;

The main reasons of piping system failure (Scenario II) are corrosion, poor bounding between pipe joints, sever cycling condition and over pressure, inappropriate method of fabrication, and wrong material. To prevent these failure causes, the following considerations should be paid attention during the design of a flow line:

- Injection of corrosion inhibitors to prevent different types of corrosion attacks such as H2S and CO2 corrosion.
- Special design requirements like stress analysis and very strict inspection level to avoid possible damages of the system due to over pressure and sever cycling conditions in flow line
- Appropriate welding mechanism and method of fabrication for pipes shall be utilized to prevent piping leakage at operation.
- Proper material selection for equipment, instruments and piping considering fluid nature and process parameters to assure proper functioning of facilities over design life of the plant.

Tubing as a mean of crude oil and gas transportation from subsurface to the ground level is exposed to corrosion attack, high temperature loads as well as elevated temperature. Therefore to prevent the undesirable event of production tube rupture in Scenario 3, the following design considerations should be applied by engineers during the design stage:

- Using corrosion and temperature resistant Alloy like Nickel Alloys to satisfy technical requirements;
- To calculate adequate wall thickness to withstand high pressure of fluid extracted from reservoir.

Organizational Causes

In addition to the design considerations other operational safeguards and procedures should be considered to prevent or decrease the consequences of hazards due to organizational causes. The most important procedures are as follow:

- Identifying escape routes from process area;
- Considering medical assistance equipments, ambulance and proper training for personnel;
- Providing environmental/waste management plan to protect the environment after any fire accident;
- Periodic operating inspection;
- Operational personnel shall be trained for toxic gases and specially H2S hazards.
- Develop emergency response procedure.
- The risk assessment and evaluation should be conducted from the earlier stage of the project
- Operators should have work permit and follow the instructions

Political Issues

Unstable political situation in oil producer countries and sanctions against countries like Libya, affect the safety of process plants in these countries by imposing limitations on supply of required materials and facilities, selection of vendors, and avoiding foreign licensor's to be companies' joint ventures. The effects of political issues on investigated hazard scenarios are described in the following paragraphs:

Scenario 1: Fire/ explosion due to leakage of gas and crude oil from 3 phase separator

Separators are generally made of carbon Steel and can withstand the fluid corrosion considering the fact that the injected corrosion inhibitor is effective in the separator. Additionally, since supplying carbon steel is not an issue even because of sanction, separator leakage as a result of material failure is not a risky scenario.

On the other hand, less qualified vendors cannot achieve welding, casting, forging and inspection qualities as high standard as reputable experienced vendor can which definitely increase the risk of vessel failure.

Scenario 2: Loss of Hydrocarbon due to rupture of flow line

Flow lines are generally made of carbon steel since it is not economical to use expensive alloys for relatively long distance. However, corrosion inhibitor is injected in the flow line to avoid any possible corrosion attack. Since supplying carbon steel is not an issue even because of sanction, flow line rupture due to material failure is not a risky scenario.

However, like the first scenario as a result of sanction, many qualified vendors from Western European countries and Japan do not show any intention to deal with some countries so that the choice of selection becomes very limited for these companies. This in turn leads to risky situations when potential vendors cannot meet some supplementary requirements to avoid sour corrosion risk in flow lines as follows:

- The quality of material in term of chemical composition maybe less than specified request.
- Some required tests such as HIC test and SSC test which affect the sour corrosion in pipe cannot be performed with less qualified vendors.

Scenario 3: Rupture of production tube due to High pressure on upstream of well
Tubing as a mean of crude oil and gas transportation from subsurface to the ground level is exposed to corrosion attack, high pressure loads as well as elevated temperature. Therefore, very costly CRA (Corrosion Resistant Alloy) like Nickel Alloys shall be selected to satisfy technical requirements.
Sanction against countries like Libya makes it nearly impossible for companies to purchase Nickel alloys so that they sometimes ought to shift to lower grades material such as duplex which could not offer adequate corrosion resistance. Additionally, designing a plant requires licensor technical support as well as its guarantee to end users. But unstable political situations in oil producer countries make licensors to stop their cooperation. So, designing plants without any licensor which fully aware of Know-How, increases the risk of plant failures in terms of material selection, process condition, etc.

7. CONCLUSIONS

The implementation of this model in the selected case study proves that the model has the ability to support decision makers and managers to take an appropriate action by addressing the key variables which may cause potential for failures (hazard situation). The success of this model is associated with addressing all key variables related to the defined goals or unwanted event. The process of variable identification should be performed by expert's backgrounds and knowledge along with developing a systematic method. Some methods such as, checklists, fishbone diagrams, brainstorming sessions can be applied to identify all key variables properly. On the other side, the management intention and openness to the expert's judgments and analysis is vital to consider all related variables during the decision making process.
The novel aspect of this model is that, all key components of risk management process are addressed clearly. Typically, in most decision making models, there isn't a clear distinguish between risk and hazard. But this model define the hazard and risk clearly and shows the relation between hazard, feeling of threat, and risk assessment process trough the decision making situation. Additionally, the presented model is general and could be applied to all types of decision making processes under uncertainty situation.

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Ergonomics in construction

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ABSTRACT
This study presents an ergonomic risk assessment in a set of tasks performed during various stages of construction of a house, specifically in the activities of tiling, projected plaster, masonry, formwork and opening channels for piping with an electric hammer. Research tools used were a semi-structured questionnaire, two check-lists, photos and footage, and data were further processed by Ergolândia 3.0 and SPSS 17.0 software. The methods used to characterize postural risk during the various activities were OWAS and RULA methods. It can be concluded that in general there are postural high-risk situations for workers involved in the activities studied, resulting from incorrect habits in carrying out their tasks. It was found among the range of activities assessed that projected plaster has higher action levels, mainly in tasks of lath walls and ceilings. Formwork also provides relevant risks to workers and the task of opening channels for piping with electric hammer generated a disagreement among results obtained by both methods. It was also found that the applicability of the RULA and OWAS methods, separately, in this sector has limitations, particularly with regard to the fact that on one hand the RULA method gives greater emphasis to more static and repetitive activities, directing its action mainly to upper limbs, and on the other hand the OWAS method has a more general assessment, easily identifying risk situations. The joint application of the RULA and OWAS methods to construction may overcome the limitations identified in the individual assessment of each of the methods.

Keywords: ergonomic risk, construction, musculoskeletal disorders, manual handling of loads; OWAS; RULA.

1. INTRODUCTION

Construction presents a high rate of national employment (69% in May 2011), playing a role of relative social and economic importance for the country (INE, 2011; Mesquita et al., 1997). Manpower in construction is presented by a diverse set of specialties (bricklayers, tilers, plasterers, painters, carpenters, etc.), both from rural or urban areas, subjected to different work situations (Mesquita et al., 1997; Saad et al., (2006)). The production process of a construction work is held outdoors, exposing workers to different weather effects. Work is in a large percentage done by hand, which is the reason why the worker has to perform high physical efforts (Saad et al., (2006)). In developing their activities workers adopt awkward postures, repetitive movements and handle high weight and size loads, factors that provide short or long term serious health problems, in synergy with the noise they are exposed to, resulting from the use of many machinery and equipment, such as concrete mixers, electric hammers, projected plaster machines, drills and grinders (Lima, 2004).

The organization of work in this sector is structured in order to achieve high productivity levels, optimization of production systems, lower costs, and finally an integration of the worker with his workplace and his job. All of this happens because of a certain development, without foreseeing the consequences that might result for the health of workers. So, in this sector, in order to reduce costs, expenses are often cut, when they could be used to maintain and promote the health of workers (Saad et al. (2006)).

The introduction of ergonomics as a tool for studies aimed at improving the quality of services in construction becomes a major challenge. The difficulty of applying results, given the diversity of tasks and the precariousness and improvisation found within the work environment provides a set of barriers that hinder the development of ideas and plans for achieving quality products and services (Gonçalves and Deus, 2001).

Within construction, a number of reasons add up to cause lesions in the musculoskeletal system (MSS) (Gonçalves and Deus, 2001). Thus, the goal of this study was to identify / assess the ergonomic risks associated with work postures and manual handling of loads (MHL) in a range of activities involved in the construction process and verify the applicability of the RULA and OWAS ergonomic analysis methods in this industry.

2. MATERIAL AND METHODS

From the entire set of existing construction companies in Portugal, the target population studied were the companies of the central region of the country, using the non-probability sampling technique. The type of sampling was by convenience, and it was studied 11 construction sites for a sample of 44 workers. The applied study was of Level II, of the descriptive-correlational type. As to its nature, the study was prospective. The nature of the study is characterized by the identification of ergonomic hazards to which construction workers are exposed to during the various stages of a work. In order to cover all these phases, a set of assessments were carried out in various activities, including tiling, projected plaster, masonry, formwork and opening channels for piping with electric hammer and manual handling of loads.

To collect data, a semi-structured questionnaire was used, which focused on a description of workers, including anthropometric data, age, occupation, years of experience in construction, MHL training, complaints at the musculoskeletal level, occurrence of occupational accidents (OA) and also workers' perception about the most painful activities. After the collection of data relating to workers, all relevant information was retained, using photos and footage, check-list based on the Ovako Working Analysis System (OWAS) and Rapid Upper Limb Assessment (RULA) methods. The analysis of the time period during which the worker is exposed to each posture also provides an action level as represented in table 2 (Moser et al., 2000; Pavani and Quelhas, 2006).

Table 1 – Interpretation of results by the OWAS method.

Action level	Postures	Corrective actions
1	Normal, without harmful consequences to the MSS	There is no need for corrective action
2	With some harmful consequences to the MSS	Necessary corrective actions in the long term
3	With harmful consequences to the MSS	Necessary corrective actions in the medium term
4	With very harmful consequences to the MSS	Necessary corrective actions in the long term

The RULA method has as main objective the determination of the effect caused by the inadequate postures and attitudes of workers. Through its application, it is possible to examine the combined postures of several limbs of the body determining their effect on the musculoskeletal system and evaluating the effect of time spent with a particular posture on the body. At the end of the analysis, it is indicated a hazard ratio of 1 to 7, in which higher values indicate higher levels of risk, resulting in the need of intervention to reduce occupational risks, as the following table represents (Serranheira, 2000; Junior 2006).

Table 2 – Interpretation of results by the RULA method.

Hazard ratio	Action level	Intervention
1	1	**Acceptable** (Acceptable posture, does not require intervention)
2		
3	2	**Investigation** (Proceed to investigation and changes may be required)
4		
5	3	**Investigation and quick modification** (Na investigation must be done and introduce changes)
6		
7 or +	4	**Investigation and urgent modification** (Changes should be introduced immediately)

After collection, data was used with the Ergolândia 3.0 software and SPSS 17.0 statistical software. For the results achieved with the RULA and OWAS methods various levels of risk for the same tasks were found, depending on the variety of postures adopted by workers. Taking into account the safety of workers, the results presented in these methods are those that represent the worst case scenario observed during the study.
In the design phase a set of ergonomics assessment methods were selected, however, during collection and processing of data some of the methods presented a non-applicability in the construction sector, which led to the exclusion of some of them and the selection of methods that showed better accuracy and reliability of results.

3. RESULTS AND DISCUSSION

The sample consisted of 44 male workers aged between 21 and 59 years. The average age of all respondents studied was 39 years. Regarding the professional category, the one of bricklayer was the most representative with 40,9%, followed by the plasterer with 34,1%. As for qualifications, 52,2% of respondents has stopped at the 1st cycle and primary education and only 9,1% reached high school, representing a low level of qualification which is consistent with what Xavier (2006) observes in his investigation, stating that the manpower in construction has a low level of education (Saad et al. (2006)).
For the average years of work in construction, the result achieved corresponds to 19 years, and the worker with more experience in this sector has 45 years of work.
The following table illustrates the results achieved in the correlation between the professional category, age of workers, working experience in construction and professional complaints indicated by respondents.

Table 3 – Relation between professional category, occurrence of professionals complaints, type of complaints and age of respondents.

		Are there professional complaints? (%)			Complaints listed by respondents (%)					
		No	**Yes**	**Total**	**Depending on the task**	**Spine**	**Knees**	**Hernias**	**Neck**	**Total**
Professional category	Plasterers	20,5	13,6	34,1	4,2	**16,7**	0	0	4,2	24.9
	Assistant	4,5	2,3	6,8	0	0	0	4,2	0	4,2
	Bricklayers	11,4	**29,5**	**40,9**	4,2	**50,0**	0	0	0	**54.2**
	Tilers	4,5	4,5	9,0	4,2	0	0	4,2	0	8,3
	Locksmith	0	2,3	2,3	0	4,2	0	0	0	4,2
	Contractor	2,3	2,3	4,6	0	0	4,2	0	0	4,2
	Other	2,3	0	2,3	0	0	0	0	0	0
Age	< 25	9,1	0	9,1	0	0	0	0	0	0
	25 – 34	9,1	13,6	22,7	0	**20,8**	0	4,2	0	25,0
	35 – 44	13,6	**22,7**	**36,4**	**8,3**	**29,2**	4,2	0	0	**41,7**
	45 – 54	11,4	15,9	27,3	4,2	**16,7**	0	4,2	4,2	29,2
	≥ 55	2,3	2,3	4,5	0	4,2	0	0	0	4,2
	< 5	6,8	0	6,8	0	0	0	0	0	0
Years of activity	5 – 14	6,8	15,9	22,7	0	**20,8**	0	**8,3**	0	29,2
	15 – 24	20,5	**20,5**	40.9	4,2	**33,3**	0	0	0	**37,5**
	25 – 34	9,1	15,9	25,0	8,3	**16,7**	0	0	4,2	29,2
	35 – 44	0	2,3	2,3	0	0	4,2	0	0	4,2
	≥ 45	2,3	0	2,3	0	0	0	0	0	0
	Total (%)	45,5	**54,5**	100	**12,5**	**70,8**	4,2	8,3	4,2	100

X^2 Test of independence | *p-value* < 0,05 in the relation years of activity and professional complaints

According to the results presented in the table above, 54,5% of the sample had professional complaints, of which 70,8% had complaints in the spine, either during work activity, either at the end of the workday. According to Concicovski (2010) in many work tasks carried out daily the spine is maintained in torsion (axial rotation) which becomes an important etiological factor of low back pain and degenerative disks (Concicovski, 2010). This statement is consistent with the complaints of workers who consider the area of the spine as the most affected during their activities. It should be noted that there were several isolated complaints according to the specific requirement of the task with a percentage of 12,5% and the existence of hernias in some workers 8,3%. The bricklayer work was the one with the largest number of complaints when compared with the other professional categories with 29,5%, of which 50% was at the level of the spine. It was observed that, depending on the age of the workers, musculoskeletal complaints were more predominant among the age range of 33-44 years with 22,7%, followed by the age range of 45-54 (27,3%) and 25-34 (25,0%) years. It was verified that, regarding the years of activity in construction, professional complaints occurred more frequently in the range of 15-24 years with a percentage of 20,5% and in considerable numbers between 5-14 and 25-34 with 15,9% for both intervals of years of activity. At the level of the spine, complaints were more frequent among the 15-24 years of service in construction (33,3%), and the presence of hernias occurred in the range of years of activity in construction of 5-14 years with 8,3%.

From the results obtained in the relation established between MHL training and OA, it can be seen that 52,3% of 44 respondents received no training in MHL and 47,7% received such training. Of those who had no training 43,2% never had a OA and 9,1% was an OA victim. Among workers with training 36,4% never had OA and 11,4% did. The workers who had no training were those who suffered fewer accidents, but there are no statistically significant differences of the influence of training in the occurrence/absence of accidents (p-value> 0,05).

Table 5 - Statistical results obtained in the relation between professional complaints / MHL training

			Training on MHL		Total
			No	**Yes**	
Professional complaints	**No**	Workers involved	10	10	20
		% Professional complaints	50,0%	50,0%	100,0%
		% Total	**22,7%**	**22,7%**	45,5%
		Ra	-0,3	0,3	
	Yes	Workers involved	13	11	24
		% Professional complaints	54,2%	45,8%	100,0%
		% Total	**29,5%**	**25,0%**	54,5%
		Ra	0,3	-0,3	
	Total	Workers involved	**23**	**21**	44
		% Professional complaints	52,3%	47,7%	100,0%
		% Total	52,3%	47,7%	100,0%

X^2 Test of independence

By analyzing Table 5, in respect of professional complaints 22,7% of the 23 workers who had no training on MHL did not complain and 29,5% claim to have musculoskeletal disorders. Of the 21 respondents who had training in MHL, 22,7% did not have professional complaints in contrast to 25%. Workers who received training have fewer incidences of diseases. Statistical differences are also not significant (p-value> 0,05).
The following tables describe the results of the assessment done according to the two established methodologies, followed by a brief discussion: OWAS and RULA.

Table 6 - Results of the assessment of the activity of projected plaster.

Activity / Task	OWAS					RULA	
	Back	**Arms**	**Legs**	**Load**	**Action level**	**Points**	**Action level**
MHL of mortar bags							
▪ Lift the bag	2	1	4	3	3	5	3
▪ Carry the bag	4	2	7	3	**4**	5	3
▪ Lower the bag	4	1	2	3	3	5	3
▪ Pour the bag	2	1	2	2	2	5	3
Project							
▪ Next to the pavement	2	1	7	1	2	4	2
▪ In an intermediate position	1	1	7	1	1	3	**2**
▪ In a higher position	2	3	7	1	2	3	2
Lath walls							
▪ Next to the pavement	2	1	4	1	3	6	3
▪ In an intermediate position	2	3	4	1	3	4	2
▪ In a higher position	4	3	4	1	**4**	4	2
▪ Scrape the pavement	4	1	4	1	**4**	4	2
Lath ceilings							
▪ In a low zone	2	3	6	1	**4**	4	2
▪ In a intermediate zone	4	3	4	1	**4**	4	2
▪ In a high zone	4	3	3	1	3	4	2

As it can be observed in the table above for the MHL of mortar bags, carrying the bag stood out as the most harmful task with an action level of 4 in the OWAS method and level 3 in the RULA. For all other tasks listed on the MHL of mortar bags the action level reached was 3 for both methods, except for the task of pouring the bag in the OWAS method that obtained an action level 2. The differences in results obtained by both methods are primarily based on the tasks of carrying and pouring the bag, due to the fact that the RULA method gives more relevance to more static and repetitive situations, while the OWAS method allows an analysis of the whole body therefore having a more general assessment in these situations (Vergara and Batiz, 2001).
In the project activity the task that presented a higher level was the projection next to the pavement and at a higher level, with an action level 2 for both methods, resulting from the combination of postures with an inclination of the spine and neck.
In the activity of lathing walls and ceilings the action levels reached are discordant in both methods. In this activity the levels of in action in the OWAS method are higher compared to RULA, standing out the tasks of lathing in a higher position, scrape the pavement, lath ceilings in low and intermediate zones with action level 4 to the OWAS method and action levels 2 for the RULA. The results verified in the OWAS method conveyed the degree of risk

present in this activity and the immediate need for postural corrections, but in the RULA method the results were unexpectedly low even though referring to an activity of high physical effort for the upper limbs. The lack of a more concrete evaluation parameter for the lower limbs and the fact that the task is very mobile and little static may have influenced these results. As stated by Pavani (2006), the OWAS method adapts to virtually all occupations which somehow does not happen in RULA, which assessment is essentially limited to the upper limbs in more static activities (Vergara and Batiz, 2001; Pavani and Quelhas , 2006).

Table 7 - Results of the assessment of the activity of formwork.

Activity / Task	OWAS					RULA	
	Back	Arms	Legs	Load	Action level	Points	Action level
Modern formwork							
▪ Lift the piece	2	3	6	2	2	5	**3**
▪ Carry the piece	3	3	7	2	2	5	**3**
▪ Apply the piece	2	2	2	2	2	6	**3**
Traditional formwork							
▪ Lift the piece	4	3	6	1	**4**	5	3
▪ Carry the piece	2	1	7	1	2	3	2
▪ Apply the piece	2	2	2	1	2	4	2
▪ Apply spacers	2	2	2	1	2	5	**3**

Analyzing table 7, the values achieved in modern formwork present an action level 2 in the OWAS method for all tasks, and action level 3 for the same tasks in RULA method. In traditional formwork stands out the value that was reached by the OWAS method for lifting the piece, with an action level of 4 compared to the action level 3 according to the RULA method. As for the application of spacers, differences in results were also verified, with the method RULA presenting a superior result (action level 3) compared to OWAS (action level 2). The remaining tasks, of transport and application of formwork piece, had an action level 2 for both methods.
The differences in the modern formwork in both methods, where the RULA method presents higher values, result essentially of the fact that in this activity, except for the transport of the pieces, the tasks of lifting and application of formwork parts are carried out in a more static way, requiring only the use of the upper limbs and twist / inclination of the spine and neck, aspects in which the RULA method achieves a better applicability than OWAS (Quelhas and Pavani, 2006).

Table 8 - Results of the assessment of the activity of tiling.

Activity / Task	OWAS					RULA	
	Back	Arms	Legs	Load	Action level	Points	Action level
Application of marble stone							
▪ Spread the glue	2	1	6	1	2	4	2
▪ Lift the stone	2	1	3	3	3	7	**4**
▪ Carry the stone	2	1	7	3	3	4	2
▪ Lower the stone	2	1	2	3	3	7	**4**
▪ Apply glue on the stone	2	1	2	1	2	4	2
▪ Apply the stone	2	1	4	3	3	7	**4**
▪ Hammer carefully	3	1	2	1	2	4	2
Tiling (+1,5 m)							
▪ Search the glue	2	1	2	1	2	4	2
▪ Spread the glue	2	2	2	1	2	6	**3**
▪ Lift the ceramic tile	2	1	2	1	2	4	2
▪ Apply the ceramic tile	4	3	3	1	**3**	6	3
▪ Hammer carefully	2	3	2	1	2	3	**2**
Tiling (-1,5 m)							
▪ Search the glue	1	1	5	1	1	4	2
▪ Spread the glue	1	1	5	1	1	4	2
▪ Lift the ceramic tile	2	1	2	1	2	4	2
▪ Apply the ceramic tile	2	1	5	1	**3**	4	2
▪ Hammer carefully	2	1	5	1	**3**	4	2
Application of mosaic							
▪ Search the glue	2	1	6	1	2	4	2
▪ Spread the glue	2	1	6	1	2	4	2
▪ Lift the ceramic tile	2	1	4	1	**3**	4	2
▪ Apply the ceramic tile	2	1	6	1	**3**	4	2
▪ Hammer carefully	2	1	6	1	**3**	4	2

According to Table 8, for the application of marble stone were verified high action levels for both OWAS and RULAS methods, with levels 3 in the OWAS method and levels 4 in the RULA method, for the tasks of raising and lowering the stone. In the transportation of the stone the action level in the OWAS method (level 3) was higher than the RULA method (level 2). In the application of tiles in a height superior to 1,5 m, the task of spreading the glue, the RULA method had an action level 3 and the OWAS method had an action level 2, and in the application of the ceramic tile both methods showed an action level 3. With regard to the application of tiles in a height inferior to 1,5 m, the tasks of applying the ceramic tile and hammer carefully had an action level 3 for the OWAS method and an action level 2 for RULA. As for the application of mosaic stand out the results of the OWAS method for lifting and applying the piece, and the task of hammering carefully for which it was verified an action level 3 compared to the RULA method that had an action level 2 for the same tasks. In tasks of seeking and spreading glue, the values achieved were the same for both methods, with action levels 2.

Comparing the results obtained in the tiling activity, for the OWAS method most of the action levels 3 are justified mainly by the combination of awkward postures of the back, legs and arms that were verified “in loco” (Moser et al. (2000)). The categories of action 2 achieved result from the combination of twisting the back with the legs upright. In the RULA method the action level 4 values obtained are consistent with the tasks considered most problematic by the OWAS method, and the justification in the face of a higher action level is mainly due to the importance that the RULA method addresses to the upper limbs and cervical region which suffered a strong physical demand during this activity (Vergara and Batiz, 2001). Note that in the transport of stone, the RULA method action level reached is 2, which somehow confirms that this method with regard to more mobile tasks, especially MHL, is not as effective, and has more prominence especially on static and repetitive postures (Serranheira and Uva, 2000).

As for the applying of tiles in upper zones it was verified that the postural risk adopted during the application of the ceramic piece, according to the OWAS method, requires corrective action in the medium term given the action level 3 reached. The remaining tasks – searching and spreading glue, lifting the tile and hammering carefully – obtained an action level 2 which results in the need for corrective action in the long term. The results obtained in the RULA method differ only in the task of spreading glue with an action level 3 against the action level 2 achieved in the OWAS method for the same task. In the worst case scenario occurred, the worker supported his body on one foot, so he could apply the piece. In view of these observations, it is justified the action level 3 reached in OWAS method, given the combination of lower limbs supported on one foot, back bent / twisted and one arm above shoulder level. The remaining action level 2 values achieved are mainly due to the execution of the task with upright legs, inclined back and upper limbs oscillating between a height above and below shoulder level. The difference observed between the methods for the task of spreading the glue reveals the greatest importance that RULA method establishes for upper limbs (Vergara and Batiz, 2001).

In applying tile to lower levels, workers posture oscillated between kneeling on the ground or legs bent with arms always below shoulder level and back a little twisted. In OWAS method categories of risk 3 are mainly due to extended posture of the lower limbs (legs bent), which combined with the back twisted originated these results. The remaining tasks did not present a considerable level of risk; however it stands out the low risks reported for the task of fetching and spreading the glue. In RULA method all tasks present an action level 2, not giving as much importance to the lower limbs as noted in OWAS method. In OWAS method concerning the application of mosaic, results show three categories of action in need of short-term measures, particularly by combining the posture of legs and back (legs bent and twisted back) (Moser et al. (2000)). In RULA method all the results are based in an action level 2, which again gives the impression that this method somehow neglects lower limbs.

Table 9 - Results of the assessment of the activity of opening channels for piping.

Activity / Task	**OWAS**					**RULA**	
	Back	**Arms**	**Legs**	**Load**	**Action level**	**Points**	**Action level**
Opening channels for piping with an electric hammer	4	2	4	1	**4**	4	2

At the opening of channels for piping, as the table above indicates, there is a big difference in the action levels obtained, where the method OWAS value 4 stands out, given the action level 2 reached in RULA method. The differences between the methods can be justified by the relative importance that OWAS method gives to back and lower limbs, establishing a high risk level for these factors. The RULA method does not allow an assessment as specific the OWAS which explains the lower values. Pavani (2006) states that OWAS method is of general use type, while RULA method assesses the situation in general with greater emphasis on the upper limbs (Pavani and Quelhas, 2006).

Table 10 - Results of the assessment of the activity of masonry.

Activity / Task	OWAS					RULA	
	Back	Arms	Legs	Load	Action level	Points	Action level
Masonry (+ 1,5 m)							
▪ Search brick	2	1	4	1	**3**	3	2
▪ Search cement	4	1	2	1	2	5	**3**
▪ Apply cement	4	3	2	1	2	5	**3**
▪ Reach brick	2	1	2	1	2	2	2
▪ Apply brick	1	2	2	1	1	5	**3**
▪ Hit with shovel	1	2	2	1	1	3	**2**
▪ Remove excess of cement	1	2	2	1	1	5	**3**
▪ Check plumb line	1	3	2	1	1	3	**2**
Masonry (- 1,5 m)							
▪ Search brick	2	1	2	1	2	3	2
▪ Search cement	4	1	2	1	2	3	2
▪ Apply cement	4	1	2	1	2	3	2
▪ Reach brick	2	1	2	1	2	3	2
▪ Apply brick	1	2	2	1	1	3	**2**
▪ Hit with shovel	2	1	2	1	2	3	2
▪ Remove excess of cement	2	1	2	1	2	3	2
▪ Check plumb line	2	1	2	1	2	3	2

According to the results in checked in table 10, for the activity of masonry in a position higher than 1,5 meters, it was reached, as the higher action level, the level 3 for the task of fetching bricks in OWAS method and action level 2 for the tasks of seeking cement, applying bricks and reach brick. In the RULA method, it was verified action levels 2 for the tasks of fetching and picking up brick, hitting with the shovel and checking plumb line and action levels 3 for the remaining tasks. For masonry in a height inferior to 1,5 m, in both methods the values achieved were similar for all tasks, with a action level 2, differing only in the task of applying brick, where it was reached a minimum level for OWAS method and an action level 2 for the RULA.

In general one can observe that in applying the RULA method higher values were reached comparing with the OWAS method activity in masonry, supporting the idea that for more static and repetitive activities its implementation is more accurate (Junior, 2006).

Table 11 - Results of the assessment of the activity of MHL.

Activity / Task	OWAS					RULA	
	Back	Arms	Legs	Load	Action level	Points	Action level
MHL superior to 20 kg							
▪ Raise the load	2	1	4	3	3	7	**4**
▪ Stabilize the load	1	1	2	3	1	4	2
▪ Carrying the load	4	1	7	3	**4**	5	3
▪ Lower/land the load	2	1	4	3	3	7	**4**
MHL inferior to 20 kg							
▪ Raise the load	2	1	4	2	3	6	3
▪ Carrying the load	4	1	7	2	**3**	3	2
▪ Lower/land the load	4	3	4	2	3	6	3

As shown in Table 11, the activity of MHL of more than 20 kg, it was found differences in action levels obtained in both methods, from which stand out an action level 4 in OWAS method for transportation of cargo, and two action levels 4 in RULA method for raising and lowering the load. In loads inferior to 20kg, the results are identical, the only differences being for the transport of loads, with an action level 3 in the OWAS method and an action level 2 in the RULA method. According to Concicovski (2010), when raising a load forces are transmitted to the spine and the discs are subjected to different pressures. If the trunk is flexed to pressure on the discs is irregular and may cause injury to the spine (Concicovski, 2010). This justification confirms the majority of results obtained in tasks of lifting loads, resulting in levels of risk mostly high and in need of immediate changes.

4. CONCLUSIONS

Because of the results achieved it was verified that the isolate application of one of the RULA and OWAS methods is not fully effective in a careful assessment of all activities studied. A compilation of both methods is the best procedure to achieve the best possible results. However, both method present limitations by failing to consider factors related to work organization and factors considered complementary. While OWAS method presents, in certain situations, low-risk values for the upper limbs, RULA method can be more accurate and realistic in this assessment. Although the OWAS method does not propose a postural analysis considering the neck, wrists and forearms (unlike the RULA method), it proved to be an important and effective tool for the assessment of ergonomic activities such as MHL, the assessment of the risk associated with spine and lower limbs, and it is easy to apply in different activities. OWAS method is able to, in general, perform a rapid identification of postures adopted by workers thus calling attention to the urgency of taking preventative measures.

The RULA method proved to be an important tool in the search and identification of risk factors for upper limb disorders, mainly in the case of static and repetitive tasks, and the results achieved can be incorporated with another wider ergonomic assessment such as the OWAS method.

The results of this study highlight the need to intervene in working methods, since in all activities studied there are high risks that may result in musculoskeletal disorders or occupational diseases. This intervention will be made mainly through training, awareness and practice, thus minimizing worker exposure to the risks found. It was found that, despite the results presented, there is some caution on the part of younger workers in the execution of activities, mainly in the tasks of MHL.

The diversity of activities, working procedures, mobility of tasks, routine of workers and the requirement that the activities of the construction area have on workers made the ergonomic analysis more difficult. For the same activity different values were obtained, from high risk to low risk, which led to a difficult compilation and discussion of results. To apply OWAS and RULA methods the use of photography and video were certainly an advantage, because the field assessment by itself would not have results with a reliable degree of accuracy

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Risk assessment process at an administrative services company, well-organized in terms of OHS

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ABSTRACT
This article presents the main findings of a risk assessment process at an administrative services company, well organized in terms of occupational safety and health (OSH). The application of a preliminary diagnosis questionnaire – Well-Being, Health and Occupational Safety Perception and the application of the Checklist to the Identification of Hazards and Dominant Health Problems, guided occupational the risk assessment process to less obvious health hazards, but with a high potential to cause discomfort symptoms and even work-related diseases and psychosomatic occupational aggravated diseases. The checklist is oriented to the identification of potential occupational hazards, codified and classified into groups and subgroups. To each hazard, the checklist defines dominant health problems that may occur (injuries from accidents, occupational diseases, work-related or occupational aggravated diseases and discomfort symptoms). The questionnaire was constructed to assess employee's perception of physical, environmental and psychological working conditions, physical discomfort symptoms and diseases related symptoms and signs. Analyzing the answers to the questionnaire, the specific hazards to this workplace are essentially from the psychosocial, ergonomics and in the work environment group. Social and individual aspects surrounding the professional activity of employees, such as the eating habits, the route between home and work (travelling time, distance), the family environment, lifestyle such as the sedentary lifestyle and the eventual lack of activity, can promote conditions affecting the general health of employees. In fact, the identification of occupational hazards to work related diseases (eventually psychosomatic diseases) and occupational discomfort requires the collaboration between occupational technicians and occupational health oriented professionals, in order to identify intervention priorities and methodologies. The identification by the occupational physician of symptoms, signs and pathologies effectively related to the occupational environment and those eventually related to the social or familiar environment is determinant in the definition of occupational measures.

Keywords: Administrative services; Safety; Occupational health; Hazards; Risk assessment; Psychosomatic diseases; Work-related diseases

1. INTRODUCTION

The procedures for analysis and evaluation of occupational hazards are a fundamental basis for the implementation of occupational control measures. The control measures (OHSAS 18001:2007) must be clearly aligned with the hazards or risk factors and potential damages identified during the risk analysis procedures, in order to prevent its occurrence. This alignment requires clear knowledge of the individual damages potentially associated with the exposure to hazards or risk factors (Cabeças and Paiva, 2010). This article presents the main findings of a risk assessment process at an administrative services company, well organized in terms of occupational safety and health (OSH), belonging to a group with social concerns, in order to provide a good working conditions for its employees. The company is located in the Great Lisbon area with 68 workers (educational level of bachelor / undergraduate university degree, 30% females).

The work area where the administrative activities are performed is an open space, consisting of standard furniture and equipment (see figure 1): height-adjustable seat with lumbar and elbows support, desk "L" type, with a side cabinet (1 x 2 m), a cabinet under the desk with three drawers (0.5 x 0.5), a computer with a LCD monitor, mouse, keyboard and telephone.

The most obvious and legal aspects related to occupational safety and health are properly organized in the company (Directive 89/391/EEC**)**, particularly in terms of facilities (Directive 89/654/EEC) and work equipment (Directive 2009/104/EC), display screen equipment (Directive 90/270/EEC), electrical installation, sanitary facilities, conservation and sanitation, traffic and escape routes, emergency exits (89/654/EEC), fixed ladders safety, electrical installation, prevention and fire protection, detection, alarm and alert systems, emergency and safety signs (Directive 92/58/EEC), lighting (EN 12464-1), thermal environment (ISO 7730:2005) and first aid procedures. Legal occupational diseases (Commission Recommendation 2003/670/EC) and work accidents were inexistent in the company in the last three years.

Figure 1 - Standard furniture and equipment of an administrative workplace in the company

The focus of the risk assessment process was on the occupational factors related to discomfort symptoms and on the signs and symptoms of work-related diseases and occupational aggravated diseases. As reported by the Commission of the European Communities (2007), *almost 28% of workers in Europe say that they suffer from non-accidental health problems which are or may be caused or exacerbated by their current or previous job (). These factors are often considered in workplace health promotion efforts*. According to the European Network for Workplace Health Promotion, workplace health promotion was defined as the combined efforts of employers, employees and society to improve the health and well-being of people at work. This vision of workplace health promotion places particular emphasis on improving the work organization and working environment, increasing workers' participation in shaping the working environment, and encouraging personal skills and professional development. Workplace health promotion focuses on a number of factors that may not be sufficiently covered in the legislation and practice of occupational health programmes, such as the organizational environment, the promotion of healthy lifestyles, and non-occupational factors in the general environment. Non-occupational factors include family welfare, home and commuting conditions, and community factors which affect workers' health (WHO, 2011). The areas of activity for WHP include life-styles, ageing, corporate culture including staff leadership, staff development, work-life balance, mental health and stress, wellness, Corporate Social Responsibility, nutrition and health (ENWHP, n.a.).

According to Council Directive 89/391/EEC the object of this Directive is to introduce measures to encourage improvements in the safety and health of workers at work. To that end it contains general principles concerning the prevention of occupational risks, the protection of safety and health and the elimination of risk and accident factors. This article is focused on the results of the application of a preliminary diagnosis questionnaire – Well-Being, Health and Occupational Safety Perception – and the application of the Checklist to the Identification of Hazards and Dominant Health Problems at an administrative services company where the most obvious and legal aspects related to occupational safety and health are properly organized. In this sense, the work methodology presented in this article describes two specific methods in the context of protective and preventive measures developed in the company in order to diagnose improvement opportunities in the direction of health promotion of the company ‘employees.

2. MATERIALS AND METHOD

The application of a preliminary diagnosis questionnaire – Well-Being, Health and Occupational Safety Perception (Cabeças and Cruz, 2011) – and the application of the Checklist to the Identification of Hazards and Dominant Health Problems (Cabeças and Paiva, 2010), guided occupational the risk assessment process to less obvious health hazards, but with a high potential to cause discomfort symptoms and even work-related diseases and psychosomatic occupational aggravated diseases.

The Checklist to the Identification of Hazards and Dominant Health Problems (Cabeças and Paiva, 2010), is a structured extensive checklist with the identification of potential occupational hazards. The hazards are codified and classified into groups and subgroups (Table 1; specific hazards were omitted in Table 1). To each hazard, the checklist defines dominant health problems that may occur as a consequence of the hazard exposition. Four types of health problems are correlated to the different hazards: injuries from accidents (AC), occupational diseases (OD), work-related or occupational aggravated diseases (WD) and discomfort symptoms (physical pain, psychological or sensorial discomfort) (DS).

Table 1 – The structure of the Checklist to the Identification of Hazards and Dominant Health Problems (identification of groups and subgroups of hazards; specific hazards were omitted)

Groups of hazards	Subgroups of hazards	Hazards codes	Dominant health problems			
			AC	OD	WD	DS
1. Mechanical	1.1 Horizontal or vertical impact with or against a stationary object (the victim is in motion)	1.1.1 to 1.1.3	■			
	1.2 Struck by object in motion, collision with	1.2.1 to 1.2.6	■			
	1.3 Contact with sharp, pointed, rough, coarse material agent	1.3.1 to 1.3.3	■			
	1.4 Break, burst, rupture	1.4.1 to 1.4.2	■			
	1.5 Trapped, crushed, etc.	1.5.1 to 1.5.4	■			
	1.6 Slippage, landslide of a material agent	1.6.1 to 1.6.3	■			
2. Thermal	2.1 Hot or burning object	2.1.1 to 2.1.3	■			■
	2.2 Cold or frozen object	2.2.1	■			■
3. Electrical	3.1 Ignition source for fire or explosion	3.1.1	■			
	3.2 Direct contact with electricity, receipt of charge in the body	3.2.1 to 3.2.2.	■			■
4. Radiations	4.1 Ionizing radiation	4.1.1 to 4.1.2		■		
	4.2 Non-ionizing radiation	4.2.1 to 4.2.4		■		■
	4.3 Thermal radiation	4.3.1	■			■
5. Noise	5.1 Noise (excessive or disturbing)	5.1.1 to 5.1.3	■	■		
6. Vibrations	6.1 Vibrations (excessive or disturbing)	6.1.1 to 6.1.3		■		■
7. Chemical	7.1 Liquids	7.1.1 to 7.1.4	■	■		■
	7.2 Solid moistures	7.2.1 to 7.2.3		■		■
	7.3 Liquid moistures	7.3.1		■		
	7.4 Gases	7.4.1		■		
	7.5 Steam	7.5.1		■		
	7.7 Solids	7.7.1 to 7.7.3	■	■		
8. Biological	8.1 Pathogenic bacteria	8.1.1		■		
	8.2 Pathogenic viruses	8.2.1		■		
	8.3 Fungi mycoses	8.3.1		■		
	8.4 Biological antigens not microbial	8.4.1		■		
9. In the work environment	9.1 Forced ventilation or air conditioning	9.1.1 to 9.1.2				■
	9.2 Natural ventilation	9.2.1 to 9.2.4	■		■	■
	9.3 Lighting	9.3.1 to 9.3.2		■	■	■
	9.4 Weather	9.4.1 to 9.4.4.	■		■	■
	9.5 Sea	9.5.1	■			
	9.6 Liquid state material	9.6.1 to 9.6.2	■			■
10. Psychosocial	10.1 Violence	10.1.1 to 10.1.6	■		■	■
	10.2 Working time	10.2.1 to 10.2.6			■	■
	10.3 Precarious work	10.3.1 to 10.3.1			■	■
	10.4 Work pace	10.4.1 to 10.4.5			■	■
	10.5 Special hazards	10.5.1 to 10.5.4			■	■
	10.6 Decision / work control	10.6.1			■	■
11. Musculoskeletal	11.1 Musculoskeletal	11.1.1 to 11.1.6	■	■	■	■
12. Other hazards	12.1 Unsafe actions, behaviours, procedures		■	■	■	■
	12.2 New emerging hazards		■	■	■	■

AC: Accident; OD: Occupational diseases; WD: work-related or occupational aggravated diseases; DS: discomfort symptoms (physical pain, psychological or sensorial discomfort)

The preliminary diagnosis questionnaire – Well-Being, Health and Occupational Safety Perception (Cabeças and Cruz, 2011) was constructed to assess employee's perception of physical, environmental and psychological working conditions, physical discomfort symptoms and diseases related symptoms and signs (Table 2). The different topics covered by the questionnaire were the following ones:

- Work place (space, evacuation, sanitation)
- Manual handling

- Uncomfortable noise
- Work postures (postures severity and alternation)
- Computer furniture, computer ergonomics and chair (chair, pc-mouse, keyboard, pc monitor)
- Thermal and ventilation work conditions
- Psychological work conditions
- Biological risks
- Lighting
- Chemical risks (cleaning products)
- Physical discomfort symptoms
- Relation between work activity and discomfort symptoms
- General symptoms, signs and diseases
- Body mass index

Regarding general symptoms, signs and diseases, the collaboration with an occupational physician was determinant. The questionnaire was oriented by organ or anatomical area, as the head / central nervous system, ears, eyes, nose, mouth / throat, heart, lungs, skin, joints / muscles, mental / emotional aspects, energy, weight, digestive tract and others. Some questions were oriented to the detection of symptoms, signs or work-related or occupational aggravated diseases, in the psychosomatic dimension.

The questionnaire was developed according to article 9 of Council Directive 89/391/EEC - *The employer shall be in possession of an assessment of the risks to safety and health at work* – and according to article 11 - *Employers shall consult workers and/ or their representatives and allow them to take part in discussions on all questions relating to safety and health at work*. The actual questionnaire and the Checklist to the Identification of Hazards and Dominant Health Problems are also according to article 6 of the Framework Directive, where the employer *must develop a coherent overall prevention policy which covers technology, organization of work, working conditions, social relationships and the influence of factors related to the working environment*.

The application of the Checklist to the Identification of Hazards and Dominant Health Problems and of the Well-Being, Health and Occupational Safety Perception Questionnaire guided the occupational risks analysis procedures into the direction of less obviously hazards, but with a potential to promote discomfort symptoms to the employees and even work-related or occupational aggravated diseases, in the psychosomatic dimension.

Before the risk analysis procedures it was applied the Well-Being, Health and Occupational Safety Perception Questionnaire to 33% (respondents) of the employees (n=23 workers respondents, 9 females, 21 with a bachelor or a 1st cycle university degree, mean age of 36 years and 2-6 years of seniority in the company), to evaluate their perception of occupational or work related hygiene factors in the workplace.

3. RESULTS AND DISCUSSION

From the application of the questionnaire, the following answers denoted improvement opportunities in the company:

- 48% of the respondents referred the existence of disturbing noise and 53% considered human voices as the main cause of noise (the work area is an open space). The disturbing noise affected seriously the concentration and the efficiency at work (65% of the respondents).
- 57% of the respondents considered that they work daily in a sitting posture for too long time and that 39% of the respondents confirm that they don´t alternate regularly the working postures (sitting – standing).
- 83% of the respondents don´t have a footrest (although the footrests are not mandatory, they are recommended in certain circumstances; an ergonomic assessment is required)
- For 70% of the respondents it is not possible to regulate the vertical distance from the monitor at the table.
- 35% of the respondents consider that the natural ventilation through doors and windows is not adequate (is insufficient).

Regarding the environmental work conditions, the following improvement opportunities were identified:

- 30% of the respondents consider that there is uncomfortable ventilation (directional air flow).
- Windows doesn´t allow for an acceptable natural lighting for 30% of the respondents and 17% consider that localized illumination is not adequate.
- The cleaning products used in the workplace are not adequately identified (labeled) for 18% of the respondents.

Regarding the psychological work conditions:

- The work performed is subjected to abnormal productivity targets for 39% of the respondents.
- 70% of the employees are subjected to regular overtime.
- 4% of the employees felt they were discriminated at the workplace.

Regarding physical discomfort symptoms, the following answers suggest improvement control actions:

- 52% felt pain or physical discomfort during the last year. The symptoms were considered a problem to 22% of the respondents; 4% have lost working time due to discomfort symptoms and to 9% of the respondents the physical discomfort made difficult current activities like eating, dressing and personal cleaning.

- 18% feel frequent discomfort symptoms in the neck, with moderate (very weak-weak-moderate-strong) intensity in 30% of the respondents.
- 13% referred frequent discomfort symptoms in the right shoulder, with moderate intensity, also in 13% of the respondents.
- 9% referred frequent discomfort symptoms in the low back area during 2010-2011, with moderate intensity in 22% of the respondents.

One open question in the questionnaire was oriented to assess the cause of the discomfort (*In your opinion what is the cause of the physical discomfort? Is it any specific activity?)*. The question was answered by 45% of the employees. To most of the respondents the discomfort symptoms are related to the time spent in a sitting posture (physical inactivity), to the type of activity (mental work), to the postures assumed in the workplace during the workday, to the driving time from home to work, to the psychological stress and to the characteristics of the seat (the seat ergonomics was considered inappropriate) and of the monitor (the vertical regulation was considered difficult to perform).

A group of closed questions was oriented to evaluate the relation of the discomfort symptoms with specific aspects in the work environment. To work seated was referred to by 22% of the respondents as having a high relation with the symptoms (without relation, some relation and high relation). To bent the trunk was considered to have a high relation with the symptoms by 17% of the respondents.

A second open question was oriented to assess the circumstances that the employees considered appropriate to reduce the discomfort intensity. The improvement conditions referred to by 36% of the employees, included physical activity during working time, to alternate sitting with standing posture, to improve the posture of the body during work time, to increase rest time, to develop outdoor physical activities during lunch time and to improve the vertical regulation system of the PC monitors.

Regarding general physical symptoms, signs and diseases, the following main conclusions were observed:

- Headaches symptoms were occasionally referred to by 48% of the respondents and frequently by 4%; frequent dizziness was referred to by 4% of the respondents.
- Frequent bags or dark circles under the eyes were referred to by 22% of the respondents and occasionally by 9%.
- Occasional or frequent watery or itchy eyes in 13% of the respondents.
- Occasional swollen, reddened or sticky eyelids in 9% of the respondents.
- Occasional or frequent blurred or tunnel vision in 22% of the respondents.
- Frequent sinus congestion, sinus infection or hay fever allergy in 18% of the respondents.
- Constant sneezing, occasionally in 43% of the respondents.
- Excess mucus formation occasionally or frequently in 9% of the respondents.
- Frequent or occasional gagging / need to clear throat in 22% of the respondents.
- Occasional chest pain in 9% of the respondents; occasional rapid or pounding heartbeat in 18% and frequent in 4% of the respondents.
- Occasional asthma and bronchitis in 17% of the respondents.
- Occasional eczema and itchy skin / dermatitis in 9% of the respondents.
- Occasional pain or aches in the lower back in 61% of the respondents and frequent in 9%.
- Occasional arthritis episodes in 9% of the respondents.

Relatively to symptoms, signs and diseases in the digestive tract, diarrhea, constipation, bloated feeling, heartburn and intestinal / stomach pain, frequent symptoms were referred to by ~9-13% of the respondents.

Regarding general mental or emotional symptoms, signs and diseases, the following main conclusions were observed:

- Difficulty concentrating was referred to by 39% of the respondents and mood swings was recognized by 43% of the respondents.
- Occasional depression was referred to by 9% of the respondents.
- Anger, irritability or aggressiveness was recognized in 48% of the respondents.
- Occasional insomnia in 9% and frequent insomnia also in 9% of the respondents.

Frequent fatigue or low energy was recognized to by 9% of the respondents and occasionally by 57% of the respondents. Frequent overweight was referred to by 17% of the respondents and occasionally by 26%.

Analyzing the answers to the Well-Being, Health and Occupational Safety Perception Questionnaire we may conclude that the specific hazards to the workplace are essentially from the psychosocial, ergonomics and in the work environment group (see table 1). Social and individual aspects surrounding the professional activity of employees, such as the eating habits, the route between home and work (travelling time, distance), the family environment, lifestyle such as the sedentary lifestyle and the eventual lack of activity, can promote conditions affecting the general health of employees. Naturally that the boundaries between health factors or health aggravating factors originated in the occupational, social, familiar or individual context may not clear.

Most probably, the obvious sources of accidents and legal occupational diseases in administrative services company, well organized in terms of occupational safety and health (OSH), are adequately addressed. The dominant accident hazards belong to the mechanical and electrical group, from the subgroups horizontal or vertical impact with or against a stationary object (falls, slips and trips) and trapped or crushed between (doors, drawers) (see table 2). The dominant occupational disease hazards are related to repetitive motions in the upper limbs and inadequate working postures. In some work places, respiratory diseases may be prevalent (Bailey, 2011). In the particular aspect of hazards to pathologies and discomfort symptoms, the collaboration between health and safety technicians and occupational health professionals is crucial. The identification by the occupational physician of symptoms, signs and diseases revealed by the employee and effectively related to work is determinant to the selection of adequate control measures.

Table 2 – The Checklist to the Identification of Hazards and Dominant Health Problems in administrative services companies well-organized in terms of OHS

Groups of hazards	Subgroups of hazards	Hazards codes	Specific hazards	AC	OD	WD	DS
1. Mechanical	1.1 Horizontal or vertical impact with or against a stationary object (the victim is in motion)	1.1.1	Vertical impact with or against a stationary object (falls from stairs, chairs, stairs and ladders)				
		1.1.2.	Vertical impact at the same level (falls, slips and trips)				
		1.1.3.	Horizontal impact with or against a stationary object (hit with the arm or knee in desks, benches, doors)				
	1.2 Struck by object in motion, collision with	1.2.4.	Struck by object in motion, including vehicles (the victim is still) – commuting accidents				
		1.2.5.	Struck by object in motion– collision with a person (the victim is in motion)				
	1.5 Trapped, crushed, etc.	1.5.3.	Trapped, crushed between (doors, drawers)				
3. Electrical	3.2 Direct contact with electricity, receipt of charge in the body	3.2.1.	Ignition source to fire or explosion (switchgear, electrical outlets)				
		3.2.2.	Direct contact with electricity (electrical outlets in the floor)				
5. Noise	5.1 Disturbing noise	5.1.3.	Disturbing noise from human voices, printers, keyboards and external environment				
7. Chemical	7.1 Liquids	7.1.2.	Spill of cleaning products on the floor and desks				
	7.2 Solid moistures	7.2.1	Dusts				
		7.2.2	Fibres				
9. In the work environment	9.1 Forced ventilation or air conditioning	9.1.1.	Indoor temperature (cold, heat)				
		9.1.2.	Indoor humidity				
	9.2 Natural ventilation	9.2.1.	Flow / renewal of air in the work areas				
		9.2.3.	Troublesome air flow				
		9.2.4.	Nuisance odours (tobacco, disinfectants, etc.).				
	9.3 Lighting	9.3.1.	Inadequate illuminance				
		9.3.2.	Inadequate luminance				
10. Psychosocial	10.1 Violence	10.1.2.	Bullying and victimization by peers or bosses				
		10.1.3.	Psychological aggression (management methods), threats and verbal abuse				
		10.1.4.	Bullying or harassment by colleagues or bosses				
		10.1.5.	Discrimination, intolerance to individual difference from colleagues or bosses				
	10.2 Working time	10.2.3.	Overtime, extra work				
	10.3 Precarious work	10.3.1.	Subcontract work (most adverse working conditions)				
		10.3.2.	Fixed-term contracts				
	10.4 Work pace	10.4.1.	Consistent high work pace, intense pace				
		10.4.2.	Short deadlines				
		10.4.3.	Abnormal productivity requirements				
		10.4.4.	Insufficient breaks				
		10.4.5.	Monotonous work, repetitive work				
	10.6 Decision / work control	10.6.1.	Lack of decision capacity / ability or lack of control over work				
11. Musculoskeletal	11.1 Musculoskeletal	11.1.1.	Manual handling of loads				
		11.1.2.	Repetitive movements with the upper limbs				
		11.1.3.	Working postures				
		11.1.4.	Work with computer PC´s				
		11.1.6.	Work systematically sitting with reduced opportunities to change the attitude				
		11.1.7.	Working in space / confined area, too small area				

AC: Accident; OD: Occupational diseases; WD: work-related or occupational aggravated diseases; DS: discomfort symptoms (physical pain, psychological or sensorial discomfort)

4. CONCLUSIONS

Administrative services company, well organized in terms of occupational safety and health (OSH), may represent a new frontier to occupational safety and health professionals. The traditional hazards with high impact in accidents and legal occupational diseases may not be dominant in this work environment (as reported by Eurostat (2010), *due to growing employment in the services sector and in highly skilled, non manual occupations where accidents are generally less frequent than in other sectors and occupations, the occurrence of accidents might decrease in the future*). A traditional attitude from the occupational safety and health professionals may conduct to the perception that their contribution in these companies may not be obvious.

In fact, the identification of occupational hazards to work related diseases (eventually psychosomatic diseases) and occupational discomfort requires the collaboration between occupational technicians and occupational health oriented professionals, in order to identify intervention priorities and methodologies. The identification by the occupational physician of symptoms, signs and pathologies effectively related to the occupational environment and those eventually related to the social or familiar environment is determinant in the definition of occupational measures. Control measures may require the application of methodologies particularly oriented to ergonomic or psychosocial occupational aspects.

Health promotion efforts from the companies may interfere with non-occupational aspects as life-styles, work-life balance, nutrition and mental health and stress. This circumstance may require from occupational safety and health professionals the capacity to implement control measures in occupational and occupational-influencing factors that globally affects employee’s health and company performance.

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Health and safety on small fishing vessels

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ABSTRACT
The majority of the European Union (EU) fishing fleet comprises vessels less than 18 metres in length. Statistics about fishermen fatalities and accidents for this vessel-length segment are rather limited. However, the latest available figures from the European Commission (2009) assign to fishing, as a whole, the highest incidence rate for fatal accidents, as opposed to other industries such as mining, agriculture and construction. This paper summarises the experience gained during the drafting of a non-binding guide for small fishing vessels. The project allowed the collection of valuable feedback from the sector. Initial inputs came from a survey, which allowed the identification of the issues that the guide must address, both for health promotion and enhancing safety. Case studies were simultaneously conducted; they revealed the difficulties in obtaining reliable and comparable data. Yet, it was noticed that France and the UK have established formal mechanisms to investigate accidents and collect comprehensive data. Analysis of such data would certainly help to identify the main target of safety campaigns and improved legislation. Technological limitations still prevail, not only regarding the vessel design but also in the fabrication of life saving appliances. In any case, it was evident that small changes could be carried out on the vessel to prevent musculoskeletal diseases. Education was found to be the main gap in most countries. Basic training courses on safety issues are not regular nor yet compulsory. Neither, is there international legislation in force to address the construction of safer vessels and setting minimum standards for education and training.

Keywords: Risk assessment; Share fishermen; Prevention education

1. INTRODUCTION

Despite the efforts undertaken by the European Commission and authorities in several Members States, the number of accidents in small fishing vessels remains considerable high. The situation is complex in this sub-sector because health and safety regulations are scarce, both at European and international level. While most fishermen fatalities occur due to the sinking of the vessel; past experience demonstrates that human error (or behaviour) is the major cause of accidents.

The fishing workforce is mainly composed of self-employed fishermen who are paid a share of the earnings or profit of the boat. Since most vessel owners (or operators) are family enterprises, there is an increased pressure for economic survival, and a great tendency to tolerate risks. This is aggravated by the lack of formal professional qualification standards. Indeed, fishing skills are generally passed down from parents to sons, or learnt on-board the vessel from experienced co-workers.

Since most EU directives, currently, exclude the self-employed; the European Commission called for the drafting of a non-binding guide of best practice for small fishing vessels. This paper briefly advises about the contents of the guide and reflects upon the experience gained during its drafting. Accordingly, it is divided in two parts. The first highlights the major challenges of this sub-sector; and the second summarises the feedback which fishermen, experts and relevant organisations provided during the various stages of the project. The draft guide produced entitled: '*European guide for safety and health awareness on small fishing vessels*'. Its translation and publication in all EU languages is expected in 2013. The guide was developed in two formats: booklet and DVD.

2. HEALTH AND SAFETY STANDARDS FOR SMALL-SCALE FISHERMEN

More than 90% of the European Union (EU) fishing fleet comprises vessels less than 18 metres in length. Data about fishermen fatalities and accidents for this vessel-length are limited. However, the latest report from the European Commission (2009) assigns to the entire fishing's fleet the highest incidence rate for fatal accidents: 28.9 per 100,000 workers; as opposed to other 'dangerous industries' such as mining (15.5), agriculture (10.1) and construction (8.8). Likewise, an analysis conducted in the United Kingdom showed that the number of fatalities and injuries remains high for the fishing sector, this despite various regulations and safety campaigns undertaken by the authorities (MAIB, 2008).

The bad performance of the fishing industry is partly attributed to the absence of compulsory legislation for both vessel construction and training. In fact, current international legislation, aimed to promote health and safety, is either voluntary or only addresses larger vessels. The European Union has been active in adopting health and safety directives among the Member States (MS). In this respect, three directives deserve particular attention, they are:

- Council Directive 89/391/EE**C** of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work (also known as the Framework Directive).
- Council Directive 92/29/EEC of 31 March 1992 on the minimum safety and health requirements for improved medical treatment on board vessels.
- Council Directive 93/103/EC of 23 November 1993 concerning the minimum safety and health requirements for work on board fishing vessels.

An assessment of the implementation of health and safety directives in the various EU Member States concluded that the above directives have made very little impact in the reduction of accidents (Commission document number 599, 2009). This situation clearly affects the goals of the Community Strategy on health and safety at work, which seeks by 2012 a 25% reduction in the total rate of accidents per 100,000 workers (Commission document number 62, 2007).

3. THE EUROPEAN GUIDE TO PROMOTE HEALTH AND SAFETY PRACTICES

In order to collect the feedback from fishermen, authorities and associations; the project required the completion of the three major tasks described below.

Figure 1 – Major project activities

3.1. The user requirement survey: online questionnaire + case studies

The user requirement survey consisted of two main activities: case study and online questionnaire. Concerning the questionnaire, the aims were as follows:
a) To identify the main health and safety issues that the guide needed to address;
b) To ascertain the format of the guide, such as pages' length and audio/video's duration; and
c) To investigate what requirements of EU directives were perceived as the most difficult to apply.
Approximately 400 invitations were sent to authorities, associations and training centres. The response rate was 20%. A breakdown of the valid responses by country in presented in Figure 2.

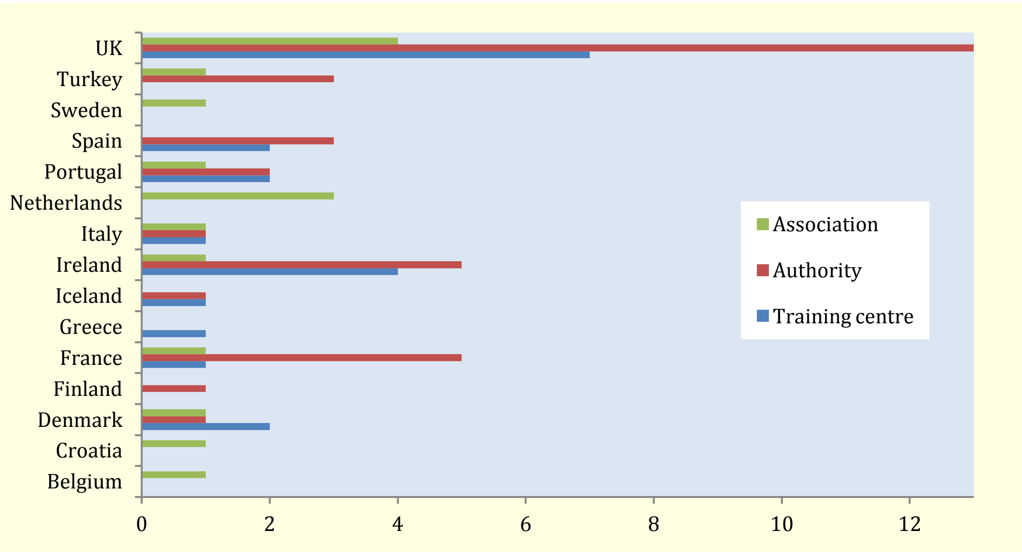


Figure 2 – Respondents group by country

The tables below present the main health and safety issues that the guide was required to address, in accordance to the responses given to the questionnaire. As it can be observed in Table 1, respondents considered the head and hands as the most vulnerable parts of the body. In this respect, it is interesting to notice that current data about injuries is very limited in Member States and do not particularly ascertain the part of the body which is mostly injured. Additional concerns related to the vessel and the crew are presented in Table 2. The risk of fishing alone is particularly relevant because presently there are no mandatory safety precautions to follow. The issue of single handed vessels is in fact very controversial. On one hand, there is an increased need to reduce manning costs but on the other hand, recovering a person who has fallen overboard may require the assistance of at least three crewmembers. In the UK, man overboard accounts for 20% of deaths on small fishing vessels. Therefore, it is worthwhile to mention that assessing the possible risks for lone workers is implicit in the EU Framework directive (89/391/EEC), which as mentioned before does not apply to those self-employed.

Table 1 – Ranking health issues in order of relevance (online questionnaire)

	1st	2nd	3rd	4th	5th	6th	7th
Body protection	Head	Hands	Back	Eyes	Feet	Skin	Ear
Emotional conditions	Fatigue	Risk behaviour	Stress	Anxiety	Boredom	-	-
Diseases	Blood pressure	Hearing loss	Respiratory problems	Diabetes	Digestion problems	Kidney problems	Genital
Most common injuries	Cuts and lacerations	Fishhooks	Burns	Food poisoning	Rash and allergies	-	-
Wellbeing and lifestyle	Alcohol and drugs	Smoking	Unhealthy eating	Sea sickness	Sexual transmitted diseases	-	-

Table 2 – Ranking safety issues in order of relevance (online questionnaire)

	1st	2nd	3rd	4th	5th	6th
Vessel operation	Watertight integrity	Structural changes	Loading	Free surface	Maintenance	-
Crew information and advice	Personal flotation devices	Training	Risk assessment checklists	Personal protective equipment	Radio and Communications	-
Special precautions	Fishing alone	Gear handling	Voyage plan	Embarking/ disembarking	Catch handling	Handling hazardous substances
Workplace performance	Financial pressure	Fishing quotas	Fast fishing pace	Language barriers	-	-
Most common incidents	Falls overboard	Fire/explosions	Adverse weather	Capsize	Leaks/swamping	-

During the survey, it was also important to identify the potential users of the guide and the preferred format for its publication. Figure 3 shows that the respondents considered the crew and skipper as the main end-users. Similarly, the training centre was clearly identified as the most likely place where the guide was to be read. Though, one respondent stated 'getting the crew to read is very difficult' and 'on the vessel they (fishermen) must get ready for fishing', consequently 'reading the guide there is very unlikely'. Another respondent suggested the 'fishermen mission centres' and 'the waiting rooms of doctors and dentists' as most appropriate places to disseminate the guide. Concerning the size of the guide, the majority of respondents agreed that the guide should not exceed 20 pages. In addition, respondents recommended audio and video versions with no more than 20 minutes of duration.

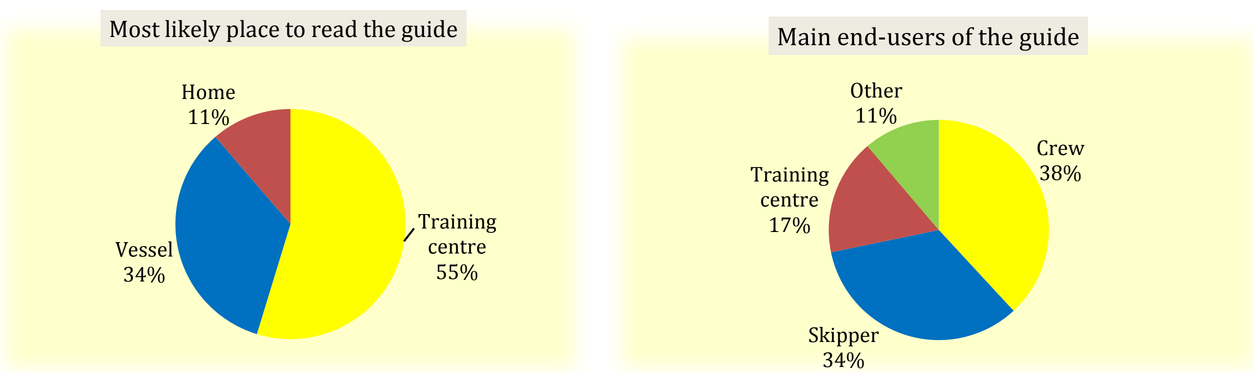
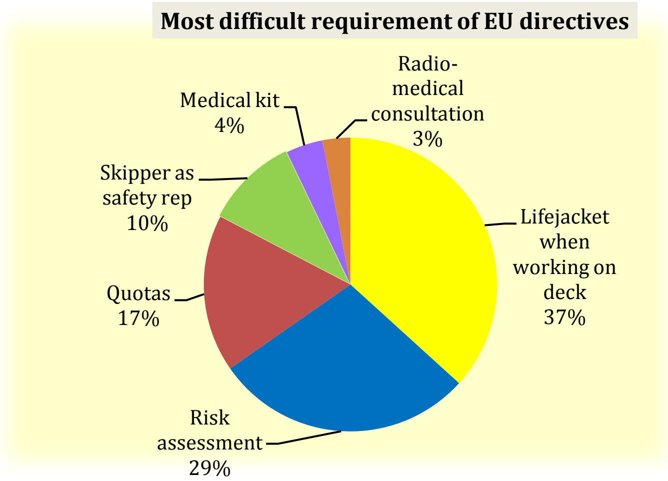


Figure 3 – Survey results concerning the usability of the guide

Lastly, the questionnaire collected the participants' views about the level of difficulty authorities may encounter in implementing six requirements implicitly endorsed in the Directives. As Figure 4 demonstrates, the majority of the respondents felt the use of lifejackets and the assessment of risks as the most difficult to apply. The truth is that despite the limitations Personal Flotation Devices (PFDs), including lifejackets, are the best technology currently available to reduce the risk of drowning. From the statements made by the participants, it is patent the strong opposition fishermen have to wearing them.



Statements made by the respondents with regard to the wearing of a lifejacket:
'New entrants are willing to wear a lifejacket but later discouraged by older fishermen'
'Brave fishermen do not wear lifejackets'
'Wearing a lifejacket is not compulsory by law'
'Insurers should not pay compensation if victims are not wearing PFDs when an accident happen'
'Skipper should dismiss crew members not wearing lifejackets'
'There is an underestimation of the risks'

Figure 4 – Survey results concerning the application of specific safety requirements

Since the review and testing of the guide in all Member States would have proved impossible, case studies were used to supplement the information collected through the online survey. Additionally, the case studies served to explore the specific needs of the fishing sub-sector in the three countries where the testing of the guide was planned: Ireland, France, and Spain. In this way, the case studies aimed the collection of the good practices implemented by the authorities in those countries. Attempts to gather comparable data about accidents in the three countries were difficult. For example, data available from the Commission and the European Agency for Health and Safety at Work were not too much useful, this because they generally provided an overall figure for both the agriculture and fishing sectors. Moreover, data about accidents, vessels and fishermen have not been categorised by vessel length or fishing method. Fortunately, data about accidents were available from the French authorities. Despite the limited data, the case studies in Ireland and France granted access to real case incidents, this kind of information was extremely useful in the preparation of one module for the guide.

3.2. Evaluation and testing of the guide

This task required two main activities: (i) an expert panel evaluation and (ii) a review or testing of the guide by fishermen in four countries. Concerning the panel, fifteen experts from seven countries and two international organisations (FAO and ILO) participated. Throughout the evaluation, the panel of experts filled in a questionnaire at the end of several sections and modules of the guide. The guide contained a total of 37 sections. From the responses given, the drafters obtained valuable feedback on how to improve the guide visually and technically. New sections were added or re-arranged into new modules. Two modules were praised by the panel: Modules III and IV. While Module III illustrated about the hazards and control measures for various fishing methods; Module IV described the real case incidents collected during the case studies.

The comments and observations made by the panel members were incorporated in the guide, which was then tested by fishermen in Ireland, Spain, Poland and France. The testing events took the form of a workshop and were held in each country with a minimum of 10 participants. During the workshops, two sessions were organised. The first session required paired reading of selected sections of the guide. In total, fourteen sections were reviewed by the attendants.

During the second session, a risk assessment exercise was conducted. As part of the exercise, the participants were requested to fill in the 'Risk Assessment Form' showed in Figure 5. The template was based upon the five-step process widely recognised to perform risk assessment. Three simple scenarios were purposely constructed and presented to the participants. They contained un-controlled risks. See Figure 6 that presents the scenarios used in Ireland. Though, the form took consideration of the basic literacy level of the participants, it was noticed that the fishermen had difficulties in completing the 'Control Measure' and 'Action Plan' columns. Some fishermen, for instance repeated the same statements in both columns. Nevertheless, more than half of the attendants in all the countries where the guide was tested felt that the form was 'easy' to use. An analysis of the profile of the participants demonstrated that those from Spain had the lowest literacy level. In fact, one out of nine fishermen declared to have secondary education, the rest only had primary education (the number of years completed was not asked). This situation explained why some of them could hardly write and complete the questionnaire and exercise.

Fishing method/activity: Vessel area:				
Hazard	**Consequence**	**Control measure**	**Assessment** *(Tick as appropriate)*	**Action plan**
			☐ **Risk is not controlled, <u>urgent action</u> is required** ☐ **Risk is not controlled, <u>action</u> is required** ☐ **Risk is adequately controlled, <u>no action</u> is required**	

Example:

Fishing method/activity: Potting Vessel area: Wheelhouse				
Hazard	**Consequence**	**Control measure**	**Assessment** *(Tick as appropriate)*	**Action**
Wheelhouse noise	Skipper hearing loss	No measure in place	■ Risk is not controlled, action is required	Install noise insulation on the engine room deck head during two week maintenance period in 6 months.

Figure 5 – Matrix for risk assessment tested during the workshops

Figure 6 – Risk scenarios used during the workshops in Ireland

3.2. Guide drafting and DVD design

The feedback collected along the case studies and the online questionnaire contributed to the drafting of a preliminary draft of the guide. Thus, three official versions were elaborated. The second version followed the panel evaluation, the guide was then organised into modules. The final layout for the modules is presented in Figure 7.

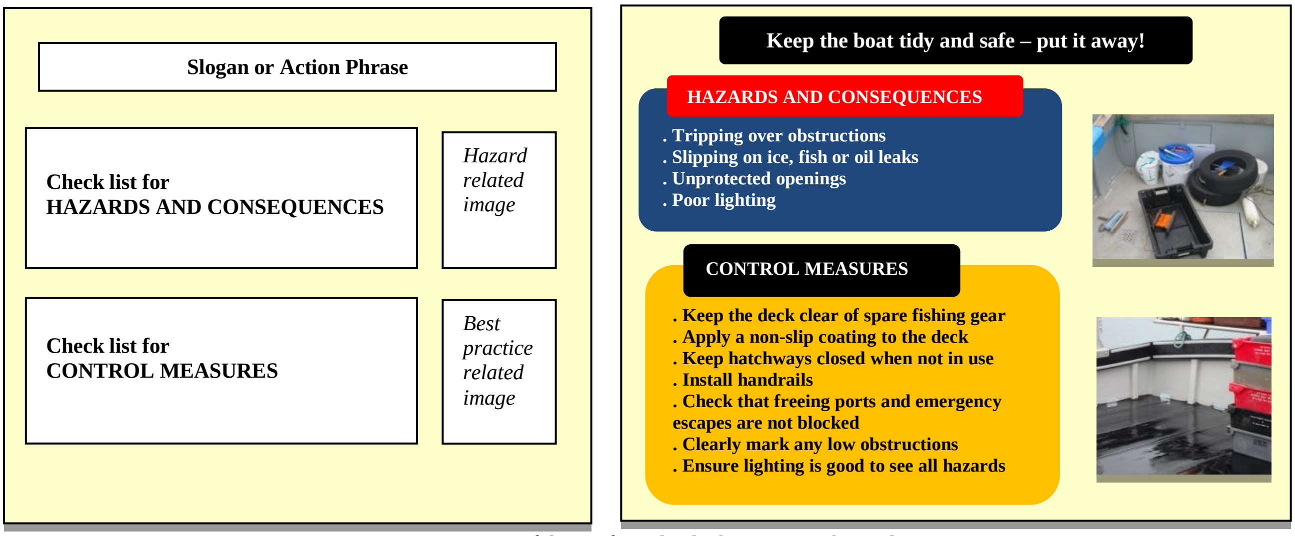


Figure 7 – Draft layout for individual sections in the guide

The guide undergone several revisions but in the end it was decided to split the information into six modules and one annex. Finally, during the testing, the fishermen had the chance to critique the guide and suggest the inclusion of new sections or themes which had not been addressed in detail. It would have been useful to test the guide in more countries but as usual, the time frame and resources of the project did not allow for that.

Taking into account that the end user of the guide does not enjoy very much reading, it was decided to make use of photographs and illustrations. Figure 8 presents the cover and final contents. In the end, the guide produced was very visually attractive and incorporated motivational slogans or action phrases. Module IV explains real case incidents, the factors that contributed to such incidents as well as the lessons to be learnt are illustrated there. Module V was dedicated to risk assessment and Module VI advises on miscellaneous topics, such as: personal flotation devices, first aid and drills. This last module also includes an ‘Incident Form’ which could be used in case of injuries to register the part of the body affected. See Figure 9.

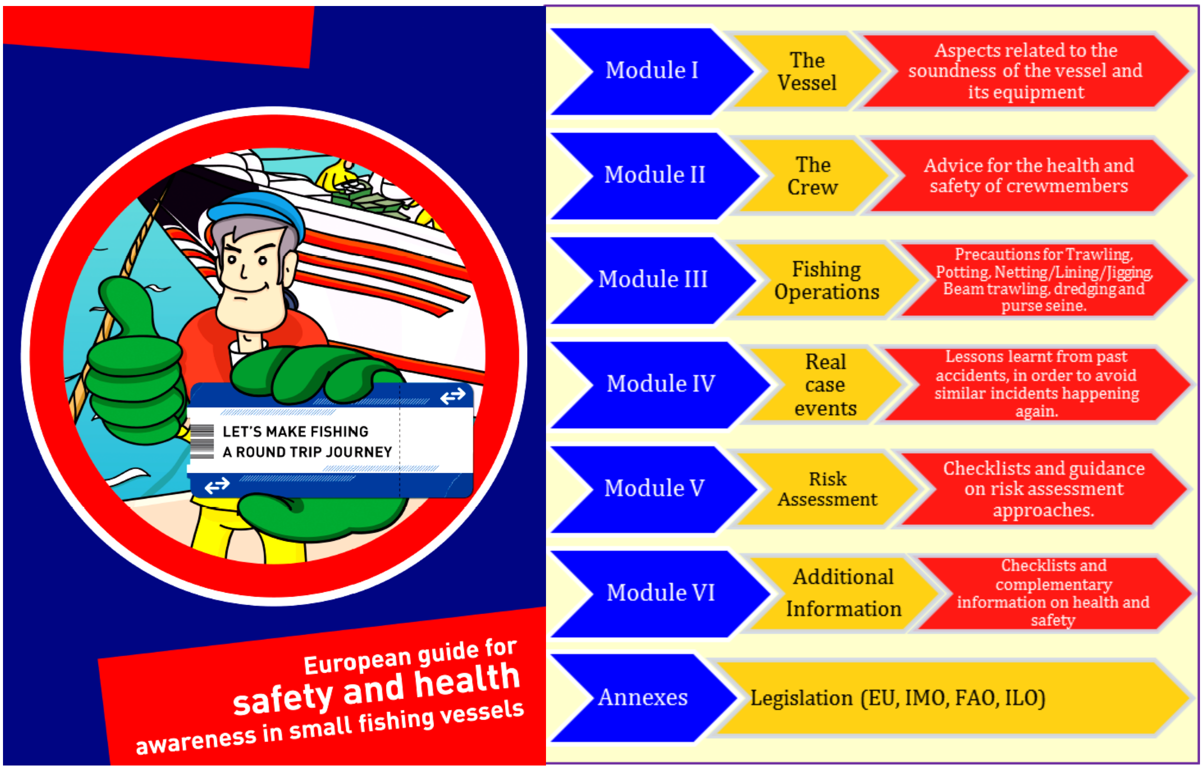


Figure 8 – Guide cover and contents

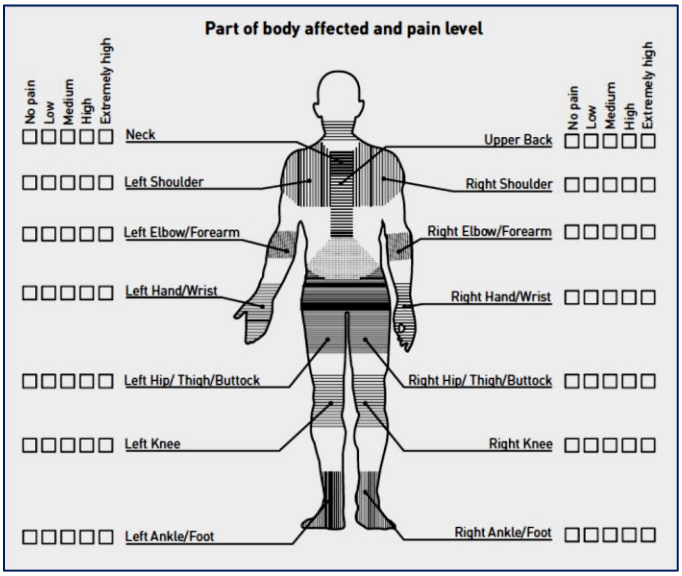


Figure 9 – Proposed form to record injuries and pain level for radio medical assistance

4. CONCLUSIONS

Implementing a culture for safety prevention is crucial to change the current rate of accidents within the fishing sector. The guide drafted for the European Commission, targets the human element. It identifies risks and provides recommendations on how to reduce and/or eliminate them. Nevertheless, the guide by itself is not enough to promote behavioural change and a life-saving attitude amongst fishermen. During the project, one of the activities required the testing of the guide and this was achieved through the organisation of workshops among the fishing communities. This activity proved to be a very rich experience for fishermen and the guide drafters. Members States, therefore, may use the material contained in the guide to create risk awareness within a sector where formal training is not yet compulsory.

5. ACKNOWLEDGMENTS

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6. DISCLAIMER

The opinions expressed belong solely to the author, and do not represent the views of the organisations herein referred.

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From Crisis to Mindfulness

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ABSTRACT
The world is constantly changing and crises to which organizations and people are exposed are recurrently happening. In this turbulent business environment, companies die, on a daily basis, while other manage to survive and even some facing chaotic situations, not only survive but also develop themselves and be born again, like a Phoenix from the ashes. Those organizations develop a mindful infrastructure that allows them to learn from their errors thereby diminishing the potential negative effects of those crises (Weick & Sutcliffe, 2007). Any kind of organization can implement and develop a mindful infrastructure, in different levels, and different formats between levels, according to their organizational characteristics and needs (Weick, Sutcliffe & Obstfeld, 1999). The mindful infrastructure has five principles (Weick & Sutcliffe, 2001, 2007), that should be followed by an organization that wishes to improve its reliability in the safety context, becoming a High Reliability Organization [HRO]. A HRO is capable of anticipating an unexpected event, and even when it happens, be capable of diminishing the severity of its consequences. This article is part of a Doctoral thesis in progress that aims to explore how organizations learn from crises and unexpected events, transforming such negative events in positive outcomes as learning, consciousness of safety issues, and safety performance development.

Keywords: Crisis, Mindfulness, High Reliability Organizations

1. INTRODUCTION

Crises have always existed; in fact, from the scientific point of view, we could consider the beginning of the world, with the Big Bang, a crisis, as opposed to the construction of the world in seven days by God. Being the main problem an explosion of accumulated energy, there is no doubt that it can be seen and studied as a crisis independently of the perspective or focus. Crises are a permanent phenomenon in human lives, being the Libyan war, a Texas fire, and a new hurricane in New Orleans, the nuclear disaster at Fukushima or simply the Murdoch tabloid's scandal. They get into our lives unexpectedly, we have to manage them and then, upon resolution, they simply are substituted by other sudden, new and unexpected crisis.

So, from the beginning of the centuries, men faced crises and had to learn to handle them. The ones that learn the lesson are able to grow within a crisis moment, whereas the ones that do not learn, will eventually suffer or perish. But this research work does not intend to be so tragic; on the contrary, it focuses on a positive perspective and in how organizations can learn and transform negative and chaotic times into positive achievements, through learning.

2. CRISIS MANAGEMENT

The literature on crises is usually grouped under the headings of 'crisis management' or 'organizational crisis' and calls for a multidisciplinary perspective, involving disciplines as diverse as sociology, psychology or technical ones (Pearson & Clair, 1998).

A human crisis such the one occurring now in the Horn of Africa cannot be seen exclusively through the lens of Anthropology, because it relates with economic questions, for instance, by focusing on populations without the minimum of sustainability, or political decisions such as buying weapons instead of food, or even management and how to more efficiently use social responsibility efforts. The same is true for other kinds of crisis such as industrial or environmental, that may need the attention of different sciences, sometimes as different as organizational psychology and civil engineering.

Alexander (1993) identified six schools of expertise in what concerns disaster analysis, to which list we can possibly add social psychology. The six schools of expertise are: anthropology, sociology, geography, development studies, geophysical sciences with engineering and health sciences. (Alexander, 1993).

A disaster can be analyzed from different points of view. If it is a natural disaster, as an earthquake for instance, we may appeal to the geophysical sciences, and geography. But for the populations living in the earthquake area, psychology must be called to deal with traumatic situations, not to mention medicine and health sciences in general. That earthquake could also rise important questions for research in economics and finance, in terms of their impact in the markets and in the economy, and even for management, in how organizations deal with the event. That diversity of fields depends on the effects and consequences of the event for societies, markets, and the environment in general. Perhaps the larger the consequences the wider the scope for different disciplines, although the evidence in the literature is lacking.

This multidisciplinarity contributes for the diversity of knowledge, but at the same time, it leads to a miscellaneous set of points of view, ideas and languages that negatively contribute for a disintegration in terms of development of the discipline, leaving the "...research on organizational crises at the periphery of management theory" (Pearson & Clair, 1998, p. 59).

The lack of a unitary language hinders the quality of the work done by researchers since there is no consensus for definitions and concepts and approaches. The creation of knowledge is enhanced with the diversity of approaches and experiences, through sharing, allowing for innovation and knowledge development. Nevertheless, this multidisciplinarity renders knowledge sharing difficult, namely for language differences. If for some authors the problem is a crisis (e.g., Boin, 2008) for others it is a disaster (e.g., Turner & Pidgeon, 1997) or unexpected event (e.g., Weick & Sutcliffe, 2001, 2007) or even accident (e.g., Mahler & Casamayou, 2009), depending on the scientific perspective by which the event is approached.

However, in a broader look, some consensus can be found in the different scientific approaches to the phenomenon of "organizational crisis", namely in defining the concept. A crisis is understood as "...an unexpected, unlikely, yet high-impact event that may cause significant change in human knowledge and performance at the individual, group, organizational, and community levels" (Hutchins, 2008, p. 302). In fact it is possible to know that a crisis may eventually happen, but not precisely when and how the consequences would be. A worker that has retrieved the protections of one engine, is putting him/herself in danger of a work accident and of having a hand cut off, for instance. But if that moment arrives, we don't immediately suspect that this work accident was caused by a neglectful behaviour. So, a crisis may be predictable since it is possible to acknowledge that there is a potential for a crisis with some peculiar characteristics to occur, but it is always unexpected in the sense that its consequences and the moment when it strikes is not predictable, even using the more advanced technologies.

This concept can include a large amount of events to be considered as crises. Pearson & Clair (1998) provide some examples of organizational crises that go from extortion, product tampering, product/service boycott and malicious rumor to terrorist attacks, leaking of hazardous materials, counterfeiting, or natural disasters that destroy corporate headquarters. Recently we watched some crises in a broader sense, like the earthquake in Haiti, the earthquake, tsunami and nuclear disaster at Fukushima, the terrorist attack in Norway, the international financial crisis that is threatening the Euro survival or the famine in the Horn of Africa that kills millions of people, especially unprotected children.

Crises can be classified as natural (which can also be human), financial, industrial or environmental, but sometimes a crisis may include several categories, like Fukushima that is a combined crisis in the sense that is a natural, environmental and also industrial. The BP disaster in the Mexican Gulf was also simultaneously an industrial and an environmental crisis. More important is the fact that we can have a single type of crisis with very severe consequences and also a multiple kind of crisis with unimportant consequences, but the contrary is also valid.

The natural crises are caused by natural phenomena such as earthquakes, hurricanes, volcanoes, landslides, but they also include human crises, when for instance populations have to abandon their homeland due to wars or to a natural disasters such as an earthquake or a hurricane and loose their properties and sustainability. The situations of famine are also considered as human crises, as well as terrorist attacks, like the 9/11, or in Norway in 2011, or the ones perpetrated by ETA, AlQaeda, FARC or by the FP 25 of April in Portugal, in the years following the revolution. The Holocaust was a human crisis also. The importance of such events lies in the severity of their consequences, but there is no consensus when it is needed to distinguish disasters from calamities.

Examples of financial crises are commonly associated with markets. These are probably the most known. Currently the markets are in crisis, the Euro faces a crisis without precedents and we do not know if it is possible to keep the currency as it is.

Industrial crises have been largely studied as a response to major accidents (e.g., Bhopal, Columbia, Seveso). The literature has given more importance to major disaster, albeit there is some evidence that tell us that the minor events have a greater potential for learning (e.g., Koornneef, 2000) Also the literature has given a stronger emphasis to the negative effects of industrial crises that the positive ones (Skjerve, 2008). The learning from such kind of events is usually not studied. Those events had repercussions in legal requirements inside the European Community, like the accident in Seveso, or in inspections to plants like Fukushima, when after the crisis some countries in Europe initiated a deeper inspection to all their nuclear facilities (e.g., France, Germany). Similar to financial crises, the industrial ones gather more consensus in its definition and conceptual approaches, even when scientific fields so different as management and engineering study the same phenomenon.

The environmental crises are gaining attention not only from researchers and experts but also from society in general. When the accident at Bhopal occurred in 1984 (see Gupta, 2002), people were not so interested in environmental consequences as they were when the BP disaster occur in the Mexican Gulf in this century. They were not sensitive to the human and health issues that the crisis raised. In the Fukushima disaster, the environmental crisis deeply affects the population not only in the years after the crisis, but that can extend for centuries, in terms of lost assets, lost affections and jobs and relocation. So the Japanese authorities, in order to manage the Fukushima crisis, should follow the mindful perspective, in that they have to consider the environmental consequences of the event and how they are going to implement actions to avoid or diminish the severity of the consequences over time.

In the midst of these chaotic circumstances, there are people that survive and organizations that continue to develop and be the top of the list in their economic markets. So, how do they do it? How do they strive in such turbulent environments when surviving is sometimes hard enough? Possibly because they respond faster and correctly to the crisis, identifying the main problem, the causes and the possible consequences, and by that, immediately take action to diminish the severity of the consequences and to implement required measures to solve the crisis in the faster time possible. Organizations that can have positive results in chaos situations are High Reliability Organizations [HROs]; these organizations, even in the riskier environments, can avoid crises and diminish their negative impacts.

3. MINDFULNESS

HROs are real examples of mindfulness and how it develops in real organizations, working in real time and in risky environment.

HROs, by implementing a mindful infrastructure, can manage risk environments efficiently and with reliability. HROs in fact are defined by Roberts (Bourrier, 2005, p.94) as organizations "...in which errors can have catastrophic outcomes, but which conduct relatively error free operations over a long period of time, making consistently good decisions, resulting in high quality and reliability operations" (Bourrier, 2005, p. 94). Those results are due to the implementation of the five principles of the mindful infrastructure identified by Weick and Sutcliffe (2001, 2007). The five principles of the mindful infrastructure are:

1) Preoccupation with failure - the organization in general tends to emphasize more the potential failures that might lead to potential crises and build the success of the organization in the principle that success in one event is not sufficient, but rather they have to keep tracking the small failures in order to become highly reliable;

2) Reluctance to simplify interpretations - the first or the simplest interpretation is not enough. Instead those organizations try to look for deep causes, the root cause of the problem. Every event is thoroughly analyzed to draw conclusions that lead to actions to prevent similar future events.

3) Sensitivity to operations - knowledge is located with the ones that develop activities, that are sensible to each activity, task, job, i.e., internal operations. Knowledge and competence have relevance, instead of bureaucratic principles. For HROs the person who knows how to do it must lead the operations and not the bureaucratic leader. Also whenever there is a crisis, they are attentive to the operations as a whole, and try to look where is the problem and act in that particular point, being it internal or external to the organization.

4) Commitment to resilience - a characteristic of HROs that distinguish them from other types of organizations is their commitment to resilience and how they face, manage, and are able to grow with crises. Learning may sometimes be the hard way, but these organizations turn the negative points of crises into positive ones.

5) Deference to expertise - when facing crises, HROs tend to create teams of experts to help the organization manage them. These teams can integrate internal or external members, When developing such teams HROs are not preoccupied about who is the boss, but rather who knows more about that issue, to lead the work, even if it means that the expert is going to boss the boss. When a crisis strikes, it is knowledge that prevails and not the bureaucratic infrastructure of the company.

Each one of those principles contributes for the development of a mindfulness state in the organization, by which people are attentive to the invisible potential risks existing inside and outside the organization that may affect it. This state is permanent, but in HROs it is a natural state albeit being complex and requiring a complex functioning. It is important to recognize the fact that any kind of organization is able to implement and develop a mindful infrastructure (Weick, Sutcliffe & Obstfeld, 1999) and that organizations can be HROs in different levels, meaning that an organization can be more reliable in the first principle *vis a vis* another one that is more reliable in the fifth principle. Inside an organization, the same is true; the second principle could be more developed than the fourth one, depending on the characteristics of the organization, its policies and strategy.

Weick and Sutcliffe (2007, p. 32) define mindfulness as "...a rich awareness of discriminatory detail". The state of mindfulness exists when organizational actors are attentive to every little detail occurring in the organization and can predict what kind of unexpected events, with which consequences, and, if they happen, they act immediately in order to diminish the severity of their consequences. On the contrary, some organizations live in a state of mindlessness, in which things are done according to unchangeable routines that do not leave space to adaptations to the reality of the moment, and by that allowing the possibility of more crises to occur.

HROs face the unexpected and survive like the Phoenix because they use the power of mindfulness and for Weick and Sutcliffe (2001), "the power of a mindful orientation is that it redirects attention from the expected to the irrelevant, from the confirming to the disconfirming, from the pleasant to the unpleasant, from the more certain to the less certain, from the explicit to the implicit, from the factual to the probable, and from the consensual to the contested" (Weick & Sutcliffe, 2001, p.44). For Weick and Sutcliffe (2007) the success of HROs remain in the fact that they try deliberately to act accordingly to the mindful principles, they refer that HROs "...organize themselves in such a way that they are better able to notice the unexpected in the making and halt its development. If they have difficulty halting the development of the unexpected, they focus on containing it. And if the unexpected breaks through the containment, they focus on resilience and swift restoration of system functioning." (Weick & Sutcliffe, 2007, p. 18).

So, HROS wherever will be the point of severity of the development of the unexpected event have always a way to face it, a solution to the problem, a modus operandi that allows them to be focus, reliable and resilient at the end of the journey.

4. HUMAN RESOURCES MANAGEMENT

One question arises: How organizations create that state of mindfulness? You may answer following the principles referred by Weick and Sutcliffe (2001, 2007), but what we meant is, how they can do it in daily working life?

Literature has been focus in same human resources management practices albeit the existing work is clearly insufficient. Practices such as benefits and rewards, socialization, staffing or training and communication have been approached in different studies but also in different perspectives (e.g., Glendon et al, 2006). For example, benefits and rewards can have positive and negative impacts at the same time in safety. Training and communication are practices more pointed by having positive impact in changing behaviors and improving safety performance. In what concerns to High Reliability Theory those three practices are seen as having positive impact. In fact, according to Roberts and Bea (2001) it is very important for organizations to establish a system of benefits and rewards that recognizes the correct behavior and punishes the wrong behavior. People have to know what they can and they can not do when they are working. That is why implementing a system of benefits and rewards in a HRO is a very important step.

Human resources management practices as communication and training are important in the development of learning with unexpected events and crucial for the development of some basic activities in which the Reason's (1997) safety culture are built (e.g., gathering, reporting). So we propose that organizations can face crisis and achieve mindfulness through human resources management practices. Namely we propose that human resources management practices like training, communication, socialization, performance appraisal and incentives mediate the relation of alarm signals, meaning the near misses and incidents occurring and learning, which in terms would result in the state of collective mindfulness.

5. CONCLUSIONS

Crises are something unexpected but they are constantly happening and people and organizations must be prepared to face them and especially to face their consequences. Crises have been studied under the lens of several and diverse perspectives as social or technical sciences; albeit some consensus, the truth is that there is no integration of 'crisis management' as a scientific field, rather a miscellaneous of voices and languages and arguments of different sciences. Even so, crisis management has been studied trying to identify how organizations learn from errors and how they behave facing unexpected events, considering a variety of events that could be in a natural, industrial, work, media, or even financial context.

Some organizations can face crises and rise again through them because they implement a mindful infrastructure following five principles that could be developed in different levels. That infrastructure allows them to be attentive to details, to be resilient facing chaotic situations, to use expertise in the correct way, to be attentive to where the work is done, and by that to be able to adjust quickly to the complexity of our world where crises happen.

HROs are attentive to details in such a way that they achieve success no matter the severity of the crisis because they always find a solution to the problems raised and a way to solve them. No matter in what level of development the crisis strikes, HROs are always attentive to little details and can sometimes predict that crisis will come, and by that prepare themselves to face it. In that preparation and in the development of the mindfulness infrastructure we propose that human resources management practices would have an important role. Human resources management practices such as socialization, training, or communication have been studied as being important for learning and for changing behaviors. This is a conceptual part of a greater work that aims to explore the role of the human resources management practices in the learning in crisis processes.

This work is part of a Doctoral thesis in progress and aims to explore how organizations can transform the negative impact of a crisis into positive results through learning.

6. ACKNOWLEDGMENTS

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Work Ability, Individual and Occupational Factors among Nurses and Nursing Assistants in a Private Hospital

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ABSTRACT
The aim of the present study was to evaluate the work ability of nurses and nursing assistants in relation with the individual characteristics and occupational variables of patient handling tasks in a private hospital. The Work Ability Index and a questionnaire, belonging to the Intervention Evaluation Tool, concerning the professional's perception of risk during patient handling tasks performance, were used in order to evaluate the work ability and the healthcare workers perception about their occupational risk. Our sample consisted of 78 healthcare workers, including nurses (44,87%) and nursing assistants (55,13%) working in two wards at a private hospital, in its majority women (79,49%), single (42,31%), with shift work (88,2%) and with an average age of 33,08 years. The results showed that the average work ability was good (38,84) and significantly correlated with the age among nursing assistants (ρ=-0,425; p=0,017). Concerning the occupational risk perception, 19,23% of the care providers had attended or carried through mobilizations or transferences with dangerous methods and 30,77% had attended or carried through mobilizations without the adequate equipment. Those who had unsafe practices showed an average WAI inferior to those who hadn´t. Those care providers that reported having had accidents in patient handling in the last 12 months had a lower WAI. The results of this study highlight the need to balance the demands of work activity of nurses and nursing assistants with its work ability in order to maintain welfare professionals throughout working life and productivity in healthcare units.

Keywords: Hospital Ergonomics; Work Ability Index; Intervention Evaluation Tool; Patient Handling; Ageing

1. INTRODUCTION

Interactions between the ageing process, heath status, lifestyle and work strongly influence the work ability (Ilmarinen, Tuomi, & Seitsamo, 2005). In recognition of the rapidly growing size of the elderly population, is important to investigate health risks that affect healthcare workers as they age (Cotrim, 2008). In this perspective, ergonomics interventions focused on the improvement of work conditions is a useful strategy for organizations in order to keep older workers healthy and to promote their work ability. The benefits of ergonomic interventions can also contribute to avoid social and work discrimination of older workers.

At hospitals, high physical demands of work related to patient handling tasks, but also the poor design of workplaces and the absence or inadequacies of equipment, influence the work practices of nurses (Hignett et al, 2003) and their work ability perception (Cotrim, 2008; Estryn-Behar et al, 2005). Patient handling is considered hazardous due to high physical demands (Alamgir et al, 2009). Moreover, the heavy physical workload related to patient handling is one of the factors leading to early retirement of nurses (Estryn-Behar et al, 2005) and probably of nursing assistants too. In fact, care providers are exposed to a multiplicity of occupational risk factors, many of them caused by the high levels of physical and mental tasks they carry out.

Staff perceptions have been used to evaluate the acceptance of mechanical lifting devices, as an effective mean to reduce patient handling related injuries (Alamgir et al, 2009), but also to evaluate occupational risk factors.

In line with these considerations, the aim of the present study was to evaluate the work ability of nurses and nursing assistants in relation with the individual characteristics and occupational variables of patient handling tasks in a private hospital.

2. MATERIALS AND METHOD

Data collection was done between January and June of 2011 based on the application of a questionnaire to nurses and nursing assistants of two units, the observation of patient handling tasks and the characterization of lay-outs and equipment.

According to the study objectives and literature review the tools selected were the following:

a. The Portuguese Version of Work Ability Index (Silva et al, 2006). This tool was used in order to characterize the work ability of the nurses and nursing assistants.
b. The Portuguese Version of Intervention Evaluation Tool (IET) (Cotrim et al, 2011). This tool has been translated and its adaptation to Portugal is in progress. IET has 12 parts, but in this paper will only be presented the results concerning the professional's perception of risk during patient handling tasks performance. This data was collected by using a questionnaire with items regarding patient handling accidents, lifting equipment and the interaction between working conditions and repositioning patients. It includes 9 questions in the scope of accidents occurring from handling patients, use of lift equipment's, interference in work conditions when changing the patient's position.

The study population consisted of all the nurses and nursing assistants of the two units (n=110) and the same number of questionnaires was delivered. The response rate was of 70,91% (n=78).

3. RESULTS AND DISCUSSION

3.1. Demographic Characteristics

Our sample consisted of 78 healthcare workers, 35 (44,87%) were nurses and 43 (55,13%) were nursing assistants. Participants had a mean age of 33,08 years (sd=9,57, min=21; max=65), 79,49% were female, 42,31% were single and in average had spent 3,63 years in the current hospital (sd=4,83). Most of them had shift work (87,18%), didn´t practice regularly physical exercise (55,13%) and didn’t smoke (61,54%).
Age didn´t have a normal distribution according to *Shapiro-Wilk Test* (p=0,000). By age groups, 65,7% of the sample had less than 36 years (table 1).

Table 1 – Age groups distribution.

Age Groups	N	%
21-25	15	23,4
26-35	27	42,2
36-45	15	23,4
46-55	5	7,8
56-65	2	3,1

By professional group, nurses had an average age of 33,58 years (sd=9,60) and nursing assistants of 32,59 years (sd=9,67). But, there were no statistical differences between the mean age of the two groups (t=-0,406; p=0,686).
Regarding the perception of work demands, the majority of our sample considered them both physical and mental (98,72%).

3.2. Work Ability Index

Only 76 professionals answered all the items allowing the WAI final scoring. The average WAI for all professionals was 38,84 (min=27; max=44; sd=3,98) corresponding to a good work ability. These average results are similar to those obtained in other studies with nurses in public hospitals, 38,4 (Chiu et al, 2007) and 38,7 (Cotrim, 2008), though the mean age of our sample has been lower. In general, private hospitals tend to have better facilities, so it was expectable that the WAI could be higher compared with public hospitals.
If we look at the WAI by categories, the proportion of nurses and nursing assistants with «good» work ability was the largest (71,05%), followed by the group with «moderate» work ability (21,05%) (table 2). The percentage of professionals with “poor” work ability (1,32%) was lower than in other studies with healthcare workers: 4,1% (Estryn-Behar et al, 2005) and 5,0% (Cotrim, 2008). This lower percentage of care providers with poor work ability can be explained by the also low mean age in our sample (33,08 yrs), compared with the one in those studies (Cotrim, 2008; Estryn-Behar et al, 2005).

Table 2 – WAI distribution by categories.

ICT Categories	N	%
Poor	1	1,32
Moderate	16	21,05
Good	54	71,05
Excellent	5	6,58
Total	76	100

The WAI didn´t have a normal distribution according to the *Shapiro-Wilk Test* (p=0,000).
By age group, the average WAI was lower for the younger group (21-25 yrs). From the group with 26-35 till the older, the average WAI decreased (table 3). But, for all professionals, no association was found between age and WAI (ρ=-0,175; p=0,177).

Table 3 – WAI distribution by age group.

		WAI					
Age Group	N	Mean	Median	sd	min	max	%
21-25	15	38,6	39	4,45	28	44	24,19
26-35	26	40,62	41	2,71	32	44	41,94
36-45	16	39,07	40	3,67	29	44	24,19
46-65	7	32,17	31,5	3,43	27	36	9,68

It’s interesting to note that for the age group of 26-35 years, 85,2% had a «good» work ability and 7,1% «excellent», the age group of 36-45 years had 78,6% of care providers with «good» and 7,1% «excellent» work ability, but over the 45 years no one reached these two categories. Our results are quite different from those of Estryn-Behar et al (2005), where 14,7% of the nurses above 45 years had an «excellent» work ability.
By professional group, age and WAI didn´t have a normal distribution among nurses (p=0,012; p=0,002) and nursing assistants (p=0,006; p=0,025), according to the *Shapiro-Wilk test*. In order to measure the relationship between these two variables, the *Spearmen’s ρ* test was used.
For nurses, no correlation was found between age and WAI (ρ=0,127; p=0,504), but for nursing assistants there was a significant correlation between these two variables (ρ=-0,425; p=0,017). This association can be explained by the decrease of WAI with age among nursing assistants (table 4). Above 45 years, nursing assistants had unsatisfactory work ability.

Table 4 – WAI distribution by age group among nursing assistants.

				WAI			
Age Group	**N**	**Mean**	**Median**	**sd**	**min**	**max**	**%**
21-25	10	39,00	39	4,97	28	44	32,26
26-35	8	39,00	39	3,21	32	42	25,81
36-45	10	37,56	38	3,68	29	42	29,03
46-65	4	31,50	31,5	3,70	27	36	12.90

To test the WAI differences between the two professional groups a nonparametric *Ancova* was used, with age as the covariate variable, and the results showed significant differences between the two groups (F (1,59)=7,673; p=0,007). Nurses had a better average WAI then nursing assistants (table 5). Also, Estryn-Behar et al (2005) stated that the more skilled the occupation, the higher the WAI, taking into consideration that the task demands play a major role.

Table 5 – WAI distribution by professional group.

			WAI			
Professional Group	**N**	**Mean**	**Median**	**sd**	**min**	**max**
Nurses	34	40,21	41	3,16	31	44
Nursing assistants	42	37,74	38	4,27	27	44

Looking at gender differences, women registered a better average WAI then men (table 6), but this difference was not statistically significant (U=341; p=0,076). In an opposite way, other results in nurses revealed an average WAI higher in men (40,71 in men; 38,27 in women) (Cotrim, 2008). Our results may be explained because the women’s mean age was lower (31,94 yrs) then the men’s mean age (37,92 yrs).

Table 6 – WAI distribution by gender.

			WAI			
Gender	**N**	**Mean**	**Median**	**sd**	**min**	**max**
Women	60	39,20	40	3,93	28	44
Men	16	37,50	38	4,02	27	43

Regarding the differences between those with shift work and those with day shift (table 7), the average WAI was similar for the two groups and no statistically significant differences were found (U=277,5; p=0,706). Also, Cotrim (2008) didn’t find any differences between the two types of schedule, but she alerts for the role that the high physical demands have in the allocation of nurses from one unit to another and for the role that age have in changing nurse’s schedules from night shifts to day shifts. Furthermore, the mean age of those with shift work in our sample was higher (40,57 yrs) then the mean age of those with morning shift only (32,14 yrs). Similar results were found by Cotrim (2008).

Table 7 – WAI distribution by schedule.

			WAI			
Schedule	**N**	**Mean**	**Median**	**sd**	**min**	**max**
Shift work		38,56	41	5,70	27	44
Day shift		38,88	40	3,75	28	44

3.3. Occupational Risk Perception of Nurses and Nursing Assistants when Handling Patients
Only 5,13% of the nurses referred having some kind of work accident, in the last 12 months, related to patient handling. This group showed an average WAI inferior to those who hadn´t reported any accident (table 8), although they had a lower mean age (25,50 ± 2,64) compared with those without accidents (33,59 ± 9,66).

Table 8 – WAI distribution by workers' patient handling accident report.

	WAI					
Patient Handling Accidents	**N**	**Mean**	**Median**	**sd**	**min**	**max**
Yes	4	34,75	35,5	5,74	28	40
No	72	39,07	40	3,79	27	44

In our sample, 19,23% of the nurses and nursing assistants referred having used, at some point, dangerous methods for handling patients and 30,77% referred having carried out tasks for handling or transferring patients without the use of lifting equipment, when this was recommended. This last aspect can be explained by the fact that these care providers frequently presented a collection of motives for not using this kind of equipment: not enough time to perform the task using lifting equipment and non-available equipment. These findings are in accordance with Holman's et al. (2010) study, which refers as motives for nurses not using the lifting equipment: not enough time in an emergency situation, non-available equipment and existing space not big enough for its use (dimension, configuration and space cluttering). Also, Alamgir et al. (2009) refer that healthcare workers frequently note increased time to transfer as a concern associated with the use of mechanical lifts.

By professional group, nurses reported in a higher percentage having used, at some point, dangerous methods for handling patients and having carried out tasks for handling or transferring patients without the use of lifting equipment, when this was recommended (table 9). These results are a source of concern because nurses, in general, have a better training in patient handling techniques then nursing assistants.

Table 9: Occupational risk perception of nurses and nursing assistants during patient handling

		Nurses		Nursing assistants	
Occupational risk perception		N	%	N	%
Having used, at some point, dangerous methods for handling patients	Yes	11	31,43	4	9,30
	No	24	68,57	39	90,70
Handling or transferring patients without using lifting equipment, when this was recommended	Yes	13	37,14	11	25,58
	No	22	62,86	32	74,42

Those care providers, who have reported having used, at some point, dangerous methods for handling patients and having carried out tasks for handling or transferring patients without the use of lifting equipment, when this was recommended, showed an average WAI inferior to those who hadn´t (table 10).

Table 10: WAI distribution by patient handling risk perception of nurses and nursing assistants.

	WAI						
Occupational risk perception		N	**Mean**	**Median**	**sd**	**min**	**max**
Having used, at some point, dangerous methods for handling patients	Yes		38,13	39	4,82	28	44
	No		39,02	40	3,77	27	44
Handling or transferring patients without using lifting equipment, when this was recommended	Yes		38,25	38	4,23	27	43
	No		39,12	40	3,87	28	44

4. CONCLUSIONS

Overall, the sample showed, on average, a "good" work ability what is in agreement with other Portuguese studies (Cotrim, 2008; Cotrim et al, 2011). The Work Ability Index varied according to age (WAI diminishes as age increases) but this relation was, only, statistically significant for nursing assistants. However, nurses showed a higher average WAI than nursing assistants.

It is also interesting to note that those care providers that reported having had accidents in patient handling in the last 12 months had a lower WAI, although they were younger in average. Those that reported not to adopt practices that carry a risk in patient handling had higher values of WAI. In this perspective, Estryn-Behar et al (2005) stated that the perception of one´s physical workload significantly influences WAI.

In summary, the results of this study highlight the need to balance the demands of work activity of nurses and nursing assistants with its work ability in order to maintain welfare professionals throughout working life and productivity in healthcare units. In this perspective, the next step refers to the ergonomic analyses of the activities of care providers in order to characterize in detail the hazardous methods and the reasons underlying the patient handling without the proper lifting equipment, aiming at promoting a safety culture in patient handling that can contribute to maintain a better work ability.

Moreover, as Chiu et al (2007) said, health systems administration should consider the effect of age on work ability in both work design and job assignment for senior nurses. Several studies point out the relevance of improving working environment and organization in order to reduce physical and mental demands to better fit the work to senior nurses (Alamgir et al, 2009; Chiu et al, 2007; Cotrim, 2008; Estryn-Behar, 2005; Hignett et al, 2003).

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Forecasting the risk of WRMSDs in home care nurses

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ABSTRACT
Studies regarding work related musculoskeletal disorders (WRMSDs) in nurses have been carried out mostly in hospitals or in other institutional contexts. Information about this theme in providing home-based care is scarce. The main goals of this work are the characterization of musculoskeletal complaints in nurses who work at the Health Centers of the northern Portugal and that provide home-based care, the identification of the main risk factors present in the homecare context and the development of statistical models to forecast the risk in the same context. The principal methodology used in this work was a questionnaire developed in electronic format which was based on the "Standardized Nordic Questionnaire" for the analysis of musculoskeletal symptoms. It were used univariate models of binary logistic regression to estimate the risk of WRMSDs present in the practice of home-based care and also to assess which risk factors that could contribute to the appearance of complaints in the lumbar region in the professionals who provide homecare. The body areas with more musculoskeletal complaints are the back and the shoulders. The nurses who provide home care have nearly triple chance of having musculoskeletal complaints in the lumbar region than their counterparts of Health Centers (OR=3.19 ($p<0.05$), 95% Confidence Interval [1.26; 8.08]). We obtained various statistical models for forecast the risk of having low back complaints in home care nurses. From all of them was selected the one that presented more stability and reliability. The model performance was evaluated by ROC (Receiver Operating Characteristic) analysis yielding a value for the area under the ROC curve of 0.889 ($p<0.05$). This value reveals a high discriminating power, that is, the model is able to correctly forecast the complaints in the lumbar region in 88.9% of cases.

Keywords: Musculoskeletal Disorders; Nurses; Home Care; Logistic Regression

1. INTRODUCTION

Work related musculoskeletal disorders (WRMSDs) have been described as the most important occupational health problem tormenting the nurses (Barroso et al. 2007; Smith et al. 2006). Some authors report that about 3.5% of nurses leave the profession due to musculoskeletal problems (Stubbs et al. 1998). Further evidence of this problem are the high prevalence of both symptoms and injuries related to the musculoskeletal system in nurses (Alexopoulos et al. 2006; Barroso and Martins 2008; Barroso et al. 2007; Daraiseh et al. 2010; Menzel et al. 2004; Smith and Leggat 2003; Smith et al. 2004; Trinkoff et al. 2003; Yip 2001).

Caring for people is considered a risk activity, with a high prevalence of musculoskeletal complaints related mainly to the back (Alexopoulos et al. 2006; Barroso et al. 2007; Daraiseh et al. 2010; Knibbe and Friele 1996; Menzel 2004).

Despite back problems in nurses have a multifactorial etiology that includes physical, psychosocial and individual factors (Sherehiy et al. 2004), the manual handling of patients is considered one of its main causes (Hodder et al. 2010). In fact, the tasks involving manual handling of patients are those that are most often highlighted as causes of back problems (Byrns et al. 2004; Garg 2006; Hignett 1996; Lagerström et al. 1998; Marras et al. 1999; Violante et al. 2004; Yassi et al. 1995; Yip 2001). It's very important to reduce back complaints, because that may lead to the suffering of professionals, to a greater absenteeism and in some cases to an early retirement. In addition, have symptoms in the lumbar region can lead to the appearance of symptoms in other body regions (Daraiseh et al. 2010).

In general, studies conducted on this subject have been carried out in the hospital or institutional context. Information regarding WRMSDs in providing home-based care is scarce and in Portugal, for example, there is no knowledge of any study about this theme.

Although hospitals and similar institutions are applying policies to dramatically reduce manual handling of patients, in most cases of home care the use of mechanical lifting devices remains rare and manual handling of patients by only one person remains a very common task (Hess and Kincl 2006). Some studies indicate that injury and musculoskeletal disorders of the back and other body parts constitute a serious problem for professionals who provide home-based care, especially nurses and nursing assistants (Brulin et al. 1998a, 1998b; Cheung et al. 2006; Knibe and Friele, 1996; Meyer and Muntaner 1999; Ono et al. 1995; Pohjonen et al. 1998; Smith and White 1993).

In a study involving a comparative analysis of musculoskeletal disorders between Greek and Dutch nursing personnel, in hospitals and nursing homes, the authors refer that the work in the latter seems to entail similar risks as in hospital care, perhaps even a little more, as the work environment is less controlled and standardized (Alexopoulos et al. 2006). Following the reasoning of the authors, it can be assumed that the provision of home care can lead to yet a higher risk, since patients' homes are a work environment even less controlled, without any kind of pattern.

Based on the above information, it was thought that WRMSDs in nurses who provide home care was an issue of major importance.

The objectives of this work are the characterization of musculoskeletal complaints in nurses who work at the Health Centers of the northern Portugal and that provide home-based care; verify if provide home-based care, by itself, represents a risk factor for WRMSDs; identify the main risk factors present in the homecare context; development of statistical models to forecast the risk in the homecare context.

2. MATERIALS AND METHODS

The principal methodology used in this work was a questionnaire developed in electronic format which was based on the "Standardized Nordic Questionnaire" for the analysis of musculoskeletal symptoms (Kuorinka et al. 1987). It is a questionnaire well tolerated by workers, it's widely used and has been tested previously for reliability and validity (Björkstén et al., 1999). There have been some adjustments in order to better adapt to nursing activities carried out during the home-based care. Several questions were added in order to collect more information to enable the application of statistical techniques to identify the largest possible number of WRMSDs risk factors and evaluate its impact on the appearance of musculoskeletal complaints. The contents of the questionnaire were validated by nurses from several Health Centers. These nurses completed the questionnaire on paper, communicating to us afterwards if they had had some difficulty in interpretation of questions, if suggested any changes or even if they thought that should add questions. Thus, after several iterations, we obtained the final version of the questionnaire with their content validated. The questionnaire was available on a website to be filled in anonymously by nurses belonging to Health Centers from the North Region of Portugal.

The questionnaire was divided into four parts: A, B, C and D. Part A covers demographic aspects and aspects relating to the profession. It also incorporates an issue that allows us to distinguish between nurses who work only in the Health Center and those who provide home-based care. Part B includes the identification and characterization of complaints and musculoskeletal symptoms self-reported by nurses. Part C, which can only be filled by nurses who provide home-based care, begins by asking how many hours per week on average, are dedicated to home-based care. The following is a list of nursing activities, which asked the nurse to select the activity performed most often during the provision of home-based care. In view of this activity, the nurses are asked to answer to a series of questions that are, in fact, an adaptation of the technique REBA (Hignet and McAtamney 2000) for musculoskeletal risk assessment. With these questions, we wanted to know what was the perception that nurses had about the postures related to various body segments (trunk, neck, legs, arms, forearms and wrists), that they adopt in general during their activity more frequent at home visits, about the force exerted during the activity and also about certain features, for example whether the activity has a repetitive nature, whether nurses adopt static postures, the type of connection between nurse and patient, among others. The last part of the questionnaire, Part D, contains questions relating to various aspects still unexplored in the previous parts, as some physical factors and also psychosocial factors (Carneiro et al. 2010).

The questionnaire was released through an e-mail message sent to all Health Centers in the northern region of Portugal during the second half of 2009 and also through mail during the first half of 2010.

To estimate the risk of WRMSDs present in the practice of home-based care, we used univariate models of binary logistic regression. In this process, provide home-based care or not, was the factor used to evaluate the association with the musculoskeletal complaints related to the body zones under study. Based on these results, we used logistic regression to predict which risk factors that could contribute to the appearance of complaints in the lumbar region on the professionals who provide homecare. The evaluation of the performance of the resulting model was carried out using the ROC curve.

3. RESULTS AND DISCUSSION

We received 147 complete responses (response rate of 5.1%). The questionnaires received have been treated statistically by Statistical Package for Social Sciences (SPSS or PAWS Statistics 19.0®).

It was found that about 87% of nurses are female and about 13% are male. The average age of nurses that are part of the sample is 35.7 years (sd - 8.88); the seniority in the profession is 12.8 years (sd – 8.39); the seniority in Health Centers is 9.2 years (sd – 7.06). About 85% of respondents refer that provide home health care.

For the overall sample the body regions with most complaints are the back (the cervical region with about 73.5% of complaints followed the lumbar region with 64.6% and the dorsal region with 49.0%) and the shoulders with 49.0%, equal to the dorsal region. These values are somewhat consistent with those of other studies that also used questionnaires based on the "Standardized Nordic Questionnaire" (Kuorinka et al. 1987), carried out both at hospital context and at home care settings (Barroso et al. 2007; Cheung et al. 2006; Knibe and Friele, 1996). Based on this sample of respondents, no differences were found between the two groups of nurses at the level of complaints in various body zones, with except of the lumbar region for which the values are 40.9% and 68.8%, respectively for nurses who don't provide home care and for the nurses who do this.

All results presented from now relate only to the group of nurses who provide home care. It was found that in general, the home care nurses work alone. In this study, about 32.8% of them say they never have help from colleagues and 38.4% said they rarely have help. The remaining 28.8% says that have some help from colleagues with frequency, often and always.

The activities carried out more frequently in the home care settings are the treatment of pressure ulcers (44.8%) and the implementation of dressings (40.8%).

About the height of the bed (or any other surface) where the treatment of patients was performed, 80.8% consider it low, 18.4% consider it appropriate and 0.8% considers it high. Ninety-two point eight percent of nurses who provide home

care reported that usually they need to move the patient to treat him and 97.6% of nurses reported that in general there are no patients lifting/transferring devices.
In the questionnaire, nurses were asked to make a general characterization of the space where performed their duties. This characterization should be done for three parameters (disposition of furniture and equipment, available space for moving around the patient, arrangement and hygiene) and should be done using a *Likert* scale with five levels (1 – bad; 2 – mediocre; 3 – satisfactory; 4 – good; 5 - very good). The results obtained can be seen in the following three Figures (1, 2 and 3):

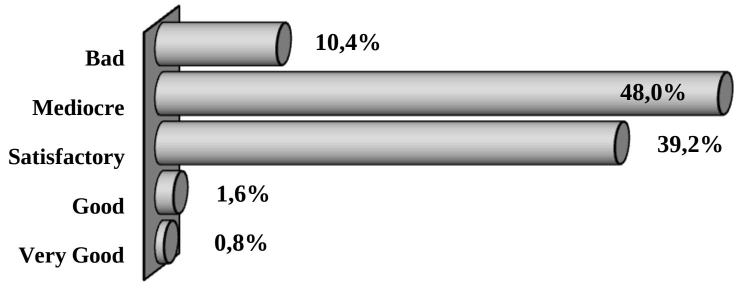

Figure 1 - Characterization concerning the disposition of furniture and equipment.

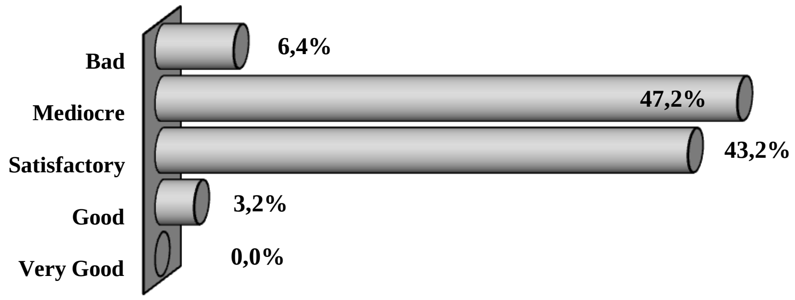

Figure 2 - Characterization concerning the availability of space for moving around.

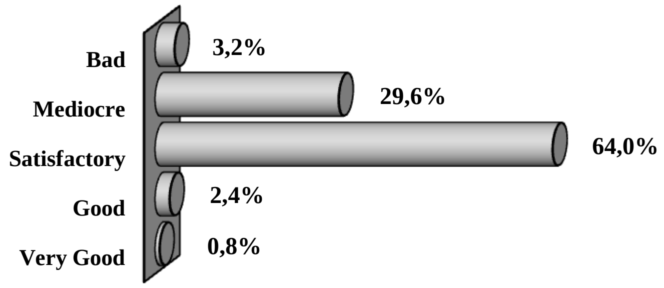

Figure 3 - Characterization concerning the arrangement and hygiene of the place.

As one can see in the graphs above, the results obtained for the characterization of the workplace are not very good, especially in what concern to the disposition of furniture and equipment and also in what concern to the availability of space for moving around. Sometimes, the lack of enough space for the nurse to move around the patient and a poor organization of the workspace, force the professional to adopt inappropriate postures that can lead to the appearance of musculoskeletal complaints (Barroso et al. 2006; Cappiello et al. 2005).
About 78.4% of home care nurses refer they feel satisfy with their work at the patients house.
To measure the association between the factors "provide home-based care" and "to have complaints at different body areas" (dependent variables) was carried out models of binary logistic regression to evaluate the odds ratio and respective confidence intervals. It was detect statistically significant association only for the lumbar region (OR=3.19 ($p<0.05$), 95% Confidence Interval [1.26; 8.08]), as can be seen in Table 1. This signifies that the nurses who provide home-based care have nearly triple chance of having musculoskeletal complaints in the lumbar region than their counterparts of Health Centers.

Table 1 – Odds ratio and 95% CI for the different complaints.

Complaints	Odds ratio	95% CI
Cervical	1.045	(0.377, 2.897)
Dorsal	1.468	(0.585, 3.681)
Lumbar	**3.185**	**(1.256, 8.076)**
Thighs	0.782	(0.212, 2.883)
Knees	0.601	(0.165, 2.188)
Ankles/feet	1.412	(0.426, 4.678)
Shoulders	0.769	(0.310, 1.910)
Wrists/hands	0.972	(0.376, 2.573)
Elbows	0.611	(0.156, 2.395)

After this verification, was investigated what factors, related only with home-based care nurses, which are associated with "to have complaints in the lumbar region". To this end, we used univariate models of binary logistic regression. We selected the variables that had a p-value lower than 0.2 ($p < 0.20$). We considered that the variables selected could contribute to the dependent variable (complaint in the lumbar region). Then, the variables were introduced in the forecasting model. To obtain statistical models for forecast the risk of low back complaints in home care nurses were used different methods for the selection of variables. From various statistical models obtained, was selected which presented more stability and reliability. To obtain this statistical model for forecast it was used stepwise forward (Wald Statistic) selection method. This process resulted in eight variables that, together, have a contribution to the risk of having complaints in the lumbar region. The contribution of each one may be positive or negative depending on the sign of the estimated coefficient. Positive contribution means that when the variable in question is verified in a particular work situation, increases the probability of lumbar complaints. In contrast, a negative contribution means that when the variable in question is verified, decreases the probability of lumbar complaints. The forecast model can be seen in Equation (1):

$$logit = 2.719 + 1.584 *X_1 - 2.222*X_2 - 1.237*X_3 + 2.093*X_4 + 1.187*X_5 - 3.404*X_6 - 4.047*X_7 - 2.056*X_8 \quad (1)$$

The meaning of the above variables is as follows:
X_1 - Complaints in the hands / wrists; X_2 - Complaints in the thighs; X_3 - Posture of the forearm; X_4 - Repetitive movements; X_5 - Posture of the arm; X_6 - The arm or its weight is supported; X_7 - Assistive devices for lifting/transferring patients; X_8 - Job satisfaction.
For a nurse who provides home care, calculating the likelihood of having complaints in the lumbar region is made through the Equation 2, below:

$$\hat{\pi} = \frac{e^{logit}}{1 + e^{logit}} \quad (2)$$

Some of the variables that are part of the forecasting model are often associated to back problems. Exemplifying and despite opinions are not unanimous, several authors refer that, whenever possible, should be used assistive devices for lifting/transferring patients in order to decrease the possibility of musculoskeletal problems (Elford et al., 2000; Evanoff et al. 2003; Kromark et al. 2009; Smith et al., 2006; Zhuang et al., 2000). The job satisfaction is also a factor sometimes referred to as a potential contributor to the occurrence of fewer musculoskeletal disorders. The dissatisfaction with certain working conditions may lead to musculoskeletal symptoms (Daraiseh et al. 2003). Repetitiveness of movements is also a recognized risk factor of WRMSDs (Bernard 1997; Brulin et al. 1998b). Other variables that are part of the statistical model for forecast the risk are less relevant in the literature, or even no, with respect to their possible influence on the occurrence of musculoskeletal disorders. However, it is known that sometimes the variables have no influence per se, but have it when combined with other variables. The inverse is also true. This is exemplifying in a literature review on risk factors associated with musculoskeletal problems (Malchaire et al. 2001). In fact, our study goes to meet the study of Daraiseh and colleagues, in which they stated that the complex interaction and the synergistic effects of different working conditions of nursing needed a better understanding since most researchers had not considered these aspects (Daraiseh et al. 2003).
The performance of the model was evaluated by ROC analysis yielding a value for the area under the ROC curve of 0.889 ($p<0.05$). The ROC curve obtained is in Figure 4. In this case, the area under the curve reveals a high

discriminating power, that is, the model is able to correctly forecast the complaints in the lumbar region in 88.9% of cases.

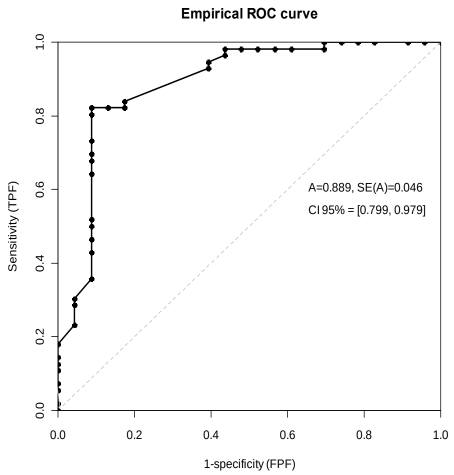

Figure 4 – Empirical ROC curve for the model.

4. CONCLUSIONS

Given that the number of responses received so far does not allow an inference about the population, however we can characterize this sample according to some important aspects, namely:

- To the overall sample the body zones with the greater number of complaints are the back (cervical – 73.5%, lumbar – 64.6%, dorsal – 49.0%) and shoulders (49.0%).
- About 80.8% of home care nurses consider the height of the bed (or other surface where's the patient) low; 18.4% consider it suitable and 0.8% consider it high. This is an important aspect because previous studies already revealed as a factor in the emergence of awkward postures and consequently of musculoskeletal complaints (de Looze et al. 1994).
- The results concerning to the characterization of the workplace performed by home-based care nurses are not very encouraging, especially in what concern to the disposition of furniture and equipment and also in what concern to the availability of space for moving around. Some of these aspects may even lead the nurses to the adoption of inadequate postures and consequently to the appearance of musculoskeletal complaints.
- We find a statistically significant association between "musculoskeletal complaints in the lumbar region" and "provide home-based care", (OR=3.19 ($p<0.05$), 95% Confidence Interval [1.26; 8.08]). So, the nurses who provide home-based care have circa triple chance of having musculoskeletal complaints in the lumbar region than their colleagues of Health Centers.
- To the group of nurses who provide home-based care, we find a model that includes eight factors that may contribute, positively or negatively, to the appearance of lumbar complaints. These factors are: complaints in the hands/wrists; complaints in the thighs; posture of the forearm; repetitive movements; posture of the arm; have the arm or its weight supported; assistive devices for lifting/transferring patients; job satisfaction. The statistical model obtained is able to correctly forecast the risk of having complaints in the lumbar region in 88.9% of cases.

As future work, new models for forecasting are going to be evaluated, only for the lumbar region since this was the only one that showed significant association with the provision of home care.

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Severity Factors of Accidents: Analysis of the Manufacturing Sector in Andalusia

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ABSTRACT
According to Occupational Health & Safety Assessment Series 18001, version 2007, the definition of "risk" is: "the combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that may be caused by the event or exposure(s)". Severity analysis is a key issue for risk assessment.
Several worker individual characteristics can affect proneness of occupational safety injuries and in case of injury, they also affect severity of injuries. In some cases, worker physical condition can be a protective barrier; in others worker differential behaviour can affect the use of protective measures.
Therefore, within the same activities, tasks and jobs, personal characteristics of workers as risk factors can explain differences in the severity of the accidents. Identification of those factors can help to develop better preventive programs and to perform risk assessment. If a certain category of workers are exposed to a certain risks in manufacturing industry, the odds of having a slight or non-slight accident would be related to their personal characteristics.
In this paper, we analyze which personal characteristics of workers are more likely related to severe and fatal accidents in Andalusian Manufacturing Sector in 2008. Severity according to the multivariate model is related to male, senior workers and foreign workers. Accidents are more severe for workers of micro and small companies, workers in activities of driving and working with machinery and workers employed as technicians and managers.
Specific preventive measures are needed for senior male workers, foreign workers and workers in micro and small companies in Andalusia Manufacturing Sector. Preventive programs at company level should take into account worker profile in training programs and task assignments need to consider personal characteristics.

Keywords: Injury rates, Worker profile, Accident Severity, Occupational Safety, Logistic Regression, Case-control, Manufacturing Sector.

1. INTRODUCTION

There are previous studies that show that in Spain there are explanatory variables for severe and fatal accidents. These studies are based on a case-control approach comparing worker characteristics of slight accidents and non-slight ones (Bolívar et al, 2009) (Villanueva & García, 2011).
Mechanisms of slight and non-slight accidents could be different (Salminen, 1992) and we cannot know if workers with slight and non-slight accidents were exposed to the same hazards.
Worker occupations, establishment activity and physical activities determine most of hazards at workplace and which injuries are expected. For this reason, we have controlled establishment activity (industry), job types (occupations) and physical activities (tasks) within manufacturing sector as indirect indicators of occupational risk exposure.
We have used National Occupation Classification (CNO-94), as an indicator of job type and NACE activity classification according to Council Regulation EEC Nº3037/90 (manufacturing sector includes NACE 15 to 37) as an indicator of enterprise's main activity. Physical activity was also included.
Besides hazard exposure, other predictors of work-related injuries can be classified in personal characteristics and work organization (Dembe et al, 2004).
Main personal worker characteristics are age, sex and nationality. Other personal characteristics related to safety behaviour are seniority and social class.
The literature on this topic indicates that young workers have more injuries than older ones, but the injuries of young workers are less severe than those of senior workers (Salminen, 2004) (Bolívar et al, 2009) (Villanueva & García, 2011). Higher severity of older workers has been identified in musculoskeletal injuries (Kelsch et al, 2009).
Besides age, there are other demographic variables such as nationality and gender. Immigrants are supposed to be another risk group, but there are important differences in terms of job assignment for each country and activity (Ahone et al, 2007). In Andalusia, foreign workers have smaller rates for slight accidents, but higher rates in manufacturing activities and fatal accidents (López-Jacob et al, 2008).
Although female workers show less severe accidents, this can be explained in terms of their different job assignment (Smith & Mustard, 2004) (Taiwo et al, 2008). In fact, when analyzed at the company level, female workers have more severe accidents at the same jobs and tasks as their male mates (Kelsh & Sahl, 1996). However, fatal accidents are very unsual in female workers (Bolívar et al, 2009) (Villanueva & García, 2011).
Seniority is related to experience of worker but also with job assignment. In previous studies the relationship with severity was inconclusive (Bolívar et al, 2009) (Villanueva & García, 2011).
The rest of the factors are related to worker labour conditions as type of company, contract type and work schedule. We considered them as possible confounding variables.

Temporary workers have more accidents and they are more severe ones (Benavides et al, 2006) (Villanueva & García, 2011). This is also associated to low seniority.
Working in small companies is considered a risk factor (Fabiano et al, 2004) (Sorensen et al, 2007). Small and micro companies have more severe and fatal accidents in comparison with medium and big companies as their safety management is less effective. However, some manufacturing activities concentrate more hazardous activities in companies with a certain minimum size.
There is evidence that extended time and shift at night also affects work safety and severity of injuries (Folkard, & Tucker, 2003) (Salminen, 2010) (Vegso et al, 2007).

2. MATERIALS AND METHOD

The study is based in comparing slight and non-slight accidents in Andalusian manufacturing sector in 2008. Although mechanism and exposure to slight and non-slight accidents are different, we assume that most of workers were exposed to similar tasks and hazards and possible differences in severity of accidents could be attributed to personal factors in some extent.
Non-slight accidents can be severe and fatal. Severe accidents are the result of a medical decision based on the expected length for recovery.
In Spain musculoskeletal disorders can be reported both as accidents and as occupational diseases. If the injury is referable to movements whereby the injured person's physical exertion exceeded what is normal, it is classed as a musculoskeletal accident. If the injury resulted from a long-term influence of working conditions it is reported as a musculoskeletal disease.
Most of the musculoskeletal accidents considered are strain and sprain injuries. It is important to note that around of 30% of accidents reported are musculoskeletal accidents, although most of them are usually non-slight ones.

2.1 Accident Data

We considered accident reports that are collected in "Official Workplace Incident Notification Forms", electronically collected through Delt@ information system. In Spain, it is mandatory that all accidents that result in an absence from work of one or more days must be notified.
For each accident reported, we have information about worker age, months of experience in the company, occupation, and some technical circumstantial information both from workers and companies. Relapses, accidents incurred when travelling to and from work and others that did not cause any absence from work, are excluded from the study. Accident severity is classified as non-severe and severe (serious accident with long recovery decided by physicians based on expected length of absence) or fatal.
Although not perfect, Spain´s accident reporting system shows good indicators for comprehensiveness and accuracy (Benavides et al, 2003) and we assume that slight accidents have been reported in most cases and that they are a non bias sample of workers in manufacturing sector.

2.2 Statistical Analysis

Case-control studies are used to identify factors that may contribute to show one of two possible categorical values, cases and controls. In some studies there is a selection of which cases and controls are studied, but we have included all accidents assuming that they were the result of the exposure of all workers. Cases selected are the severe and fatal accidents and the controls are the slight accidents.
Odds ratio are calculated with logistic regression (Agresti, 2002) with severity as dependent variable, both univariate and multivariate. In the multivariate analysis, we adjusted odds ratio for some worker characteristics, controlling possible confounding variables.
As accidents are multicausal, we tried to control as many possible confounding variables as we could. In case-control approach, odds ratio is the ratio of the odds of having a severe accident to the odds of having a slight one.
Logistic regression coefficients provide estimation for odds of each categorical value to one of them considered as a reference. If they are calculated with a multivariate model, those odds are adjusted considering the rest of variables of the model are constant (Sorock & Courtney, 1997).
SPSS v.18 was used to perform logistic regression after coding each accident variables with appropriate categorical values. Data, models and results are available under request.

3. RESULTS AND DISCUSSION

We have used a logistic regression model, where severity is the dependent variable with only two categorical values (slight or non-slight). Several models have been developed. First we calculate odds ratio in univariate analysis for each of the possible explanatory variables available. Afterwards, we tried multivariate models, both stepwise and with direct introduction of variables.

3.1. Univariate analysis of severity

The case-control approach can provide a first insight in which worker characteristics affects severity of accidents. As shown in Table 1, severe and fatal accidents are more frequent in male workers, older workers and foreign workers.

Non-permanent workers show less severe accidents. Also we found less severity in accidents of workers in companies with less than 250 employees (small and medium enterprises).

Tenure (months in the same position), age and job have no statistically significant relationship with the severity of accidents.

Table 1 – Univariate severity analysis. Andalusian Manufacturing Sector accidents reported in 2008

Variable	Categories	Slight accidents	Severe and fatal accidents	OR not adjusted (sig.)
Worker Gender	Female	2,533	12	0.45-0,64 (<0.01)
	Male	21,598	252	Reference
Worker Age	<30	8,924	62	Not significant
	30-44	10,136	113	
	>44	5,071	89	
Worker Nationality	Foreign	1,134	18	1.20-1.78 (<0.01)
	Spaniard	22,997	246	Reference
Job Type	Clerical	661	6	Not significant
	Qualified	17,816	196	
	Manager	105	3	
	Non qualified	5,327	55	
	Technician	222	4	
Company size (number of workers)	Micro (1-9)	33,587	675	2.01-2.88 (<0.01)
	Small (10-49)	65,755	994	1.52-2.15 (<0.01)
	Medium (50-249)	45,096	478	1.05.-1.53 (0.01)
	Big (>249)	17,601	147	Reference
Worker Tenure (in months)	0-3	5,827	60	Not significant
	4-12	5,324	56	
	>12	12,980	148	
Contract type	Non Permanent	11,701	125	0.84-0.99 (0.02)
	Permanent	12,430	139	Reference

3.2. Multivariate analysis of severity

As previous studies have shown, there are possible confounding variables because there are differences in task assignment depending on worker profile, and it should be controlled. We have used job, work type and physical activity to control task assignment in a multivariate analysis.

The adjusted model is shown in Table 2. R^2 of Nagelkeof this model is 0,10. Severity according to this model is strongly related to male, senior and foreign workers. Accidents are more likely severe for workers in micro and small companies, workers in activities such as driving and working with machinery and workers employed as technicians or managers.

Table 2 – Multivariate severity analysis. Andalusian Manufacturing Sector accidents registered in 2008.

Variable	Categories	Sig.	OR adjusted
Worker Gender (reference male)	Female	<0.01	0.51-0.73
Worker Age (reference >44)	<30	<0.01	0.39-0.49
	30-44	<0.01	0.57-0.70
Worker Nationality (reference Spaniard)	Foreign	0.01	1.16-1.74
Job Type (reference Technician)	Clerical	0.35	0.53-1.25
	Qualified	0.86	0.72-1.47
	Managerial	0.02	1.13-3.15
	Non qualified	0.84	0.72-1.50
Worker Tenure, in months (reference >12)	0-3	<0,01	1.06-1.30
	4-12	0,11	0.98-1.22
Company Size in number of workers (reference Big)	Micro (1-9)	<0.01	2.14-3.09
	Small (10-49)	<0.01	1.58-2.25
	Medium (50-249)	<0.01	1.11-1.61
Work type (reference Warehouse)	Agricultural	0.72	0.57-2.24
	Cleaning	<0.01	1.41-2.60

	Construction	<0.01	1.70-2.79
	Installation	<0.01	1.61-2.47
	Maintenance	<0.01	1.33-2.17
	Other	<0.01	1.20-1.86
	Production	0.32	0.91-1.32
	Services	<0.01	1.82-3.24
Physical activity (reference Transport)	Drive	<0.01	3.47-5.71
	Machines	<0.01	4.75-7.14
	Manipulation	<0.01	1.31-1.96
	Movement	<0.01	1.49-2.27
	Other	<0.01	3.84-6.26
	Tools	<0.01	1.40-2.15

3.3. Discussion

As previous studies have noticed, there are many differences in terms of jobs, skills and industries where workers are employed because of their personal characteristics. The purpose of this paper is show which worker characteristics are explanatory of severity of accidents even after adjusting the multivariate model.

As we are comparing slight and severe accidents in each worker category, the results indicates the odds of having a severe accident instead of a slight one for each category. However, as we did not control the number of workers, odds do not imply that the injury rate of severe accidents is higher or not. The strength of this work is to identify if severe accidents are more likely to happen than slight ones for a specific category but not if the risk in terms of injury rates as we do not control the amount of workers exposed and the task assigned.

Task assignment has been identified by job, company activity, work type and physical activity. As expected, jobs such as construction, installation and maintenance are hazardous and the more severe accidents occurred in driving and machine operating tasks son accidents used to be more severe than in other assignments.

Type of contract has no significant relationship in the adjusted model. Although workers with non permanent position are not as well trained as the permanent ones, one possible explanation is that they are employed in less hazardous tasks.

Female workers have less severe accidents. To explain this result, some authors consider that; even with the same working place, job and activities; there is differential segregation of tasks. Heavy works and hazardous activities are assigned to male workers. Although female workers have more musculoskeletal injuries, severe and fatal accidents are more likely related to tasks assigned to male workers.

Young workers have less severe accidents, possibly because of their stronger physical condition under similar accident scenarios. Management should take into account this result in assigning tasks to senior workers. Additional preventive measures should be provided for them. In our univariate analysis age was not significant, perhaps because of its association with work type. In fact, in maintenance and services, the percentage of old workers was higher as those jobs need of higher qualifications.

Foreign workers are identified as another risk factor for severity in our model. Besides the possibility of assignment segregation, foreign workers have usually less adequate training and they have a different understanding of safety rules. Preventive activities should focus on foreign workers to assure that they are equally trained.

Tenure is an important protective factor. Training and knowledge of jobs and preventive measures can explain that workers with less than one year in the company have more severe accidents. Specific preventive actions should be implemented to deal with this period of training.

4. CONCLUSIONS

Safety deals with accident risk. Accident risk depends on probability of accidents and their consequences. Part of preventive activities should be dedicated to protect workers in case of accident. Worker characteristics, according to our research, are important explanatory variables of severity of accidents in Andalusian Manufacturing Sector and preventive plans and protection measures should consider these results.

As risk is a combination of the likelihood of an occurrence of a hazardous event and the severity of injury, some worker characteristics should be taken into account in risk assessment. Even though we did not calculate the likelihood of accidents for each task, activity and category of workers, the results provide important warnings of

Specific preventive measures are need for senior male workers, foreign workers and workers in micro and small companies in Andalusia Manufacturing Sector. New workers in company need better safety training. Even after controlling work type and physical activity, those personal characteristics show statistical significance in our model. Safety assessment needs to be performed accounting not only technical issues but also who are the workers assigned.

Limitations in our results are mainly related to lack of knowledge of worker's real assignment and risk exposure. Also, our method of case-control approach can be bias because slight and non-slight accidents do not have the same causation path and mechanisms. Some accidents are more likely severe such as the falling from height or being struck by a machine. If certain categories of workers are more likely assigned to those tasks, part of the differences identified could be explained.

Mechanism of traumatic accidents and musculoskeletal accidents are very different too. Further research should be done of differential risk factors for each injury type in order to consider those possible differences and to detect if gender, age and nationality are explanatory variables considering the type of injury.
A possible alternative strategy for a deeper research should be matching cases and controls based on accident causation path (Holcroft & Punnet, 2009).

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Safety at work and worker profile: analysis of the manufacturing sector in Andalusia in 2008

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ABSTRACT
According to the Encyclopaedia of Occupational Health and Safety (Saari et al, 1998), causes of accidents should be classified as immediate causes (unsafe acts, unsafe conditions) and contributing causes (safety management performance, mental condition of workers and physical conditions of workers). This model implies that individual worker characteristics can affect occupational safety in terms of proneness to injuries because they are related to physical and mental conditions. Within the same company, activity, task and job, there would be personal risk factors that can affect the likelihood of accidents. The identification of those factors can help to develop better preventive programs and optimize resources. Public prevention programs can be designed and adjusted to those collectives of workers at risk. Future Public Strategies should propose specific actions for them.
In this paper we analyze which worker characteristics can constitute risk factors in the Andalusian Manufacturing Sector (activities classified as NACE from 15 to 27 according to Council Regulation EEC Nº3037/90) based on the First Andalusia Working Conditions Survey Instituto Andaluz de Prevención de Riesgos Laborales, 2009).
Workers in manufacturing sector are not equally employed and there is a differential job assignment in terms of activities, occupations and tasks for different collectives. Differences in job assignment can confound the true relationship between worker characteristics and accident proneness. The cross-sectional data gathered can be used to control some of those possible confounders using a multivariate logistic regression model. The main strength of this paper is controlling possible confounding variables, such as activities, occupations and company size. Adjusted odds ratio show some risk factors as being older than 45 years old, having more than 6 months of experience, being employed as technicians, reporting mechanical as their main risk or working on average more than 45 hours per week.

Keywords: Risk factors, Worker profile, Occupational Safety, Logistic Regression, Manufacturing Sector, Working Condition Survey.

1. INTRODUCTION

In this paper we analyze which worker characteristics can constitute risk factors in the Andalusian Manufacturing Sector (NACE 15 to 27, Council Regulation EEC Nº3037/90) based on a survey of working conditions. Working Condition Surveys allowed cross-sectional analysis of safety at work and identification of predictors of work-related injuries (Dembe et al, 2004; Warner et al, 1998). Our purpose is to determine if there are worker characteristics that influence accidents in Manufacturing Sector in Andalusia like age or gender, controlling possible confounders such as differential employment of each worker group or company characteristics.
There is no previous information in Andalusia about which worker characteristics could influence injury rates in the manufacturing sector. Explanatory variables have been selected based on a literature review. Main variables should be worker occupation and the company's main activity because they determine most of the injury hazards at workplace related to immediate causes (unsafe conditions).
Other possible explanatory variables at company level are company size (Sorensen, Hasle & Bach, 2007), work shifts (Folkard & Tucker, 2003), extended work hours (Vegso et al, 2007) and type of contract (Benavides et al, 2006; Saloniemi & Salminen, 2010).
According to previous studies the individual worker risk factors that should be taken into account are: age, gender, nationality and seniority. As demographic variables their distribution among manufacturing activities and tasks are differential. It is known that some specific works and tasks are assigned to male, foreign or experienced workers.
The majority of studies have reported that young workers had a higher injury rate, especially if they are men (Salminen, 2004) or under 18 years old (Walters et al, 2010). However there are some findings of U-shape relationship (Lin et al, 2008). This behaviour has also been checked at company level (Pollack et al, 2007; Loomis et al, 1999).
There are important differences in terms of job assignment for each country and activity and foreign workers are expected to be employed in more dangerous tasks (Ahonen et al, 2007). However, topics like cultural and language can affect their safety behaviour, and not every ethnicity shows the same pattern (Pollack et al, 2007; Dembe et al, 2004).
Female workers show lower injury rates as a general trend (Islam et al, 2001) but not for every industry or occupation. In fact, when analyzing at company level, female workers have more accidents than their male counterparts (Taiwo et al, 2008; Kelsh & Sahl, 1996; Pollack et al, 2007). Even with the same jobs and tasks. Some authors propose that this can be explained because of differential jobs and task assignment (Smith & Mustard, 2004) and the differential mechanism of

injury (Leijo et al, 2005). Moreover, men have higher rates for acute injuries and women for musculo-skeletal ones. Specific injury types are more frequent for female workers.
Seniority is a very difficult variable. Survey gathered how many months the worker has been in the company. This variable could show the expertise of a worker but this can be confound by their previous training and other working experiences in other companies. At company level, both time in current job and time since hire seems to be a protective factor (Pollack et al, 2007)
As a first insight and reference, we have calculated raw injury rates based on official notifications of accidents and in the estimation of number of workers gathered by National Employment Survey ("Encuesta Nacional de Población Activa") performed by National Institute of Statistics ("Instituto Nacional de Estadística") and available at http://www.ine.es. Accident notifications are electronically collected through Delt@ information system in Spain for all accidents that result in an absence from work of one or more days. Stratified information in terms of age, gender and seniority for Andalusia is available only for some manufacturing activities (NACE 15 to 22 and 26 to 37). Raw injury rates are higher for young workers, inexperienced and male workers (see Table 1).

Table 1 –Raw Injury Rates estimation based on National Employment Survey (accidents per 1,000 workers).

Characteristic	Categorical value	Workers (x1,000)	Number of Accidents	Injury Rates
Age	<30	40.43	8,155	201.70
	30-44	65.27	8,833	135.33
	≥45	44.98	4,519	100.47
Seniority (tenure in months)	<12	39.39	11,267	286.04
	≥12	164.90	10,566	64.08
Gender	Male	151.18	19,720	130.44
	Female	53.11	2,201	41.44

2. MATERIALS AND METHOD

2.1 First Andalusian Working Conditions Survey

The universe used for this survey consists of currently employed people who work in any economic activity, living in villages with more than 5000 habitants in Andalusia. Sampling unit is the worker. The sample frame has been obtained from the Active population survey (EPA 2006) which provides grouped data according to the activity sector where working, and the province of residence. Resultant population is composed of 3.219.200 workers. It has been stratified in terms of province of residence, gender and, economic activity and number of employees in the company they are working in.
In relation to economic activity, companies have been included in thirteen groups, as suggested by the Spanish Classification of Economical Activities CNAE-93. Global results have been synthesized in four productive sectors: agriculture, manufacturing, construction and services and six groups of company's size: no employees, from one to nine, form 10 to 49, form de 50 a 249 employees, from 250 to 499, and over 500 employees.
Information was collected trough personal interviews carried out in the interviewed' homes which were selected following random routes. It was hoped to achieve maximum margin of error for every final strata to be under 5%, for a level of confidence of 95,5% and P=Q. Because of that, sample size is fixed in 8275 interviews.
The questionnaires covered issues of type of employment, leadership styles and worker participation as well as the general job context, working time, work organization, pay, work-related health risks, cognitive and psychosocial factors, work-life balance and access to training.

2.2 Manufacturing workers data.

Only those cases who declare being employed in the manufacturing sector have been analyzed (909 cases). Survey micro-data and regression models are available upon request for other researchers.
For each case, there are available several explanatory variables, based on their reported answers. Workers were asked if they had been involved in at least one accident during the last two years. This variable is used as the dependent variable in logistic regression analysis of data (108 cases reported accidents). We have calculated the odds ratio, both univariate and multivariate. For each variable we have classified cases according to categorical values. One of these categorical values is used as reference for odds ratio calculation (therefore OR is 1.00 for reference variables).

3. RESULTS AND DISCUSSION

3.1. Univariate analysis of First Andalusian Working Conditions Survey.

The categorical variables were checked as explanatory risk factors (Table 2). According to the univariate analysis, risk factors are: male workers, workers over 45 years old, workers in big companies, technicians, workers in companies with worker representation, workers with more than 45 hours per week, workers with night or rotating shifts, workers of subcontractors, workers without a university degree and workers who reported that their main risk was falling, mechanical or working place.

Table 2 –Univariate Logistic Regression analysis of I Andalusian Working Conditions Survey.

Variable	Categories	Cases	Injured	OR (sig.)
Gender	Male	605	100	1.94-8.47 (<0.01)
	Female	196	8	Reference
Age Type	16-29	276	14	0.11-0.39 (<0.01)
	30-44	358	53	0.39-0.94 (0.03)
	45-64	167	41	Reference
Contract Type	Permanent	558	85	Not sig.
	Temporal	232	23	Reference
Outsourcing	Direct Work	765	99	0.23-1.05 (0.06)
	Subcontractor	34	9	Reference
Company Size	Micro (1-9)	448	51	0.26-0.69 (<0.01)
	Small (10-49)	122	16	0.25-0.94 (0.03)
	Medium (50-249)	116	10	0.15-0.68 (<0.01)
	Big (>249)	115	31	Reference
Seniority (tenure in months)	Inexperienced (1-2)	186	7	0.08-0.39 (<0.01)
	Experienced (3-6)	226	18	0.22-0.64 (<0.01)
	Senior (>6)	389	83	Reference
Education	Primary	345	50	1.51-9.88 (0.01)
	Secondary	323	53	1.71-11.16 (<0.01)
	University	133	5	Reference
Occupation	Clerical	128	2	0.01-0.16 (<0.01)
	Manager	70	5	0.06-0.46 (0.01)
	Non Qualified	184	17	0.12-0.42 (<0.01)
	Qualified	337	50	0.22-0.59 (<0.01)
	Technical	82	34	Reference
Worker Representation	Yes	375	76	1.75-4.17 (<0.01)
	No	426	32	Reference
Main Risk (self-reported)	Fall	193	21	1.74-11.09 (<0.01)
	Mechanical	193	64	5.67-31.54 (<0.01)
	Hygiene	85	4	Not sig.
	Workplace	88	13	Not sig.
	Other	242	6	Reference
Working hours per week	<40	113	4	0.03-0.28 (<0.01)
	40-45	592	68	0.19-0.48 (<0.01)
	>45	96	36	Reference
Shift Type	Morning	349	36	0.30-0.77 (<0.01)
	Afternoon	227	24	0.29-0.84 (0.01)
	Other	225	48	Reference

In univariate analysis, other variables show no significant relation with accidents: nationality, type of company (private or public) training hours in the last two years, contract type, outsourcing and some main risks perceived as hygiene or workplace. Explanatory variables, chosen to be included in a multivariate regression, are: gender, age, company size, worker representation, education level, occupation, seniority, main risk, weekly working hours and shift type.

Nationality could not be analyzed as none of the foreign workers (13 cases) reported an accident in the last two years. Future survey sampling should be adjusted to have enough cases of this emergent issue in safety science.

3.2. Logistic regression analysis of First Andalusian Working Conditions Survey.

As the survey is a cross-sectional study, multivariate logistic regression can be performed to check if there are possible confounders of the univariate relationships. We tried several options, both backward and forward stepwise introduction of variables; finally two models were adjusted (with SPSS v.18) because seniority and age are strongly correlated and they should not be included at the same time.

After adjusting these models, see results in Table 3, personal characteristics such as gender, age and education are no longer significant and they were not included. Also, no evidence could be found to support the idea that company size, worker representation, shift type or subcontracting are safety risk factors according to the models.

The adjusted models show that in Andalusian manufacturing sector main risk factors are occupation as technician, seniority longer than 6 months, working over 40 hours per week and reporting of mechanical as the main risks.

Table 3 – Multivariate Logistic regression analysis of I Andalusian Working Conditions Survey. Model 1.

MODEL I (with seniority)			
Characteristic	**Categorical value**	**Sig**	**OR (adjusted)**
Occupation type (reference "Technician")	Clerical	0,008	0,027 - 0,582
	Manager	0,066	0,116 - 1,071
	Non Qualified	0,062	0,231 - 1,038
	Qualified	0,009	0,253 - 0,819
Seniority in months (reference ">6")	1-2	0,006	0,134 - 0,717
	3-6	0,008	0,250 - 0,817
Main risk (reference "Other")	Fall	0,127	0,802 - 5,868
	Mechanical	<0,001	2,650 - 16,256
	Hygiene	0,825	0,303 - 4,475
	Workplace	0,072	0,917 - 7,728
Working hours per week (reference ">45")	<40	0,003	0,058 - 0,557
	40-45	<0,001	0,184 - 0,532

Table 4 – Multivariate Logistic regression analysis of I Andalusian Working Conditions Survey. Model 2.

MODEL II (with age)			
Characteristic	**Categorical value**	**Sig**	**OR (adjusted)**
Occupation type (reference "Technician")	Clerical	0,003	0,022 - 0,465
	Manager	0,022	0,095 - 0,835
	Non Qualified	0,002	0,157 – 0,646
	Qualified	0,001	0,212 - 0,660
Age (reference "45-64")	16-29	<0,001	0,118 - 0,469
	30-44	0,092	0,390 - 1,074
Main risk (reference "Other")	Fall	0,052	0,990 - 6,970
	Mechanical	<0,001	3,151 - 19,151
	Hygiene	0,918	0,277 - 4,168
	Workplace	0,035	1,085 - 9,026
Working hours per week (reference ">45")	<40	0,001	0,050 - 0,463
	40-45	<0,001	0,205 - 0,573

4. CONCLUSIONS

Workers in manufacturing sector are not equally employed and there is a differential work assignment in terms of activities, occupations and tasks for different collectives as female, foreign or young workers. Differences in work assignment can confound the true relationship between worker characteristics and accident proneness. The cross-sectional data gathered can be used to control some of those possible confounders using a multivariate logistic regression model (R^2 Nagelke = 0,298).

The main strength of this paper is controlling possible confounding variables, such as activities, occupations and company size. Adjusted odds ratio show some risk factors of being injured in manufacturing sector as being older than 45 years old, having more than 6 months of experience, being employed as technicians, reporting mechanical as their main risk or working on average more than 45 hours per week.

Other variables like gender are not significant when occupation and main risks are included in the model. This result implies that female accidents are more related to job assignment in the Andalusian manufacturing sector. Age and seniority have a strong association. We checked two models (I and II), age was significant if seniority was not included. This means that seniority is more important than age in terms of statistical signification but age is a risk factor. Thus, workers with over 45 years old and long tenure in the same company would need special re-training and safety motivation. This is the main result provided.

Further research is needed both to confirm the role of the factors studied and to better understand how these factors influence in the occurrence of accidents.
In the meanwhile, there are actions that could already be performed: re-training of long-tenured workers and ok workers over 45 years old, avoiding extended working time or, if this is not possible, providing additional preventive measures, especially for those who work more than 45 hours per week. Andalusian Strategy for Occupational Health and Safety now in progress should take into account these results and design specific preventive programs for these collectives.
Main limitations of this study are related to quality of data as it is based on survey data. Besides, the models only considered the existence of accidents but neither its severity nor the type of injury (mechanism are different for traumatic, musculo-skeletal and non-traumatic accidents). The information through accident investigation of how certain worker characteristics explain accident causes can help in that purpose and will be helpful for safety assessment and production organization.

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Which companies have more accidents? Analysis of the companies of the manufacturing sector in Andalusia

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ABSTRACT
Injury rate is an indicator of the labour risk prevention performance. There are other indicators more helpful for safety purposes as those from safety climate assessment or safety audits but it is the most used.
Causes of occupational accidents can be classified as micro-level, meso-level and macro-level. Most causes are attributed to micro-level (worker and job conditions) but other causes (at macro and meso levels) can influence accident occurrence. Our interest is to identify possible explanatory variables of injury rates at meso-level.
In this study we focus on company injury rates. We have analysed injury rates of manufacturing companies in the south of Spain (Andalusia) collected from accident reports registered from 2003 to 2008. This study offers a perspective on the relationship between injury rates of a company and some explanatory variables. Typical factors at company level would be economic and financial, organizational, safety management and profile of staff.
Turnover and profits per employee are both significant in univariate and multivariate analysis. Companies with a bigger turnover per employee have usually higher relative injury rates. This can be explained both in terms of work stress and working pace and in terms of intensity in the use of production assets.
Further research should be done, and better indicators of safety management should be included to decide which economic and financial ratios are explanatory of safety at work. This preliminary result shows that there is a risk for management if they misunderstand the importance of occupational safety.

Keywords: Economic performance, Benefits of safety, Injury rate, Small size companies, Accident risk factors, High risk companies.

1. INTRODUCTION

Injury rate is an indicator of the labour risk prevention performance. Injury rate is a lagging indicator that only has safety interpretation when we can control exposure levels whereas other indicators can be more helpful for safety purposes as those from safety climate assessment or safety audits. Moreover, occupational accidents have a highly skewed distribution and multiple factors. In spite of these limitations (Sgorou et al, 2010), it is the most used indicator and therefore there is an interest in which factors can explain differences in company's injury rate.
Causes of occupational accidents can be classified as micro-level, meso-level and macro-level (Cedergren & Petersen, 2011). Most causes are attributed to micro-level (worker and job conditions) but other causes (at macro and meso levels) can influence accident occurrence. Thus, explanatory variables of injury rates can be associated to micro, meso and macro levels.
We have to account that most of causes of accidents and risk factors are related to micro-level. Therefore meso-level factors will explain a small part of variance of injury rates and any regression model only based in company level explanatory variables will have little predictive capacity. Besides, we do not have information about many other possible explanatory variables (Cagno et al, 2011) (Zwerling et al, 1997).
At macrolevel (regional or national level), some studies have suggested a relationship between evolution of injury rates and some macroeconomic variables (Davis et al, 2009) (Lanoie & Tavenas, 1995) (Anderson & Buchholz, 1988). Most of explanatory variables are associated to labour market.
There is evidence that safety management practices are explanatory of injury rates (Shannon et al, 1997) (Geldart et al, 2010). Workplace factors, both technical and organizational, determine a safety environment.
Company size (Leigh, 1989) (Fabiano et al, 2004) has been found significant to explain the injury rate at company level. Also establishment size is a significant factor (Nichols et al, 1995). In manufacturing sector, most companies have only one establishment. In our study we have chose company size. Injury rates are related to company size because of better safety management in bigger companies. In Spain most small and micro companies do not have workers specialized in safety and rely on external consultant services (called "Servicios de Prevención Ajenos") whereas medium and big companies have their own preventives services and workers with safety assignment. Another issue considered has been the differential attitudes of management (Huang et al, 2011).
Some experts have also pointed out that economic performance at company level could be related to safety management effectiveness (Fernández-Muñiz et al, 2009) (Arocena et al, 2008). These studies were based on survey and not in accounting data.

There is a growing interest in safety as a business case. Some studies have tried to demonstrate the economic advantages of safety management (Verbeek at al, 2009) whereas recent research could not find any effect of safety investment in the company's economic performance (Kankaanpää et al, 2008).
Economic and financial ratios are usually used to identify company economic performance. Ratios usually used for these purposes are sales, operating margin, debt ratio and profitability. If we find that there is a relationship between injury rate and such ratios, they can be included as explanatory variables in regression models. These regression models are interesting in terms of public policies and program evaluation, because these models can be used to detect which companies have worse safety performance and would need public assessment. Besides, these models can be used to evaluate the success of public programs and also of private preventive initiatives.
Very few of these analyses have been done at enterprise level (Filer & Golve, 2003) (Corcoran & Shackman, 2007) including economic or financial factors. They show that relationship is not straight forward, at low level of operating margin they found safety was positive correlated with operating margin. Debt or leverage was also a factor considered.

2. MATERIALS AND METHOD

2.1. Accident reports data

In Spain, it is mandatory that all accidents that result in an absence from work of one or more days must be notified. Data sets are collected from official Workplace Incident Notification Forms. This accident report is reported by electronic means using an on line application called Delt@. For each report we have information about worker age, months experience in company, occupation, seniority and some technical circumstantial information both from workers and companies. Relapses, accidents incurred when travelling to and from work and others that did not cause any absence from work, are excluded from the study. Accident severity is classified as non-severe, severe (serious accident with long recovery decided by physicians) and fatal (deadly).
We have calculated some variables associated to company's profile as indicators of possible risk factors. Although injured workers are a bias selection of workforce, they provide an estimation of how is the company staff profile. According to previous studies we have considered as possible explanatory variables percentage of women (Taiwo et al, 2008), age of workers (Salminen, 2004), tenure or contract type (Benavides et al, 2006) (Saloniemi & Salminen, 2010). Most of these explanatory variables were included in econometric studies at company level (Leigh, 1989) (Filer & Golve, 2003) (Corcoran & Shackman, 2007) as control variables in the regression models.
Others possible explanatory variables are related to work organization. Assuming that there is also a bias in this data, we have calculated the percentage of accidents on weekends for each company and in extended time (Folkard & Tucker 2003) (Vegso et al, 2007) (Salminen, 2010).

2.2. Cohort of companies

Companies selected for this study are identified with their fiscal identity number –CIF-. Only companies with the main activity in manufacturing sector are included (activities are coded with NACE rev.1 approved by Council Regulation EEC nº 3037/1990 as the statistical classification of economic activities in the European Community, manufacturing sector includes activities from 15 to 37 section).
The financial accounting data has been gathered from "Andalusian Companies Economic and Financial Analysis" published by "The Andalusian Financial Enterprise Analysis Institute", and it is data collected from official accounting reports. In this study we use accounting data for 2007 year (Central de Balances, 2009). We have chosen only industrial manufacturing companies with accounting data gathered available
Accidents and injury outcomes are very rare in small companies, and if there is not any accident, we lack of information about the company. For this reason, we have selected only companies with at least one accident in every year of the period 2005-2008. This has been used in other studies in order to have a more stable set of companies (Haviland et al, 2010) (Morse et al, 2004), but an indirect effect of these criteria is excluding most of micro and small companies.
A set of 1,183 companies were selected using accounting and accident report information. As our dependant variable is defined using the mean activity injury rate, we decided to consider those companies in activities with at least 50 cases in order to have enough cases in every activity. From all activities with NACE in manufacturing sector (15-37), only 8 activities had at least 50 companies. Finally, only 1,003 companies from those 8 activities were included in the study.

2.2. Descriptive statistics

There are significant differences for injury rates in terms of both activity (see Table 1) and company size (see Table 2). Most authors consider as a rule of thumb that regression analysis needs a minimum of ten cases per explanatory variable. Injury rate is calculated as number of accidents per 1.000 of workers. As expected standard deviation for injury rate is very big.

Table 1 – Univariate severity analysis. Andalusian Manufacturing Sector accidents registered in 2007

NACE	Mean of injury rate	Standard deviation of injury rate	Cases
15 Food and beverages products	156.15	122.79	186
20 Wood products	212.85	196.14	50
26 Non-metallic mineral products	194.74	147.33	160
27 Basic and fabricated metal products	229.11	189.44	56
28 Metal products	275.58	213.33	241
29 Machinery	186.64	130.68	67
35Other transport equipment	271.47	227.26	52
36 Furniture and n.e.c.	171.89	137.76	191

In terms of company size there are also significant differences. However, micro and small companies mean injury rates are calculated with companies with accidents in every year, so many small companies are not included. This can explain that their injury rates are bigger.

Table 2 – Univariate severity analysis. Andalusian Manufacturing Sector accidents registered in 2007

Company Size	Mean of injury rate	Standard Deviation of injury rate	Cases
MICRO (1-9)	458.05	756.86	79
SMALL (10-49)	200.78	158.46	791
MEDIUM (49-249)	148.36	123.16	282
BIG (≥250)	123.65	140.59	31

2.2. Methods

Injury rates as a result of accident risk are related to many different variables. There are immediate causes such as work and prevention conditions but also environmental factors. From a socio-technical perspective, organizational and climate issues influence safety. In order to take into account this multifactor model, we used a regression model.

Not all the explanatory variables are included and we lack proper information about safety and work conditions in each of the companies so unfortunately expected injury rates in terms of intrinsic risks are not available.

Poisson or Negative Binomial has been usually used to model injury rate behaviour (Quintana & Pawlowitz, 1999) (Bailer et al, 1997). In econometric models (Filer & Golve, 2003) (Corcoran & Shackman, 2007), linear regression is of common use.

Although those approaches are possible, we preferred to use a logistic regression instead. This logistic regression is used in a similar way to epidemiology studies, and it is easier to understand. Another advantage of categorical analysis is that it is easier to identify company profiles.

Dependent variable is a dichotomise variable depending on if injury rate is higher than 150% mean injury rate in their activity. This is a criterion used in Andalusia to decide if a company needs public safety assessment (PAEMSA is the acronym of a program for high injury rates companies in Andalusia). Explanatory variables available were categorized.

3. RESULTS AND DISCUSSION

We calculated odds ratio for each explanatory variable to dependent variable PAEMSA (see Table 3) in univariate analysis. In the Andalusian manufacturing companies, we have found statistical significant relationship between their size, turnover and profits per employee and the probability of being included in public assessment (PAEMSA). Also, in univariate model, mean tenure of injured workers was a significant explanatory variable.

Multivariate analysis allowed us to control possible confounders of these relationships. Turnover and profits per employee were both significant in univariate and multivariate analysis.

Companies with a bigger turnover per employee usually have higher relative injury rates. This can be explained both in terms of work stress and working pace and in terms of intensity in the use of production assets.

Companies with a high profitability per employee show higher relative injury rates, too. Tradeoffs between safety and profitability are a common concern among safety experts. Although most authors consider that a proper safety management should be interesting from the economic point of view (this is known as "the safety business case"), some companies are able to have economic success even with theoretical poorer safety behaviour.

Table 3 – Logistic regression model. Dependent variable PAEMSA (relative injury rate > 150%)

Variable	Categories	OR not adjusted (sig.)	OR adjusted (sig)
NACE	15, 26, 27, 28, 29, 35, 36	Not significant	Not significant
Company Size (ref. no micro)	Micro (0-9)	2.33-6.38 (0.00)	2,16-6.33 (0,00)
% Injured Women (reference < 5%)	(5-10), (10-50), ≥50	Not significant	Not significant
% Injured Foreign (reference < 3%)	(0-3), ≥3	Not significant	Not significant
Mean Age of Injured (reference 35-45)	<30, (30-45)	Not significant	Not significant
Mean Tenure of Injured (reference >24)	<12	1,06-2,92 (0,03)	Not significant
	(12-24)	1,11-3,48 (0,02)	Not significant
% Injured temporary (reference 30-70)	<10, (10-30), ≥90	Not significant	Not significant
% Injuries on weekends (reference ≥3)	(0-3)	Not significant	Not significant
Turnover k€/employee (reference ≥ 200)	(0-200)	0.48-0,99 (0.05)	0.31-0.75 (0,00)
Profits k€/employee (reference ≥ 5)	(0-5)	1.02-2.21 (0.04)	2.05-1.29 (0,00)
Economic profitability (reference 0-5)	<0, (5-10), ≥ 10	Not significant	Not significant
Return on equity (reference 0-10)	<0, (10-20), ≥20	Not significant	Not significant

4. CONCLUSIONS

Control variables were obtained as percentage of each characteristic in the accident reports. They are a bias estimation of real staff profiles, but as they were not significant, their influence in the direction of relationships should be weak.

In a first approximation, we have found a relationship between company financial and economic ratios and injury rates. Although injury rates are not the best safety indicator, the "safety business case" could be a trap. Some companies have a good economic performance with a high injury rate in comparison with their activity counterparts.

Possible explanation of this situation, in Spain, is the way costs of non-safety are shared through a public insurance system. Insurance costs are almost constant and independent of injury rates. Public enforcement of European Frame Work of Health and Safety at Work should discourage such temptation and correction measures are needed in the public insurance system.

Little efforts, but relevant ones, have been implemented in the last years in Spain with the introduction of a bonus system that depends on the reduction of injury rates to acceptable levels (Ministerio de Trabajo e Inmigración, 2010). These corrections are still not enough to balance the safety-profitability trade-off in Spain.

Further research should be done, and better indicators of safety management should be included in the models to identify which economic and financial ratios are explanatory of safety at work at company level. This preliminary result shows that there is a risk for management in misunderstanding the importance of occupational safety but we can not understand the implicit mechanisms.

The key issue upcoming is to explain how a good economic performance can lack of appropriate occupational safety in order to design new regulations that help to avoid that unfaithful competence. In the meanwhile communication strategies need to be redesigned in order to convince upper managers about the benefits and the reasons for an effective safety management.

This paper shows that there is an important research field to be explored. The language used in this topic would be easy to understand by managers and can provide safety advisors with new tools. At the end of the day, top management need to be convinced that safety matters but also that safety is good business.

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Exposure to forest fires, radioactivity and health risks

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ABSTRACT
It is known that vegetation fires release particles and a large number of chemical compounds into the atmosphere, including previously deposited radionuclides from the Chernobyl nuclear accident. However, the release of naturally-occurring radionuclides accumulated in vegetation was not investigated before. This work reports results of a study on natural radionuclide concentrations in vegetation including bushes and forest trees, and radionuclides in smoke from vegetation wildfires. Results show high concentrations of alpha emitting radionuclides in smoke particles, especially ^{210}Po, and enrichment of this radionuclide in smoke particles by a factor of 10^2-10^3 when compared with ^{210}Pb. Polonium activity is higher in the smallest particles (<0.50 µm) of smoke aerosols, while refractory radionuclides such as uranium and thorium displayed low concentrations in this aerosol fraction and higher concentrations in larger particles (fly ash particles). Especially due to ^{210}Po, the inhalation of smoke from vegetation fires may deliver significant radiation doses to the lung. In a person respiring smoke near a vegetation fire over 24 hours, the radiation dose may be 4000 times higher than the annual dose to a person respiring clean air. Even disregarding the effect of particles and other toxic compounds also present in smoke, the protection of the respiratory tract is needed due to these high ^{210}Po concentrations in smoke.

Keywords: Polonium, uranium, forest fires, radionuclide inhalation, radiation dose to man.

1. INTRODUCTION

Every year around the Mediterranean basin thousands of hectares of forest and bush are destroyed by wildfires. For example, in Portugal in the year 2010 fires destroyed 113,000 ha of vegetation cover. The plant biomass burned attains many thousands of tons every year and combustion releases considerable amounts of carbon, particles, and gases including toxic organic substances into the atmosphere (Lazaridis et al., 2008; Vos et al., 2009).
In the smoke more than 200 volatile substances were already identified and, amongst them, one counts toxic gases such as carbon monoxide, formaldehyde, acrolein, hydrocarbon compounds and dioxins (Vos et al., 2009; Gonçalves et al., 2010). The smoke particles are aggression agents to the respiratory tract and its inhalation in areas impacted by forest fires were related with asthma and other lung diseases (Vos et al., 2009). Less investigated has been the release of toxic elements such as heavy metals and radionuclides. The re-suspension into the atmosphere of radioactivity of artificial origin, such as cesium-137 (^{137}Cs) released by the Chernobyl nuclear accident in 1986 and deposited onto soils and forests across Europe, was recently observed again following forest fires that occurred in summertime in Belorussia and Ukraine (Paatero et al., 2009). The forest fires that took place in those regions originated again radioactivity transport (^{137}Cs) by atmospheric processes into central, northern and western European countries, although in much smaller scale than in 1986.
Besides radioactivity of artificial origin, vegetation fires are likely to release also radionuclides of the naturally-occurring radioactive families of uranium, thorium and actinium that plants absorb from the soil and accumulate in their structures. However, so far the radiological impact of these emissions was not investigated (Carvalho et al., 2011a). This paper shows preliminary results of a study aiming at evaluating the atmospheric release and the radiological risk of such radioactivity emission on public health. The results obtained have implications relevant also to the elements of fire brigades and population that fight vegetation fires.

2. MATERIALS AND METHODS

The smoke sampling was performed in the field close to bush and forest fires following and working closely with fire brigades in the center of Portugal (Viseu) and North of Portugal (Chaves). In the air sampling performed close to the flames in order to obtain freshly produced smoke particles, were used portable aerosol samplers (F&J Specialty, USA) powered by a battery, with microfiber glass filters (Whatman, 50 mm in diameter) and with moderate air flux of 60 L/min. To obtain larger smoke samples were used stand-alone large volume samplers (F&J Specialty, USA) powered by an electric generator (Yamaha, 10kVA) using microfiber glass filters 110 mm in diameter, and with a flux of about 1400 L/min. Other large volume air samplers (Andersen) mounted on a tripod, were used with microfiber glass filters 20cmx20cm, and air flux of about 1600L/min (Figure 1). Filters with aerosol samples, mostly composed with smoke particles from the vegetation fires, were weighted to determine the dry load of smoke particles and afterwards used for determination of radionuclides. The concentration of radionuclides in six classes of aerosol particles was determined on samples obtained with a Cascade Impactor air sampler (Andersen). The cascade impactor allowed the collection on Whatman filters of the aerosol particles in size classes of] >7.6 µm];]7.6-3.2 µm],]3.2-1.6 µm],]1.6-1.0 µm],]1.0-0.5 µm], and] <0.5 µm].
Plant samples of the same species of those burned by vegetation wildfires were analyzed following collection in vegetation areas not burned.

Analysis of radionuclides was performed by radiochemistry and alpha spectrometry according to tested procedures (Oliveira and Carvalho 2006; Carvalho and Oliveira 2007). Briefly, isotopic tracers (^{232}U, ^{229}Th, ^{224}Ra, ^{209}Po) were added in known amounts to aliquots of samples, to be used as internal tracers for the determination of radiochemical yields. Plant and aerosol samples were dissolved in nitric and hydrochloric acids (3:1) and radioelements were separated and purified through ion exchange chromatography columns, both pre-packed (Eichrom) and prepared in the laboratory with Bio-Rad resins. Radioelements were then electroplated on either stainless-steel or silver discs. The alpha particle emission from the discs' surface was measured with ion-implanted silicon detectors in an alpha spectrometer (OctetePlus, EG&G Ortec) (Carvalho and Oliveira 2007). Uncertainties presented with the analytical results are propagated uncertainties for the entire procedure and are given at the 1 σ significance level (Table 1). Water and soil samples were analyzed following a similar protocol. Quality assurance of the analytical methods was regularly checked by the analysis of IAEA certified reference materials and by participation in international analytical interlaboratory comparison exercises (Carvalho and Oliveira, 2007).

***Figure 1**. Smoke sampling with a large volume Andersen air sampler.*

3. RESULTS AND DISCUSSION

The results of analysis of bush and wood from trees, showed low radionuclide concentrations, as one could expect based on previous results of analysis made on wild vegetation and cultivated plants (Table 1). Naturally-occurring radionuclides originate from root uptake of radionuclides from soils and irrigation water. Their concentrations in plants are generally low, even in plants growing in zones with enhanced radioactivity, i.e., above average background such as zones near old uranium mines and uranium mining and milling wastes (Carvalho et al., 2009a, 2009b, 2011b). Some radionuclides existing in the atmosphere, such as the long-lived radon (^{222}Rn) daughters ^{210}Pb and ^{210}Po, are deposited on leaves and other aerial plant structures. For these radionuclides, foliar uptake is a supplementary pathway to root uptake and contribute to radionuclide accumulation in plants. With the fire, radionuclides as well as many other elements and compounds concentrated in plants are released into the atmosphere as smoke components.

The analysis of smoke from vegetation fires revealed an enrichment of the specific activity of radionuclides in the aerosol particles collected near the vegetation fire compared to reference aerosol samples collected in other areas and in the absence of vegetation fires (Table 1). In aerosols sampled at the vicinity of fires the radionuclide activities per unit of air volume was systematically higher with higher particle load in the air, suggesting that smoke particles collected on filters were the vehicle for transport of radioactivity in the atmosphere (Figure 2).

The analysis of radionuclide concentrations on filters indicated more than just higher radioactivity. The proportions of radionuclides in the smoke were modified in comparison with background aerosols and with unburned plants. For example, the concentration ratios $^{210}Po/^{210}Pb$ in vegetation before the fire were often about 0.1, while in the smoke from vegetation fires this ratio increased up to 12, revealing an extraordinary enrichment of smoke particles in ^{210}Po.

We hypothesize that the release of radionuclides from plant biomass may occur through two mechanisms. One consists in the volatilization of elements when the flame temperature exceeds the volatilization point of those elements. The other is the enrichment through enhancement of element concentrations in ash/smoke particles (refractory fraction) due to reduction of plant material mass with the volatilization of water, organic compounds, and elements of low volatilization point.

Measurements made in the field using an infra-red thermometer with laser pointer, have shown flame temperatures up to 700ºC in fires of bush vegetation, and above 1000ºC in the combustion of pines trees. The volatilization point of polonium compounds is around 390ºC and some are volatile even at lower temperatures, while for radium compounds volatilization points are likely higher (although not known), and certainly are much higher for uranium and thorium compounds (>>800ºC, and even above 1400ºC for some compounds). The occurrence of volatilization of uranium and thorium compounds in bush fires, and thus their release into the atmosphere as gaseous compounds seems unlikely, but their presence in fly ash particles may occur due to the combustion of organic compounds and reduction of plant mass until refractory materials only are left in the ash. In contrast to these elements, polonium and probably part of radium, are volatile at lower temperatures and may be released into the atmosphere as gaseous compounds. Polonium atoms in the gas phase are positive ions and can easily be recaptured by electrostatic charges onto the aerosol particles.

Polonium-210 is an alpha emitting radionuclide and it is much more absorbed into the human organism than heavy radioactive elements such as uranium and thorium (IAEA, 1996). Polonium-210 in man has its main origin in the ingested diet but it is also accumulated from the air through inhalation and lung absorption (Carvalho, 1995).

Table 1. *Radionuclide concentrations in plants and in the smoke from plant combustion (Bq/kg dry weight).*

	^{238}U	**^{234}U**	**^{226}Ra**	**^{210}Pb**	**^{210}Po**	**^{232}Th**
Vegetation:						
Thorny bush	0.00142±0.00006	0.00144±0.00006	0.066±0.014	-	-	0.00089±0.00006
Grass	0.94±0.03	0.094±0.03	5.3±0.4			0.40±0.02
Olive tree materials						
Leaves	-	-	-	9.4	1.05	-
Trunk	-	-	-	4.3	0.14	-
Smoke of						
Eucalyptus wood	64.6 ± 5,2	88.0 ± 6,6	318 ± 65	52,2±4	125±10	34.7 ± 3.4
Acacia wood	11.0 ± 1,4	35.7 ± 4,2	503 ± 165	440±19	611±28	<29
Bush wildfire (Chaves)	169±7	167±7	2492±639	369±36	4422±186	-
Pinewood wildfire (Viseu)	204±11	217±12	3547±1678	-	3972±157	117±8
Reference aerosol (Sacavém)	34±2	35±2	432±92	5468±193	886±32	25±7

The sampling of aerosols containing smoke from vegetation fires performed with the Cascade Impactor air sampler allowed for the analysis of radionuclide distribution in several classes of aerosol particles. The distribution of refractory elements such as uranium (^{238}U) in the particles of several size classes, showed a reasonable homogeneity of ^{238}U specific activity concentration from large particles, >7.6 µm, to 0.5 µm, but the very fine particles below 0.5 µm displayed the lowest concentrations. Thorium isotopes showed the same distribution pattern, with the lowest concentrations in the very fine particles. In contrast with this, polonium specific concentrations were the highest in particles of the size classes] 1.0-0.5 µm] and <0.5 µm. Taking this radionuclide distribution into account, the inhalation of the smaller aerosol particles, <0.5 µm, in the vicinity of a vegetation fire may lead to the inhalation of an activity of about 70 mBq/m^3, mostly due to ^{210}Po radioactivity associated to the finest particles in the smoke. When inhaled, these very fine particles deeply penetrate the lung, therefore carrying most of the alpha radioactivity into the lung tissues. The attachment of most alpha radioactivity to the smallest aerosol particles enhances exposure to radioactivity in the vicinity of vegetation and forest fires by fire fighters and also by the population with potential but yet unveiled implications on health.

Similar studies were performed on radioactivity of cigarette smoke and it was concluded that ^{210}Po inhaled with the smoke particles originates the exposure of lung to a significantly elevated radioactivity and up to levels able to trigger a lung cancer, even without taking into consideration the health effects of other substances present in cigarette smoke. It was computed that the lung of a chronic cigarette smoker of one cigarette pack per day, receives from inhaled ^{210}Po a radiation dose of about 30 mBq/day. This dose rate is about 40 times higher than the dose for the non-smoker, 0.66 mBq/day, originated from background ^{210}Po in the air which is about 30 µBq/m^3 in Lisbon area (Carvalho, 1995; Carvalho and Oliveira, 2006). The radiation dose received from ^{210}Po inhaled with smoke from vegetation fires by a person located 24 hours in the vicinity of a fire might be 80 times higher in comparison with the daily dose rate for chronic cigarette smoker, and about 4000 times higher than the daily dose received by the non-smoker breathing in clean air.

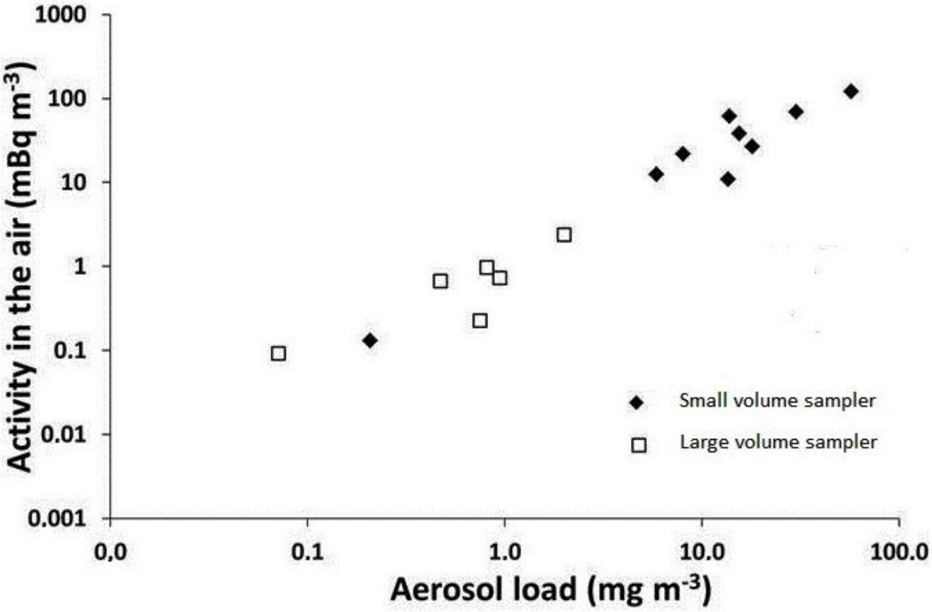

***Figure 2**. Aerosol load in surface air with smoke from vegetation fires and ^{210}Po radioactivity in the air. Correlation is highly significant (p<0.01).*

4. CONCLUSIONS

The analysis of the main naturally-occurring radionuclides in bush and forest vegetation confirmed their accumulation in the plants through root uptake from soils. The specific concentrations of those radionuclides in plants (Bq/kg), including uranium and thorium isotopes, ^{210}Pb, ^{210}Po, and ^{226}Ra are generally low. However, the combustion of plant biomass releases those radionuclides into the atmosphere and the total radioactivity released is likely very significant in terms of radiological impact on humans.

As radionuclides are released in the gaseous phase and in the ash fraction, two mechanisms at least might be involved in concentrating radionuclides in the smoke particles: one through recollection of gaseous ions onto the aerosol particles and the other through re-suspension of fly ash particles containing the refractory radionuclides. Some elements, such as uranium and thorium, are refractory and remain with the plant ash. These radionuclides in the fire smoke are present in lower concentrations in the very fine aerosol particles (<0.5 µm) than in medium and large particles. Other elements such as polonium, and may be radium up to a certain extent, are present in higher concentrations in the finest particles (most of their activity) and display lower concentrations in larger aerosol particles. The recollection of gaseous ^{210}Po ions onto smoke particles in the air enhances the concentrations of this radionuclide in aerosol particles in comparison to the progenitor ^{210}Pb. The enrichment of ^{210}Po activity concentration in smoke particles is 100 to 1000 times higher than concentrations in the vegetation.

Prolonged exposure to smoke from vegetation fires might lead to lung exposure to high radiation doses and, potentially, much higher than determined for the cigarette smokers of one pack of cigarettes per day. Disregarding the noxious effects of other substances that may be inhaled simultaneously and the health effects of inhaled particles, ^{210}Po inhalation with the smoke from vegetation fires, on itself justifies the need for protection of the respiratory tree, in particular of firemen and members of the public in areas close to vegetation fires. The implications of this radiation exposure to occupational and to public health are still to be assessed.

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Occupational exposure to ionizing radiation in non-nuclear industries and the European radiation protection basic safety standards

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ABSTRACT
Exposure of workers to ionizing radiation in non-nuclear industries or NORM (Naturally-occurring radioactivity materials) industries was already addressed in the EU Directive 96/29 that also introduced the harmonized radiation dose limits for workers and members of the public. In 1996, that Directive placed the responsibility on EU Member States to identify those NORM industries where radiation exposure could occur, and to apply there the radiation basic safety standards. Several EU Member States and radiation protection authorities undertook case studies that identified significant re-concentration of radioactivity in products, by-products, and waste materials from non-nuclear industries and workplaces with risk of radiation exposure above legal limits. A revised and updated version of the EU Directive was recently prepared based on revised international safety standards, which will include industrial sectors where radiation doses shall be controlled. NORM industrial sectors in Portugal are still to carry out this radiological risk assessment and urged to do so.

Keywords: European Union basic safety standards, Radiation protection, Dose limits, NORM industries.

1. INTRODUCTION

The Euratom Directive 96/29 established the responsibility of member States in assessing the risk of exposure to ionizing radiation resulting from the presence or re-concentration of naturally occurring radioactive substances in materials used in non-nuclear industries. Previously, these industries were not subject to application of the radiological protection and safety standards simply because the presence of radioactivity occasionally in high levels was not known and because these radiation safety standards were initially developed for the protection of nuclear industry workers and a few other radiation workers such as, for example, those of medical radiological facilities (EU, 1996).
In accordance with Chapter VII of Directive 96/29 and the responsibilities assigned therein, most states in the EU undertook the study of various non-nuclear industries to assess radiation doses to workers and to members of the public. Studies have shown that in certain industrial facilities often there are exposures to radiation doses above natural radioactive background and, occasionally they may exceed the legislated radiation dose limits.
In this paper we review the conclusions of some of these studies and the implications for several non-nuclear industry sectors, and what needs to be done in Portugal.

2. EXISTING DATA

The publication of the Directive 96/29 EURATOM, partly transferred through several decrees into the national legislation, placed the responsibility to identify the sectors and activities with exposure to ionizing radiation, on each Member State (EU, 1996). This call on every EU Member State to proceed with the identification of industries now currently designated as NORM (Naturally-occurring radioactivity materials) in which such exposure could occur, resulted mainly from the scarcity of studies on natural radioactivity in raw materials, products, and waste and on radiation doses imparted to workers in these industries and to members of the public. One can understand that with such a short knowledge on the extent of radiation exposures in NORM industries it would be difficult to legislate and to harmonize safety standards at European level. Nevertheless, with the same Directive 96/29 the EU Member States were provided with harmonized dose limits for radiation protection of workers and members of the public, respectively 20 units of millisievert per year (20 mSv/a) and 1 millisievert per year (1 mSv /a). Furthermore, these dose limits should be applied to all situations, including non-nuclear and nuclear industries, in order to protect humans from the harmful effects of ionizing radiation (cancer).
Therefore, from 1996 onwards each State responsibility lies in identifying and evaluating the cases and activity sectors where radiation exposures may occur and enforce the radiation dose limits legally adopted in the EU.
The radiation exposures in NORM industries being relatively unknown to the public, a few examples may help to introduce these issues.
A well-studied case is that of the industrial sector of phosphate industries. Briefly, the phosphate industrial cycle includes the extraction of phosphate ore (eg, in Florida, Mauritania and Morocco), the production of phosphoric acid through the reaction of phosphate ore with sulphuric acid, which also generates a by-product or waste, the phosphogypsum. With the phosphoric acid, and allowing it to react with new quantities of phosphate ore, are produced the phosphate fertilizers commonly used in Portugal and many other countries.
The raw material used by these industries are phosphates of sedimentary origin (fosforite) that contain high concentrations of uranium and uranium progeny radionuclides, such as ^{230}Th, ^{226}Ra, ^{222}Rn, ^{210}Pb, and ^{210}Po. The activity

concentrations of uranium in phosphates from Florida range from 750 to 3100 Bq/kg, and in the phosphates from Morocco uranium concentrations range between 1000 and 1500 Bq/kg (Carvalho, 1995; Falck and Wymer, 2006). During the fertilizer manufacturing process, these radionuclides split between the final product and the wastes and thus part of the radioactivity follows the fertilizer while other part follows the phosphogypsum and the process water.

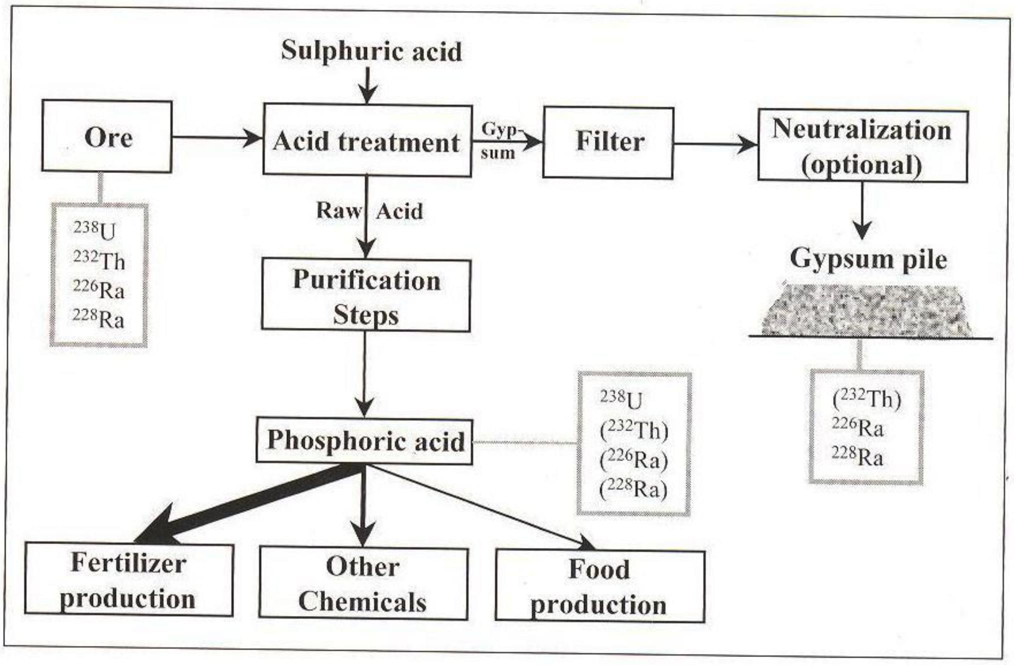

Figure 1. *Diagram of the wet process of extracting phosphorus from phosphate ore, and distribution of radionuclides in the several fractions (Falck and Wymer, 2006).*

In the entire industrial cycle of the phosphate sector, including the steps of phosphate transport, milling, chemical reaction, filtration, packaging and storage, dust and radiation of the product in storage, including the release of the radioactive gas radon, can lead to a significant radiation dose to workers.
As a result, the adoption of appropriate hygiene and radiation safety measures in the workplaces, and also appropriate measures for protection of members of the public and of the environment should start with the analyses and characterization of radioactive substances and radiation doses (Carvalho, 2007).
In France, following a resolution made by the Government, studies for characterization and evaluation of the radiological risk in NORM industries were requested to the "Institut de Radioprotection et Sûreté Nucléaire". The case studies elected, were carried out and cover several sectors, namely: Production of refractory ceramics, foundries and glass industry (49%); Coal plants (16%); Production of zirconium, baddeleyte, titanium, bismuth and thorium (15%); Production of phosphoric acid and phosphate fertilizers (6%); Production or use of products with thorium (3%); Production of pigments with lanthanide (2%); spas (1%); Groundwater treatment facilities 1%. From these case-studies of industries, the IRSN evaluated the concentrations of radionuclides, the radiation doses to workers, and contributed to a better definition of workplaces (Cazala et al., 2011).
Other countries, like Italy, Germany, UK, Spain, Holland, among others, have carried out similar studies and the results are convergent. For example, studies of ceramics and porcelain manufacturing plants in Italy, which especially focused on the analysis of radioactivity associated with waste and dust, revealed extraordinarily high activities of ^{210}Pb and ^{210}Po, respectively 21 000 and 35 000 Bq/kg, in dust released from refractory ceramic kilns (Zampieri at al., 2008). Maintenance and cleaning of these facilities poses a serious risk of radiation exposure and require revision of the workplace and adoption of procedures to reduce the risk of occupational radiation doses. Notwithstanding, in many cases in NORM industries the exposure to ionizing radiation does not exceed legal limits and often does not represent a significant occupational hazard.
The fate of by-products and wastes, such as phosphgypsum and bottom ash from furnaces, should also be cautiously and properly managed because of potential radioactivity concentrated therein and radiation doses associated. According to international standards, the exemption level of material containing radioactivity is 1 Bq/g. A residue exceeding this radioactivity concentration level should be treated as radioactive waste, and cannot be managed or disposed of as common industrial waste because of the radioactive risk that it potentially poses to the environment and members of the public (Wymer, 2008; EU, 2011) .
There is a need also to perform the radiological assessment of certain products from NORM industries made available to the public or used as raw material for another industry. Examples of such products are the phosphate fertilizers for use in

agriculture, the phosphates used as ingredient in animal feed, the ceramics and tiles that may contain radionuclides, the ash from coal burning used as concrete hardener, radio and radon concentrations in spring waters used in spas, and operations for geothermal energy production.

3. THE REVISION OF DIRECTIVE 96/29 AND NEW SAFETY RULES

In recent years it was admitted by various committees and international working groups that the European legislation on radiation protection needs updating, especially after the recommendations made by the International Commission on Radiological Protection (ICRP Publication No. 103 of 2007) and after the experience gained in implementing the legal requirements currently enforced. In particular there is a need for revision of Directive 96/29, which is due to:

- A strong indication of an effect on the eye lens following exposure to radiation doses below the threshold assumed earlier. This is important for some specific categories of medical workers exposed to radiation;
- A large proportion of workers in manufacturing industries where NORM materials are used receive may be exposed to doses above the legal dose limit for members of the public, but still are not classified as radiation workers and do not enjoy any protection as such;
- High-doses for the population resulting from exposure and inhalation of radon inside houses, including residences, workplaces and public buildings.

As a result of increased awareness on these issues and continued development of radiation protection concepts, the rules laid down in Directive 96/29 were recently reviewed by experts and international organizations such as the EU, the World Health Organization (WHO) and the International Atomic Energy Agency (IAEA), which agreed on several changes.

The text recently approved for the revised Directive states that «protection against natural radiation sources, rather than being addressed separately in a specific title, should be fully integrated within the overall requirements. In particular, industries processing materials containing naturally occurring radionuclides should be managed within the same regulatory framework as other practices». Furthermore, «recent epidemiological findings from residential studies demonstrate a lung cancer risk from exposure to indoor radon at levels of the order of 100 Bq m^{-3}. The new concept of exposure situations allows the provisions of Commission Recommendation 90/143/Euratom on the protection of the public against indoor exposure to radon to be incorporated in the binding requirements of the Basic Safety Standards while leaving enough flexibility for implementation». Another important professional exposure to natural radiation concerns aircrews. The draft Directive states that exposure of aircrew to cosmic radiation should be managed as a planned exposure situation. The operation of spacecraft should come under the scope of this Directive and should be managed as a specially authorized exposure (EU, 2011).

Also, and this relates particularly to areas affected by waste containing radioactivity as the old uranium mining areas, the « health protection of the general public allows for the presence of radioactive substances in the environment. In addition to direct environmental exposure pathways, consideration should be given to the protection of the environment as a whole, including the exposure of biota, within a comprehensive and coherent overall framework. As far as a mankind is part of its environment, this policy benefits to long term health protection. »

In the medical area, important technological and scientific developments have led to a notable increase in the exposure of patients. In this respect, the Directive «should emphasize the need for justification of medical exposure, including the exposure of asymptomatic individuals, and should strengthen the requirements concerning information to be provided to patients, the recording and reporting of doses from medical procedures, the use of diagnostic reference levels and the availability of dose indicating devices. Accidental and unintended medical exposures are a source of continuing concern. Their prevention and follow-up, should they occur, need to be fully addressed. In this respect, the role of quality assurance programmes, including risk analysis in radiotherapy, to avoid such incidents should be emphasized, and recording, reporting, analysis and corrective action should be required in such cases » (EU, 2011).

The recently acquired knowledge from case studies of NORM industries led to the introduction of a list of industrial sectors to which the risk assessment of exposure applies, as well as materials including raw materials, manufactured products, and waste to be checked for radioactivity. The draft Directive establishes (*Article 24)* <u>the need for identification of practices involving naturally occurring radioactive material</u> and «Member States shall ensure the identification of practices involving naturally occurring radioactive material and leading to exposure of workers or members of the public which cannot be disregarded from a radiation protection point of view. Such identification shall be carried out by means of surveys or by any other appropriate means taking into account industrial sectors listed in Annex V» (see Appendix). The industries listed include the production of phosphate fertilizers, coal burning, cement kilns maintenance, metal casting, and groundwater treatment plants, among others. The revised Directive will be prescriptive for maximum concentrations of radionuclides in building materials, and maximum concentration of radon in the air inside already existing buildings that will be lowered from 400 to 300 Bq/m^3 (EU 2011).

4. CONCLUSIONS

Several industrial sectors in Portugal, amongst those designated as NORM industries, should undertake the analysis of the risk of exposure to ionizing radiation. These industries encompass sectors such as mining and metal ore production, manufacture of ceramics and glass, production of phosphate fertilizers, cement kilns maintenance, water treatment

facilities, and spring sources used in spas. The adoption of measures to comply with radiation exposure limits for workers and members of the public, properly sized and commensurate with the risk, require effective characterization of radioactivity and radiation doses beforehand.
The EU Directive 96/29 which has adopted the limits of radiation dose placed also the responsibility to identify industrial sectors with radiological risk due to NORMs on States and competent authorities in radiation protection, which is now revised. The revision of radiation protection standards (Basic Safety Standards) was coordinated between European and international organizations (IAEA, WHO, etc.) and is now nearly ready for publication. The urgency of these measures for radiation protection is reinforced also in the current revision of the Basic Safety Standards. The limits of exposure to radon (radon concentration in indoor air) will also be reduced as well.

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Appendix
ANNEX V
List of industrial practices involving naturally occurring radioactive material. For the purposes of Article 24, the following list of industrial practices involving naturally occurring radioactive material, including relevant secondary processes, shall be taken into account:
(1) extraction of rare earths from monazite;
(2) production of thorium compounds and manufacture of thorium-containing products;
(3) processing of niobium/tantalum ore;
(4) oil and gas production;
(5) geothermal energy production;
(6) TiO2 pigment production;
(7) thermal phosphorus production;
(8) zircon and zirconium industry;
(9) production of phosphate fertilizers;
(10) cement production, maintenance of clinker ovens;
(11) coal-fired power plants, maintenance of boilers;
(12) phosphoric acid production;
(13) primary iron production;
(14) tin/lead/copper smelting;
(15) ground water filtration facilities;
(16) mining of ores other than uranium ore.

Production of low frequency noise in highways and railways

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ABSTRACT
This study had as main purpose assess which levels of infrasound and low frequency noise are produced in road and rail network in the city of Coimbra and has a second purpose determine which are the physical, environmental and technical means that can influence the noise spreading. To achieve this, we carried out a study on the nature of cross-sectional cohort and the type of study considered was descriptive and correlational (level II). We considered the target population the road network existent in Coimbra district, where the sample design was defined as non-probabilistic sampling technique and rationale for selection or typicality. The sample was constituted by 31 road and rail vehicles. The study had the duration of three trimesters and the period of data collection occurred between the second half of may to the first week of June. The data collection developed in two stages, consistent with the study purposes. To the first stage was elaborated a registry datasheet and it was used the Brüel&Kjær model 2260 soundmeter equipped with the software BZ 7108 FFT and to the second phase was used the same soundmeter equipped with the software BZ 7210. The data collected were statically analyzed using the data processing software SPSS version 17.0. It was used also the statistical tests One-Way ANOVA, T-test for equality of means; and Pearson Correlation test. The statistical tests interpretation recurred to the base level of significance of $\alpha = 0{,}05$, with a level of confidence raging 95%. With the realization of this study we conclude that the low frequency noise produced in road and rail networks do not represent a single pattern, being subjected to the influence of several variables, should be assess by frequency and in the various time periods. It was proven also the risk of developing vibroacoustic disease is not limited to occupational exposure, so it must be faced has a public health problem, for which its urgent the definition of a legal base that determines the exposure limits to this type of noise.

Keywords: low frequency noise; road network; rail network; vibroacoustic disease.

1. INTRODUCTION

Historically, science has divided the acoustic spectrum in a very simplistic way, in infrasound, audible sound and ultrasound, considering as potentially dangerous acoustic phenomena the infrasound and audible sound (Alves-Pereira and Branco, 2009). The amplitude of an acoustic phenomenon is usually expressed in decibels (dB), and the national legislation on noise uses dB(A) as a fundamental unit, thus aiming exclusively acoustic phenomena that can be perceived by the human ear. The use of noise values expressed in dB(A) in a scientific study can only be justified if the aim is only to assess the risk of deafness, because when considering the Infrasound and Low Frequency Noise (ILFN <500 Hz) and their biological effects this value is clearly insufficient (Alves-Pereira and Branco, 2007[1]).

In the context of Vibroacoustic Disease (VAD) – a systemic disease caused by overexposure to ILFN – respiratory lesions present specific characteristics; however, the dose-response relationships with respect to exposure to ILFN are not yet established, and therefore a methodology for assessing the risk of VAD is also not established (Alves-Pereira and Branco, 2007[2], Branco et al., 2007). It is considered that, in terms of public health, the use of values of noise in the A-weighting (in dB(A)) should be abolished, except in cases where it assesses the risk of deafness, and that acoustic environments can only be compared with scientific rigor if the amplitude of noise (in dB Linear) and the content of frequencies are considered simultaneously. VAD is not limited to occupational exposures, and it has already been documented as a result of residential contamination by ILFN (Alves-Pereira and Branco, 2009; Alves-Pereira and Branco, 2007[1], Alves-Pereira and Branco, 2007[2]).

Although the harmful effects to health caused by exposure to ILFN have already been proven in several studies, in Portugal there is still no legislation indicating the obligation of assessing exposure to this type of noise and, therefore, protection and prevention measures more effective in safeguarding human health are not always taken.

Given the importance of road and rail routes nowadays, as key components for the development and modernization of society, the following question was placed: Are the ILFN levels produced in road and rail routes sufficient to cause Public Health problems? To answer to this question, it was established as the main goal of the study to assess levels of infrasound and low frequency noise produced in the road and rail routes of the city of Coimbra, and as a secondary goal to determine which physical, environmental and technical means might influence the spread of this type of noise.

2. MATERIAL AND METHODS

The target population of this study consists of all existing traffic routes in the district of Coimbra, which corresponds to 31 roads and rail circulation routes. The collection of data was done in two phases with different objectives; however, in both phases were performed measurements in the three reference periods defined in the General Regulations of Noise

(Ministry of Environment, Spatial Planning and Regional Development – Ministério do Ambiente, do Ordenamento do Território e do Desenvolvimento Regional, 2007). Measurement positions were also defined similarly in both phases: 1 to 2 meters of the facade of the most exposed building, from 1,2 to 1,5 meters above the ground, and whenever possible at 7,5 meters horizontally from the axis of the trajectory of the vehicle (CE, 2003; IPQ, 1996; ISO, 2007).

The first phase had as main goal to assess the factors contributing to limit or increase the spread of Low Frequency Noise (LFN), and for the collection of data at this stage it was used the Brüel & Kjaer Sound Level Meter, model 2260, equipped with software BZ 7208 FFT, and the equipment was properly calibrated. Based on this treatment four locations were selected for the development of the second phase of the study, and it was adopted as a selection criterion: the higher levels of LFN in the reference periods *Evening* and *Night*, due to the fact that people are more in their homes during these periods.

The second phase was aimed at assessing the extent to which levels of ILFN produced in road and rail routes can induce health problems of the population exposed, and for the collection of data at this stage was used a Brüel & Kjaer Sound Level Meter, model 2260, equipped with software BZ 7210. The data obtained in this second phase were transferred into a data matrix and compared with reference values obtained in a study conducted in cockpits of commercial airlines, where it is proved that the levels of ILFN lead to the development of VAD (Araújo et al., 2004).

3. RESULTS AND DISCUSSION

For the first phase of the study, it was used a total sample of 31 points, 26 of which corresponded to road traffic, 2 to railway traffic and 3 to road and rail traffic.

Table 1 - L_{Aeq} (dB) in the various periods in relation to the type of traffic

Frequency (Hz)	Type of traffic	N=31	Day		Evening		Night	
			$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
20,1	Road	26	47,43	8,06	39,59	6,44	**36,06***	6,10
	Rail	2	53,15	14,88	39,39	7,36	**32,68***	2,13
	Road/Rail	3	46,62	1,77	38,95	2,62	**45,08***	7,18
24,9	Road	26	49,44	9,77	43,13	6,46	39,66	7,36
	Rail	2	46,51	19,04	43,04	1,91	34,66	9,04
	Road/Rail	3	43,30	6,82	45,19	7,53	44,67	3,06
31,5	Road	26	48,67	8,81	41,99	7,55	**35,33***	8,14
	Rail	2	50,29	28,48	42,20	5,25	**33,92***	1,07
	Road/Rail	3	48,59	0,84	50,95	3,50	**49,82***	3,11
39,9	Road	26	43,87	9,57	42,22	11,03	33,70	8,00
	Rail	2	49,30	12,70	41,85	0,99	39,32	4,84
	Road/Rail	3	40,48	6,59	47,77	0,93	38,66	0,22
50,2	Road	26	43,93	10,28	41,24	9,21	**31,84***	9,13
	Rail	2	48,31	19,09	38,47	8,92	**31,85***	7,81
	Road/Rail	3	39,73	10,37	43,28	4,48	**46,03***	5,75
63,0	Road	26	43,87	10,00	39,47	12,04	30,99	11,40
	Rail	2	42,58	17,39	36,99	5,82	29,95	6,53
	Road/Rail	3	47,75	5,66	42,56	3,32	41,57	2,49
80,2	Road	26	38,51	9,36	34,18	8,85	28,10	6,90
	Rail	2	41,20	26,29	32,09	2,15	25,50	3,13
	Road/Rail	3	47,43	8,06	39,59	6,44	36,06	6,10
100,0	Road	26	53,15	14,88	39,39	7,36	32,68	2,13
	Rail	2	46,62	1,77	38,95	2,62	45,08	7,18
	Road/Rail	3	49,44	9,77	43,13	6,46	39,66	7,36
124,9	Road	26	46,51	19,04	43,04	1,91	34,66	9,04
	Rail	2	43,30	6,82	45,19	7,53	44,67	3,06
	Road/Rail	3	48,67	8,81	41,99	7,55	35,33	8,14
157,1	Road	26	50,29	28,48	42,20	5,25	33,92	1,07
	Rail	2	48,59	0,84	50,95	3,50	49,82	3,11
	Road/Rail	3	43,87	9,57	42,22	11,03	33,70	8,00

* *p-value* <0,05 | *One-Way ANOVA* Test

When analyzing the LFN by "type of traffic" (Table 1), it can be observed that there were significant differences between the spread of LFN in *road*, *rail* and *road / rail* routes during the *night* period on the frequencies 20,1; 31,5 e 50,2 Hz.

Table 2 - L_{Aeq} (dB) in the various periods in relation to the road conditions

Frequency (Hz)	Road conditions	Day			Evening			Night		
		N=29	$\bar{x}$	s	N=29	$\bar{x}$	s	N=29	$\bar{x}$	s
20,1	Dry	19	48,42	7,51	25	40,31	6,19	13	35,88	7,13
	Wet	10	45,30	7,84	4	34,62	2,61	16	37,90	6,39
24,9	Dry	19	48,14	9,50	25	43,13	6,63	13	**37,30***	7,06
	Wet	10	50,07	10,18	4	44,71	5,92	16	42,52	6,56
31,5	Dry	19	48,45	7,27	25	42,72	7,64	13	**31,90***	7,72
	Wet	10	49,05	10,49	4	44,11	9,27	16	**40,82***	7,97
39,9	Dry	19	**41,02***	8,09	25	42,55	11,27	13	31,82	6,16
	Wet	10	48,27	9,93	4	44,34	4,80	16	36,15	8,47
50,2	Dry	19	41,60	10,19	25	40,79	9,01	13	30,22	8,64
	Wet	10	47,10	9,65	4	45,58	6,91	16	35,82	10,24
63,0	Dry	19	43,26	9,66	25	39,34	11,96	13	**26,74***	7,56
	Wet	10	46,20	9,81	4	42,55	8,24	16	**36,42***	12,12
80,2	Dry	19	36,71	9,91	25	34,52	8,79	13	27,93	7,25
	Wet	10	41,38	6,09	4	32,47	7,23	16	29,28	7,81
100,0	Dry	19	35,19	6,47	25	32,96	8,37	13	26,05	5,61
	Wet	10	38,72	9,14	4	31,11	6,00	16	30,03	10,68
124,9	Dry	19	31,81	8,71	25	29,86	11,41	13	22,22	8,96
	Wet	10	34,60	12,26	4	26,31	13,04	16	24,77	9,11
157,1	Dry	19	31,06	6,50	25	25,43	11,06	13	19,33	10,33
	Wet	10	33,19	13,15	4	27,17	11,58	16	24,84	8,98

* *p-value* <0,05 | *T-test for equality of means*

In assessing whether the "road conditions" influenced the spread of the LFN (Table 2), it can be seen that there were significant differences between the spread of LFN in *dry* or *wet* roads during the *night* period for the frequencies of 31,5 and 63 Hz.

Table 3 - L_{Aeq} (dB) in the various periods in relation to the type of acoustic barrier

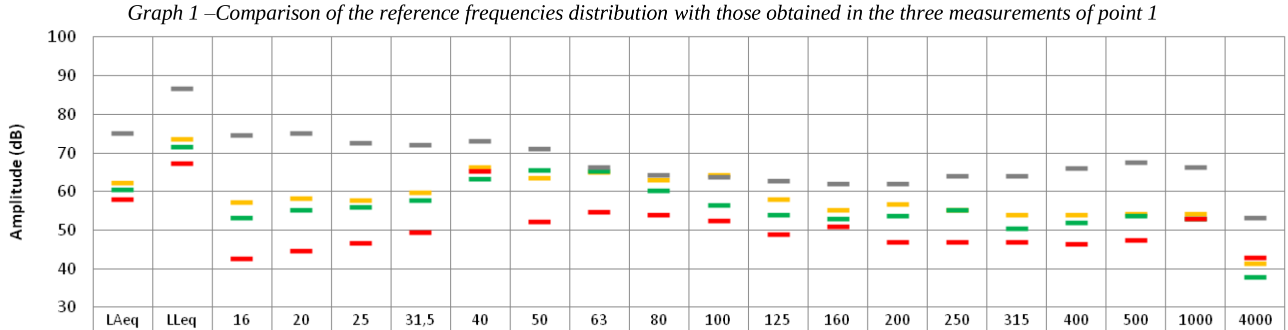
Frequency (Hz)	Type of acoustic barrier	N=31	Day		Evening		Night	
			$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
20,1	Masonry	1	53,55	---	40,71	---	31,17	---
	Prefabricated	4	48,56	8,81	38,59	7,77	36,50	10,67
	Non-existent	26	47,36	8,11	39,61	6,07	36,96	6,06
24,9	Masonry	1	70,44	---	44,39	---	46,78	---
	Prefabricated	4	44,94	3,95	37,44	5,20	39,21	9,43
	Non-existent	26	48,39	9,75	44,19	6,10	39,65	7,10
31,5	Masonry	1	63,54	---	39,09	---	37,55	---
	Prefabricated	4	47,24	1,69	45,02	5,48	33,09	11,30
	Non-existent	26	48,43	10,04	42,68	7,92	37,15	8,53
39,9	Masonry	1	44,99	---	**58,13***	**---**	35,30	---
	Prefabricated	4	35,56	13,85	**42,85***	6,90	33,38	8,06
	Non-existent	26	45,13	8,34	**42,12***	10,47	34,69	7,84
50,2	Masonry	1	**55,94***	---	34,75	---	26,18	---
	Prefabricated	4	**39,84***	12,68	44,45	5,67	34,53	7,51
	Non-existent	26	**43,95***	10,23	41,01	9,13	33,29	10,06
63,0	Masonry	1	59,76	---	53,12	---	35,29	---
	Prefabricated	4	39,64	9,07	40,56	3,84	28,40	8,12
	Non-existent	26	44,26	9,67	38,94	11,80	32,36	11,57
80,2	Masonry	1	39,10	---	33,34	---	23,10	---
	Prefabricated	4	33,66	6,00	34,58	5,71	26,32	10,14
	Non-existent	26	39,23	10,46	34,05	8,81	29,01	7,00
100,0	Masonry	1	37,16	---	41,29	---	45,27	---
	Prefabricated	4	33,22	6,86	23,64	4,55	23,04	4,78
	Non-existent	26	37,86	9,65	33,45	7,63	27,74	8,66
124,9	Masonry	1	37,91	---	26,44	---	18,44	---
	Prefabricated	4	27,81	5,57	21,78	6,27	22,43	12,60
	Non-existent	26	33,80	11,51	30,49	11,59	23,42	8,69
157,1	Masonry	1	33,13	---	35,17	---	20,07	---

Prefabricated	4	32,88	2,13	19,90	7,21	20,25	12,21
Non-existent	26	32,29	12,18	26,42	10,92	22,53	9,57

* *p-value* <0,05 | *One-Way ANOVA* Test

In this study it was also found that there were significant differences in the spread of the LFN in places with different kinds of “noise barriers” in the *evening* period to the 29,9 Hz frequency and in the *day* period for the 50,2 Hz frequency (Table 3). It may also be noted that, during the three periods, LFN levels were generally higher in places with *masonry* acoustic barrier, followed by places without any sort of acoustic barrier and the places with *pre-fabricated* acoustic barrier were the ones with lower levels of noise.
When checking the spread of the LFN in different types of roads (motorway, main itinerary, complementary itinerary national highway, county road, or a combination of all of these), we conclude that there were significant differences for all types during the *day* period for the frequencies 24,9; 39,9 and 50,2 Hz, as well as during the *day* and *evening* periods for the frequency 100 Hz, and during the *day* and *night* periods for the frequency 124,9 (p <0,05).
Another of the parameters analyzed in this study was the influence of the “height of the buildings” surrounding the point under consideration in the propagation of low frequency noise. Therefore, it was found that there were statistically significant differences between the spread of LFN in points with surrounding buildings with different heights during the *day* period for the frequencies 24,9; 39,9; 50,2 and 157,1 Hz, during *day* and *evening* periods for the frequency 63 Hz and during the three periods for the frequency 100 Hz.
During the study it was also verified the influence of “watercourses” in the spread of the LFN, for what were analyzed three points with “watercourses” to less than 100 meters away from where the analysis was carried out and comparing them with 28 locations where there was no “watercourses” nearby. From this analysis it can be concluded that there were significant differences in the spread of LFN for the 24,9 Hz frequency during the *day* period, for the 31,5 Hz frequency in the *evening* and *night* periods, for the 50,2 Hz frequency during the *day* and *evening* periods and for the 124.9 Hz frequency in the *evening* period.
In examining whether the type of “vegetation cover” (tree, shrub or non-existent) existing at the analyzed location influenced the spread of LFN, one can see that there were significant differences in the propagation of noise in areas with different vegetation covers, during the period of *sunset* for the 39,9 Hz frequency and the period of *day* for the 50,2 Hz frequency.
In general, regarding to the results obtained in the first phase of the study it can be observed that “type of traffic”, “type of road”, “road conditions”, existence of “watercourses” in the vicinity of the places with *road* and *rail* traffic, type of “vegetation cover”, the “approximate height of the buildings” surrounding the locations where the measurements where made and the existence of different types of “noise barriers” significantly influenced the propagation of low frequency noise, depending on the type of frequency and on the time of day analyzed. However, it was also verified that the existent “number of traffic lanes” and the type of “land occupation” did not have a significant influence on the spread of this type of noise.
For the second phase of the study four points were selected, three of which corresponded to road traffic and one corresponded to rail traffic.

Graph 1 –Comparison of the reference frequencies distribution with those obtained in the three measurements of point 1

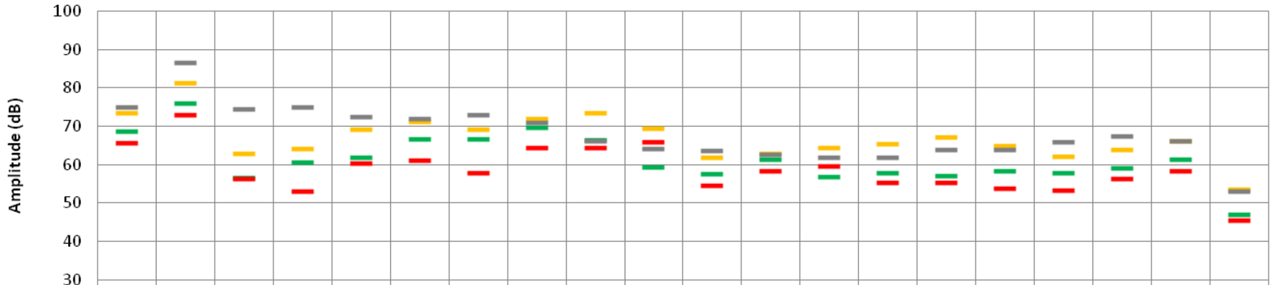


	LAeq	LLeq	16	20	25	31,5	40	50	63	80	100	125	160	200	250	315	400	500	1000	4000
Day	62,12	73,35	56,99	58,21	57,54	59,6	66,1	63,35	64,78	62,97	64,04	57,75	55,18	56,53	55,12	53,68	53,69	54,14	54,14	41,33
Evening	60,31	71,47	53,09	55,07	55,77	57,51	63,09	65,37	65,07	60,03	56,23	53,75	52,86	53,65	55,13	50,36	51,76	53,5	52,7	37,58
Night	57,95	67,21	42,52	44,37	46,52	49,26	65,1	51,96	54,52	53,82	52,24	48,82	50,91	46,85	46,88	46,87	46,36	47,2	52,75	42,62
Reference	74,95	86,49	74,48	75,01	72,35	71,83	72,91	70,87	66,06	64,09	63,66	62,67	61,85	61,96	63,88	63,77	65,84	67,34	66,18	52,98

Frequencies (Hz)

When analyzing Graph 1, it can be stated that the reference levels ILFN were not exceeded by the levels obtained in the three measurements made in point 1. However, it appears that the L_{Aeq} levels were very close to 60 dB during the three periods and that the L_{Leq} levels even exceed 70 dB during the periods of *day* and *evening* and was close to this figure during the *night*. It was also observed that it was in the *day* period that ILFN levels were higher at all frequencies except 50 and 4000 Hz, followed by the *evening* period, with the exception of 40 and 4000 Hz in which the level was higher during the *night* period. It can also be verified that between the frequencies 40 and 200 Hz the levels obtained at point 1 were very close to the reference values.

Graph 2 –Comparison of the reference frequencies distribution with those obtained in the three measurements of point 2

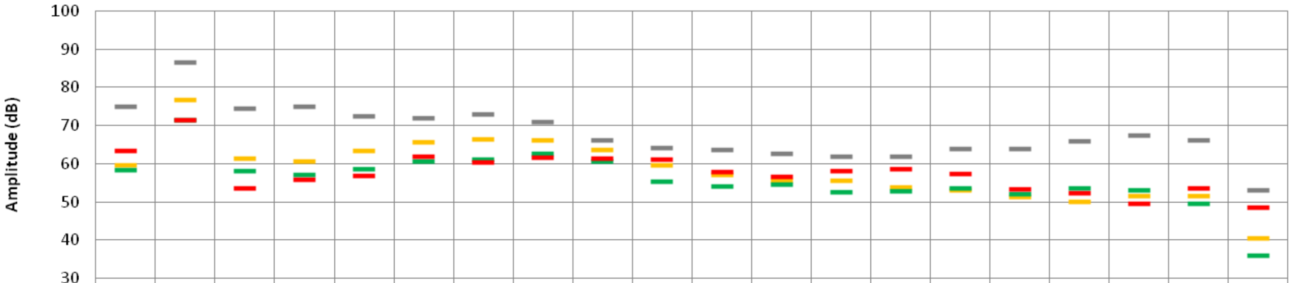


	LAeq	LLeq	16	20	25	31,5	40	50	63	80	100	125	160	200	250	315	400	500	1000	4000
Day	73,36	81,21	62,86	64,18	69,04	71,1	69,21	71,87	73,43	69,4	61,85	62,94	64,33	65,49	67,05	64,83	62,08	63,96	66,12	53,45
Evening	68,76	75,98	56,57	60,6	61,85	66,65	66,75	69,61	66,29	59,29	57,68	61,48	56,83	57,93	57,2	58,31	57,84	59,03	61,3	46,89
Night	65,65	72,97	56,44	52,93	60,23	61,13	57,87	64,34	64,48	65,77	54,64	58,27	59,72	55,4	55,35	53,72	53,28	56,23	58,4	45,49
Reference	74,95	86,49	74,48	75,01	72,35	71,83	72,91	70,87	66,06	64,09	63,66	62,67	61,85	61,96	63,88	63,77	65,84	67,34	66,18	52,98

Frequencies (Hz)

By the analysis of Graph 2 it may be observed that the reference levels were exceeded by the levels obtained from measurements made in point 2 during the *day* period, at frequencies from 50 to 80 Hz, from 125 to 315 Hz and 4000 Hz. It is also observed that the *night* period presents lower ILFN levels than the obtained in the remaining periods, with the exception of 80 and 160Hz. During the *evening* period the reference levels were not exceeded at any frequency. With regard to L_{Aeq} and L_{Leq}, it can be seen that they were below the reference values during all different periods .

Graph 3 –Comparison of the reference frequencies distribution with those obtained in the three measurements of point 3



	LAeq	LLeq	16	20	25	31,5	40	50	63	80	100	125	160	200	250	315	400	500	1000	4000
Day	59,62	76,67	61,3	60,59	63,32	65,74	66,41	66,11	63,62	59,48	57,14	55,54	55,66	53,73	53,07	51,29	50,14	51,59	51,46	40,47
Evening	58,46	71,41	58	57,01	58,47	60,52	61,1	62,5	60,51	55,23	54,03	54,55	52,62	52,83	53,65	52,01	53,65	53,07	49,41	35,85
Night	63,25	71,31	53,57	55,86	56,82	61,86	60,35	61,53	61,37	61,1	57,74	56,55	58,04	58,57	57,4	53,18	52,34	49,53	53,47	48,4
Reference	74,95	86,49	74,48	75,01	72,35	71,83	72,91	70,87	66,06	64,09	63,66	62,67	61,85	61,96	63,88	63,77	65,84	67,34	66,18	52,98

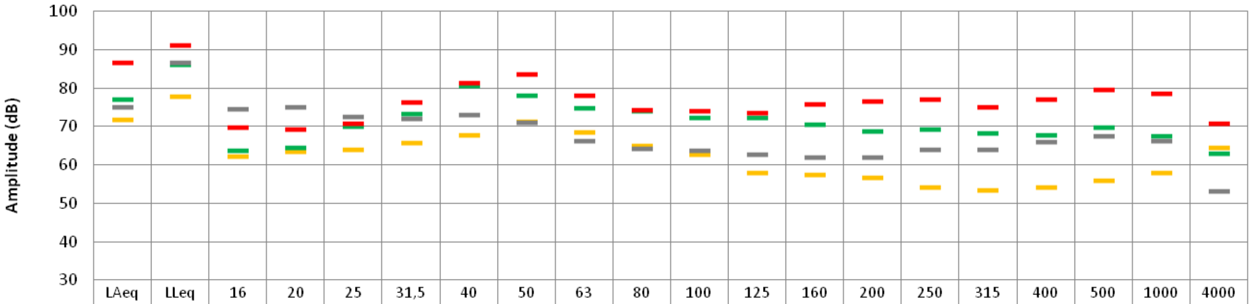
Frequencies (Hz)

Analyzing Graph 3 one verifies that the ILFN reference levels were not exceeded by the levels obtained in the three time periods. It is also observed that L_{Aeq} levels had an amplitude close to 60 dB and L_{Leq} levels had an amplitude superior to 70 dB, and that at the *day* period it reached an amplitude close to 80 dB. It was further noted that in lower frequencies (up to 63 Hz) ILFN levels were higher during *day* than during the other two periods, while for the remaining frequencies the levels were higher during the *night* period, with the exception of frequencies 400 and 500 Hz Finally, it can be observed that the levels of ILFN were closer to reference values between 63 and 200 Hz frequencies.

As previously evidenced in the results relating to the second phase of this study, noise levels found in a location varied depending on the wavelength of each frequency, thereby producing different effects in different structures of the human organism.

An analysis of the first three points under study, related to road traffic, one can see that L_{Leq} levels were close to 70 dB, and point 2 stood out because this value was closer to 80 dB, especially during the *day* period and therefore was closer to the reference level. However L_{Aeq} levels showed values close to 60 dB in points 1 and 3, and values close to 70 dB in point 2. Thus, it was proven once again the need to remove the A-weighting when the objective is to analyze the ILFN so that it is possible to have a scientifically accurate perception of the real acoustic environment to which the population is exposed (Alves-Pereira and Branco, 2007[2]). Regarding the analyzed frequencies, it can be seen that in these three points, those relating to infrasound (16 and 20 Hz) were remote from the reference values. However, the following frequencies, up to 315 Hz, were very close to the reference values during the three periods of the day.

Graph 4 –Comparison of the reference frequencies distribution with those obtained in the three measurements of point 4



	LAeq	LLeq	16	20	25	31,5	40	50	63	80	100	125	160	200	250	315	400	500	1000	4000
Day	71,7	77,84	62,17	63,48	63,94	65,67	67,74	71,2	68,35	64,95	62,57	57,82	57,25	56,54	54,02	53,29	54,07	55,75	57,73	64,34
Evening	77,06	85,9	63,55	64,4	69,94	73,21	80,51	78	74,68	74,03	72,29	72,13	70,52	68,71	69,11	68,27	67,56	69,77	67,37	62,91
Night	86,62	91,12	69,71	69,12	70,59	76,14	81,17	83,61	77,96	74,24	73,9	73,54	75,81	76,4	76,85	74,92	77,04	79,55	78,43	70,55
Reference	74,95	86,49	74,48	75,01	72,35	71,83	72,91	70,87	66,06	64,09	63,66	62,67	61,85	61,96	63,88	63,77	65,84	67,34	66,18	52,98

Frequencies (Hz)

In assessing Graph 4, relating to road traffic, it can be stated that the L_{Aeq} and L_{Leq} reference levels were exceeded during the *evening* and *night* periods, and the values obtained for the *day* period are also close to the reference values. On the frequencies 31,5 and 40 these levels were exceeded for *evening* and *night* periods, while in the frequencies between 50 and 80 Hz the reference values were exceeded in all three periods. From the 100 Hz frequency on the reference levels were exceeded in the *evening* and *night* periods, with the exception of 400 Hz, where it was exceeded in all periods.

As previously highlighted in the results relating to the second phase of this study, noise levels found in a location varied depending on the wavelength of each frequency, thereby producing different effects in different structures of the human organism

Regarding the results obtained in point 4, relating to road traffic, we can see that in the *evening* and *night* periods LFN levels exceeded the reference values, except for the 4000 Hz frequency. It can also be observed that the reference values have not been exceeded only for infrasound and some frequencies during the *day* period.

Thus, it can be stated that the results obtained in this second phase showed that there is risk of VAD development in populations living in the analyzed locations, and this risk is increased in the case of the point on rail noise. These results could prove once again that VAD is not restricted only to occupational exposures and should be seen as a public health problem, and measures should be consistent with the extent of the problem in question. Thus, it is proven the need for adoption of effective and efficient planning laws, such as the placement of residential areas behind large office buildings instead of surrounding major road and rail routes.

4. CONCLUSIONS

First of all, it is important to note that we are aware that if more traffic routes had been studied, in order to find a more homogeneous sample, the study could be more significant. However with the conduction of this study we may conclude that the low frequency noise produced in roads and railways does not have an invariant single standard, on the contrary, this type of noise is subject to the interference of many variables and should be evaluated by frequency and in different periods of time. Thus, it was also concluded that the ILFN in human population should be evaluated with regard to potential risks, both for the welfare of population and for their physical and mental health.

Due to the absence of national legislation for ILFN, it is important to understand the harmful effects of this noise on people's health must be transformed into environmental criteria, in order to limit and mitigate the impacts of population exposure. It should be established a dose-response or exposure-impact relationship, that provides the basis for the determination of limit values (dB) for the various indicators of ILFN.

For a deeper understanding of the technical and theoretical knowledge and in the face of the results obtained, we suggest future studies where different factors that may limit or increase the spread of noise are taken into account, making the calculation of the LFN levels depending on aspects such as the distance from the watercourse, its average flow, or nature, among others. With regard to road conditions, it would be interesting to ascertain what the causes for the existence of more noise at lower frequencies are. It is also suggested that in future studies an examination of the influence of the vegetation cover in the spread of the LFN is made, selecting the locations depending on the sizes recommended in literature. Because it was analyzed only one place with "acoustic barrier" of the *masonry* type and given the results presented, it is pertinent to deepen the understanding of this issue in order to verify if these results have implications for a more uniform sample.

It will be important to conduct this type of studies taking into account environmental factors such as temperature, relative humidity and wind speed, which could have a substantial influence on the propagation of low frequency noise. Finally, it would be desirable to perform diagnostic tests on the population living in the locations where tests were conducted for this study in order to perform the screening of VAD.

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Agents approach to Occupational Health and Safety at construction sites

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ABSTRACT
In the Brazilian industry as well as in most countries, the construction represents an important share of the economy to be responsible for hiring many workers. Due to expansion in this sector and the necessity of meeting deadlines, which are becoming shorter, still coupled to the high number of manpower disqualified, the number of accidents at work is growing at alarming rates. Thus this paper aims to demonstrate, by means of current Brazilian data, the number of accidents has increased in recent years, in particular, our discussion draws especial attention over the construction industry. This will use the database developed by the annual Brazilian protection. In this light the yearbook, it was found that the number of accidents have not increased in similar proportions as the number of workers who started in this industry. For these numbers are reduced is necessary to apply a management system of safety and health at work within the construction site, so that each member company to participate and collaborate for the safety of all. In addition, policies should be created that value and encourage employees in the exercise of their functions, all aimed at a reduction required, the rates of occupational accidents in Brazil calculated.

Keywords: Accidents at work; management system; prevention.

1. INTRODUCTION

The issues related to health and physical integrity of workers have been highly debated ever since the potentiation of the means of production and the deplorable working conditions arising from the Industrial Revolution intensified the volume of disease at work, culminating in the signing of the Treaty of Versailles whose conventions aimed mainly overcoming the exploitation sub-human (Clemente, 2010, p. 14).

Although great advances have been achieved, the Occupational Safety and Health (OSH) should be frequently in debate and revision, in view of the increased rates of accidents that point mainly to the lack of planning, of signalling, low-skilled to carry out the activities and bad (or none) use of safety equipment (Monteiro, 2010, p. 13).

These risks are inherent in the execution of any professional activity, which may be of ergonomic order if they are caused by physical exertion, carry weight and inadequate posture; social order where they are on a corporate policy (such as alternating turns, excessive division of work) and also caused by the risks present in the workplace, in poor conditions, operational processes or in the agents (physical, chemical and biological), which depending of the nature, concentration, intensity and exposure time can affect the health of workers. Although no training is free, some offices are more likely to undergo misfortunes (Silva, 2010, p. 12).

In the case of industries, the construction one in particular, has the highest values with probabilities of occurrence of injuries in double and triple of fatality, possessing 355 thousand the number of fatal accidents every year worldwide, of which 20% occur in construction sites and almost 60 000 are caused by actions with dangerous character, according to estimates by the International Labour Organization (Lima Junior, 2005, p. 3). In this environment that demands a large number of activities, with the lack of consistency and timeliness in which they are performed, combined with high turnover, the relevance of this study is justified.

According to Fung, Tan, Lu & Lo (2010) work in the area of construction is high risk in modern society, caused by a combination of several factors such as low education, deskilling of the workforce, poor stability, lack specialization, control, guidance and practice of unsafe acts, where most activities are done by hand. The authors also mention that the most effective way to secure a performance that is prevention should range from the highest offices (providing equipment, making speeches, raising awareness and reporting the employees occurred), passing by the workers (identifying risks and acting caution) and being monitored by the responsible agencies (increasing compliance with the required items and recording the cases).

Protect workers from risk, and compliance with laws, is a fundamental condition to minimize waste and increase productivity in construction, for the second Barreto (2011) these accidents beyond human factors, such as large losses and traumas, even cause great harm to the welfare system and do not add value to the production system, as complete Mariano and Krüger (2008).

The research for this article was based on literature review of the main and most recent authors, along with analysis of the latest available figures for the main institutions responsible for the subject, and as we can see from this brief literature review, the health and safety programs in construction work have emphasized the scope of security, the prevention of accidents because of the large and immediate visibility of these diseases when compared to the consequences of which

are slow to appear. Compounding the situation, the health worker may also be affected long after their exposure to a particular contaminant or agent in the work (López-Valcárcel, 2005, p. 39).
This paper therefore aims to show that the growth of construction and the need to meet deadlines make you hire a lot of manpower, which in most cases, and also disqualified, still need to work expeditiously, resulting in a large number of accidents, and evaluate the effectiveness on the participation of all stakeholders in promoting workplace safety in construction sites.

2. THE MARKET

In the European Union with the construction industry has a great economic participation, from 18% of work accidents, 24% are fatal. According to the International Labour Organization (ILO) the distribution of these accidents worldwide in 2005 was 64% for Asia and the Pacific region, 17% for the Americas, 10% to 9% for Africa and Europe. The data is so important that when talking about work-related accident, the first image that comes is that he was in the construction sities (Dias, 2005, p. 51).
The Anuário Brasileiro de Proteção (2011) says that the great neglect of issues of Health and Safety is global, since the 204 countries with more workers in the world, only the smallest portion (usually developed countries) periodically sends data the ILO, keeping them updated and complete, while 35% do not report the number of accidents and 36% did not disclose the deaths. In addition to the downgrade is another difficulty in comparing the records, because each site has a specific concept of informing occurred, being possible to establish a relationship only by the number of deaths, which in 2009 totaled that 50,793 of the 8,752,991 accidents noted. An estimate of the ILO is that each year about 330 million workers suffer worldwide, 160 million new cases of occupational diseases arise and die more than 2,000,000 dies (1,574,000 victims of industrial diseases, 355,000 from accidents and 158,000 on the route to work).
As we can see in Table 1, based on the same directory, in Brazil between 2000 and 2009 the number of workers increased only about 58%, while the accidents almost doubled (increased approximately 99%), despite the significant decrease in the number of deaths by 80%. This reduction in deaths, as well as the values and non-accident records between the years 2008 and 2009 are attributed to awareness campaigns and prevention made by the Ministry of Labour and Social Security.
Even in decline, the index is still considered high, because according to the last update in 2009, of 732,452 accidents occurred, only 528,279 were registered: 421,141 described as typical (occurring within the work environment), 89,445 commuting (both in flight and in return, regardless of the time, and in the midst of movement of workers and within or outside) and 17,693 occupational disease (repetitive strain injury, postural problems, etc.). It is also estimated that 195,173 cases were not recorded and others 2496 resulted in death.

Table 1 – Number of Diseases and Work Accidents in Brazil

Year	Workers	Number of work accidents				Total accidents	Deaths
		Recorded			Not Recorded		
		Typical	Route	Diseases			
2000	26.228.629	304.963	39.300	19.605	-	363.868	3.094
2001	27.189.614	282.965	38.799	18.487	-	340.251	2.753
2002	28.683.913	323.879	46.881	22.311	-	393.071	2.968
2003	29.544.927	325.577	49.642	23.858	-	399.077	2.674
2004	31.407.576	375.171	60.335	30.194	-	465.700	2.839
2005	33.238.617	398.613	67.971	33.096	-	499.680	2.766
2006	35.155.249	407.426	74.636	30.170	-	512.232	2.798
2007	37.607.430	417.036	79.005	22.374	141.108	659.523	2.845
2008	39.441.566	441.925	88.742	20.356	204.957	755.980	2.817
2009	41.207.546	421.141	89.445	17.693	195.173	723.452	2.496
On average	32.970.507	369.870	63.476	23.814	180.413	511.283	2.805

Source: Anuário Brasileiro de Proteção (2011).

Like most countries, Brazil's construction industry represents an important fraction of the economy because it generates many jobs, directly or indirectly and also the one that have the greatest number of casualties. The Anuário Brasileiro de Proteção (2011) also says that in 2009 were 54,142 recorded cases occurred in construction, 34,663 of them were described as typical, 4970 of route and 1064 due to illness and possibly 13,445 were not recorded. With this, the National Social Security Institute (INSS) spent in the same year only to accidents at work about $ 6,897,737,000.00 (see table 2), making the country occupied, according to the Brazilian Chamber of Construction (CBIC), the tenth in the world ranking of occupational accidents.

Table 2 – Cost of work accidents in Brazil

Annual value of the expenditure from INSS (US$ thousand), according the kind, from 2003 to 2009							
Description	2003	2004	2005	2006	2007	2008	2009
Special retirement	2720823	2991584	3175466	3335924	3159765	3552202	3813975
Disability retirement	460377	555676	661737	763978	753955	905422	1028788
Sickness benefit	556671	712891	1431509	699545	816578	932159	1169711
Accident benefit	466484	531869	594337	662408	657403	809180	816112
Additional benefit	49789	54113	56772	57219	61836	171183	69151
Total	4254144	4846133	5919821	5519074	5449537	6370146	6897737

Source: Anuário Brasileiro de Proteção (2011).

In an increasingly competitive market, the economy has driven small and large businesses to produce more and better products at a small cost in order to survive. Whereas the Brazilian Association of Technical Standards (ABNT, 1999) defines work-related accident as "unexpected and undesirable event, instantaneous or not, related to the performance of work, which results or may result in personal injury," job security can be an important tool for reducing costs, since the investment spent on this sector is reversed in increased productivity, as well as ensuring quality of life, hygiene and health at work, allowing a good professional performance, as many those professionals who use brute force, and unskilled, still working under precarious conditions considered (Alvim, 2010, p. 11).

3. COLLABORATION OF EACH PARTY INVOLVED

For a long time it was believed that the implementation of safety rules would be the sole responsibility of the companies, applying and punishing non-compliance, while today it is known that a large number of accidents would be avoided if everyone complied with the standards, required training and improvement of the same (Silva, 2010, p. 18). For this Barreto (2011) argues that the installation of a Management System Occupational Health and Safety (MSOHS) must contain a number of initiatives, duly formalized through policies, programs, procedures and processes integrated into the business, in accordance with the requirements and legal duties, with the participation of directors, employees and tax, acting consistently and conducting activities with ethics and social responsibility.

The promotion of safety in the workplace must come from an association between good planning and use of basic tools that attempt to neutralize the dangers and if they occur. According to Marques (2010) attention is made by signs that awaken the senses, from short form, clear and objective information that can prevent human error and warn of impending accidents, such as oral communications (with simple instructions and direct), the tactile (hand signals, different textures, embossed markings, etc..), visual (such as plates, signs and bright apparent and understandable, with proper contrast to the environment) and auditory (by sirens, horns and whistles the noise level was higher than the outside, without being excessive and clearly identifiable). Since the neutralization, according to Clemente (2008), arises from the proper use of safety equipment collective or individual, that protects the worker, protect against incidents and absorb the loads that would be aimed directly at them.

Teo, Ling and Chong (2004) report that about 90% of workplaces are not completely safe to do so and, in some countries there are policies and OHS programs aimed particularly the construction sector, which generally include regulations, technical standards , advisory and inspection services, information, studies, publications and provision of specific training for the construction sector. Thus, the active participation of employees in understanding the responsibilities of security is paramount to the success of the programs, correcting and reporting activities to a supervisor, you need to be competent enough to identify unsafe practices and encourage employees to follow procedures correct.

But this is not usually the case in most developing countries, where the action is somewhat different for each sector and lack of specific programs for SST construction (Lima Junior, 2005, p. 41). According to the Occupational Accident Law (Brasil, 1976) all accidents must be reported to the Regional Labor by Work Accident Communication (CAT), which in most cases, and not, when they do, in completing the document does not contain all the necessary data for identification of the lesion.

Another fact very common in Brazil, as described by Silva (2010), the company is not to report the occurrence in order to maintain a good image and not owning up, so that in most cases the conflicts are resolved in court or even even if the workers to plead guilty for fear of reprisals. For these reasons, data from the Anuário Estatístico de Acidentes do Trabalho do Brasil, 2009, show that from 54,142 accidents on construction sites, only 40,697 were reported, showing that almost 25% are neglected even by those who suffered the burden, making it impossible to registration and subsequent development of strategies for its prevention.

Although in some cases accidents occur by the practice of unsafe acts by the worker himself, conscious of failure to comply with basic assumptions (such heights without climbing belt, using electronics in wet and driving at high speed), most of the risks in construction is the result of bad management, since the quality, productivity and security can only be guaranteed if the right time are three factors in shaping logistics: the workers (in quantity and satisfactory with the

necessary skills), equipment (appropriate in good repair and accommodation) and materials (sufficient quantity and quality), leading to the conclusion that a well organized and work well done is also a work safe, and requiring, prior planning and operation at each step (Clemente, 2008, p. 20).
Teo, Ling and Chong (2004) point out, however, a difficulty encountered by the process management is the large number of subcontractors in construction due to the diversification of activities, whereas with subcontracting the chances of accidents are more frequent, caused mainly by lack of communication, coordination and control. The authors argue that the main contractors can change the security responsibilities for subcontractors, but cannot ensure that contractors provide a safe working environment.
On the other hand, it is known that other factors may also complicate the planning of a work, as little uniformity of buildings, variety of tasks and milestones of the construction process, sometime between the bid and the beginning of the work schedule to be completed, lack of definition or reforms in the project, unforeseen climatic changes, environmental factors (cold, rain, time, humidity, wind speed, etc..), increasing number of serious and fatal accidents (López-Valcárcel, 2005, p. 39-41). However these issues can be circumvented from the research and technical literature on the subject and greater involvement in the selection of the profile of the workforce, making, however, always possible to plan the minimum for the safety, eliminating the cause or predicting (Lima Junior, 2005, p. 20).
To this end, Clemente (2008, p. 42) evaluates the construction site as a place of transformation, where the design work is influenced by a variety of activities, which is an iterative process, where each change starts a new solution, hence need approach to simplify and organize the decision-making should be adopted, for example, a study in order to layout a better location of machinery and equipment, also considering that to be a changing structure in the course of construction, some adaptations should be provided.
According to Lima Junior (2005), usually the security programs in this sector have priority in the prevention of serious and fatal accidents related to burial, electrocution, falls from height and machinery and equipment without protection. But you should also consider ergonomic issues, environmental, educational and health problems due to a deficiency in the existing housing, food and transportation workers, and the application of penalties for non-compliance with laws such as the work of the embargo, a ban the establishment and notifications.

4. CONCLUSIONS

At the end of all this research we can conclude that for the workers, especially the construction´s one, the risks will only work environment reduced when all fully understand the importance that should be given to security issues, aiming beyond the quality, the creation of basic conditions that meet the needs of both employees as the building itself and realizing that this should be seen as an evolving process, not allowing stagnation of the same.
One way to succeed at these points is implementing a Safety Management System and Health at Work in which all members actively participate in the company, always seek to improve the program, where each group of employees has defined responsibilities and that these policies to value the worker, giving it stability by exercising his office.
Thus, agents that are related to the phases of construction as the developer, the security team, senior management, the author of the project, managers, supervisors / engineers, contractors, foremen and other workers, tasks and responsibilities must have graduated and well detailed, assigned according to the particularities of their duties, experience and knowledge.
Another factor that has great influence is the way the construction site itself is installed, a time to be well signposted and disposal of project components follow a logistics use, the likelihood of accidents is much lower. However we must also consider the possibility that these things happen and should always be recorded and reported to authorities, that the documentation will be able to develop tools, methods and preventive actions and brokers, eliminating or minimizing the risks.
But none of the above will be meaningless unless it is emphasized that each worker is primarily responsible for their own safety and the safety of other persons who may be affected by their work, demystifying the thought that prosaic Safety and Health at Work is only the responsibility of specialists. It is actually a joint action of all members.
It is hoped that this article spread to all markets, especially the construction sector, along with the importance being enlightened about the active participation of all stakeholders to be effective security work.

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Abandonment and Accessibility in Historic Buildings: a study of the railway stations of Central do Brazil Station and Leopoldina - Juiz de Fora, MG

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ABSTRACT
Being a heritage fallen to have to be preserved does not mean that the property should not adapt so that everyone can have access to them. The tipping should not be seen as a measure to "plaster" and "paralyze" the place. Accessibility is important and essential in the lives of people with disabilities, is required for both promotion of accessibility and inclusion. Given this theme, were studied and evaluated two railway stations in the city of Juiz de Fora. Accessibility studies were done in these spaces that were not designed to assist people with disabilities because it is still the beginning of the nineteenth century. Accessibility is a tool, but it should be noted that personal interests must be taken into account, they can make spaces accessible to become underutilized simply because there is no identification with the place, where there is an assignment of a value (cultural, historical or even sentimental) on the part of the public.

Keywords: acessibilty, mobility, railway stations, Brazil.

1. INTRODUCTION

This work demonstrates the development of research conducted in Juiz de Fora, MG, whose objective is the assessment of two areas of the city's railway station, in order to make people understand and access the historical and cultural heritage of this city. Do use this study for a possible solution to the problem of rail abandonment of the historic buildings of the city, especially the stations of the Leopoldina Railway (Figure 1) - EEFL Station-Central Railroad of Brazil (Figure 2) - EFCB - as well as discussing the issue of accessibility to them. This research is still in development and in the end it is expected to collaborate to safeguard the memory of the railroad and future research to contribute to the understanding of urban spaces that encourage such research, contributing to the formation of built environments that offer universal accessibility and promote the safety of these users with special needs and this is one factor contributing to the improvement of quality of life users of these spaces.

The two railway buildings are landmarks in the history of the city, formed the first nucleus for urban development (Esteves, 1915), located at Praça João Penido, popularly known as Station Square. They are located in the central area, popularly called "parte baixa" among streets Halfeld and Marechal Deodoro. Square came up with the construction of the railway station of Dom Pedro II (later Central of Brazil), inaugurated in the early nineteenth century, was one of the gateways to the city. At that time, early industrial period, the railway was the main access road to Juiz de Fora, thus, the square represents the heyday of industrialization of the city. Near the railroad focused commercial and industrial development. The city developed around it, the buildings remain to this day, creating an area of great economic growth and dynamics (Oliveira, 1953). Currently, this space houses the main historic core of the city.

Figure 1– Station of the Leopoldina Railway

Figure 2 – Station the Central Railroad of Brazil

2. MATERIALS AND METHOD

To develop our research, we used data obtained through direct documentation, field research, with simulation of accessibility by persons with disabilities (mobility, visual).The simulation allowed the concrete analysis of the physical difficulty of insertion of the disabled in these historic buildings, where there are many stairs at the main entrances and there is no ramp and handrail to serve as support, the field research identified there by the majority of the population is a stigma relation to the group that houses the railway stations, especially Station Central Railroad of Brazil, which is underutilized.

After analyzing the physical conditions of the property, realized the possibility of adapting the buildings for access by persons with special needs. These adaptations must meet specific legislation, the Brazilian Standards NBR 9050 who determined by NBR 9050 the basic conditions of Accessibility to buildings, furniture, equipment and urban spaces. But these buildings, being part of the main body of the city's historic buildings are in special protective conditions governed by municipal laws that do not allow modifications or adjustments to their original structures. Thus, in addition to overcome physical barriers to adaptation, it is necessary to overcome the legal barriers. All proposed changes must be approved by municipal agency responsible for protecting this type of building, the City Council for the Preservation of Cultural Heritage (COMPPAC). Adaptations of these buildings "protected" should be made so as not to compromise its integrity, ie, ramps must have its own structure and should not be posted in buildings and support structures, such as handrail, should preferably be established in floor, so as to cause the least possible damage to it.

It was noticed that the buildings do not have exterior signage identifying efficient, which means that many people do not identify them as buildings of historical value. This situation occurs more intensely in the building of the Leopoldina Station, because the building does not present specific characteristics of building rail.

The survey data collection was conducted in July 2011 consisted of mapping and architectural study of the conditions of access for people with sensory disabilities: access to and inside buildings.

We present the results in tables of evaluating the conditions of access to buildings Leopoldina of Brazil and Central Railway Stations, highlighting stairs, ramps, circulation areas, types of doors and floors and there are adapted toilets. In this analysis it was found that both railway stations have stairs in your entries and their main accesses are closed to the public for security reasons.

The building of the Leopoldina Station is located at the Complex Tancredo Neves, where also is located the administrative building of the municipality of Juiz de Fora and some annex buildings. The main entrance of the station is made only by the access to the parking lot of the complex, without a specific location for the transit of the pedestrian. This entry is made by the door with two leaves, with enough passage (2.00m) to access for wheelchairs, however the lack of the ramp impedes access, as we can see in Figure 3. In addition, there is no tactile floor route to help makes blind people to this entry.

Figure 3 – Main access to Station of the Leopoldina Railway

The main building of the station Leopoldina is a two floors building, where the first floor runs the Railway Museum, and the second floor is closed without use. Their entries secondary, access doors to the old station boarding platform, function only as access to these patios, which are enclosed by fence on its side facing the railway line and level crossing are the only existing access to the old warehouses of station. The other entrances are closed and on the outside of this façade there is a garden, which prevents its use, there is only one service door of the auditorium in working condition. In this building now operates an auditorium and a multipurpose room. As the buildings are located in an administrative complex and no expedient on weekends, the car park entrance is closed during this period, making it impossible access to these buildings.
Regarding the analysis made in the building of Brazil's Central Station, located near the wide, one called Station Square, it was observed that this access is made by one of the city's busiest routes, named Avenida Francisco Bernardino. The avenue is one of the main arteries of the city with a large volume of traffic of cars and buses that are attended by a large bus stop near the main entrance of the building. This building has access by the stairs, which invalidate access for disabled. Added to this factor, another problem: the width of the walk between the curb and the first step, to rise, is 80cm, which brings a very significant sense of insecurity for pedestrians, proximity to the local bus transit, this can be seen in Figure 4.
The existence of floor podotatil sidewalk access to this building would be a safety factor for the visually impaired circulating in that locality, the movement of wheelchair users is compromised because the space is small and this would not go along with other person.

Figure 4: Details of access to Station the Central Railroad of Brazil

The other doors that would be the secondary access to the building, facing the old departure platform have a step with approximately 20 cm and there isn't also nearby tactile floor to guide the direction of access to people with sensory disabilities. In annex to the Station there a departure platform, which remains closed with a screen to turned face the railway line and the bars turned face the avenue. Your gate and old turnstile entrance and exit of people are locked, which makes it more difficult access to the building. Could be two more alternate entrances to the building which would help to avoid underutilization of the area (Figures 5 and 6).

Figure 5 – Station the Central Railroad of Brazil

Figure 6 – Station the Central Railroad of Brazil

After the analysis of access to stations, will specify the analysis carried out within the buildings, see:
At the station Leopoldina, after climbing the few steps to reach a large hall where the reception functions, this room serves as the central point of the building is well lit which favors the circulation, where it is located the stairs to the second floor, which is closed.
The main hall, difficult to access depending on the stairs, is well lighted well lighted which facilitates viewing of your space. There are also no adaptations in any of the restrooms of two buildings; however, the size of spaces offers the possibility to adapt to accessibility standards, which require some minor adjustments.
There are no obstacles for users of wheelchairs, but the visually impaired have no reference because there are no tactile floors and no information in Braille. This makes the visually impaired frequently need information to orient themselves and move through space The obstacles in the internal areas would not be inconvenient for the visually impaired if they were flagged. After you reach the foyer to the old platforms, today transformed into the area of access to auditorium
After the foyer you reach to the old platforms, where there are two old locomotives on display and a panel where they are exposed photos of the region in several periods (Figure 7). There is not any sign to warn the blind about these objects, which transforms them into obstacles for these special people.

Figure 7 – Outer area of Stations of the Leopoldina Railway

On this platform we come to the old warehouses, which now operate a multipurpose room and an auditorium. Access to both is done by step about 20 cm. In the auditorium there isn't a local forecast for parking wheelchairs without interfering with the circulation.
Regarding Brazil's Central Station, the floor of your outdoor area has significant unevenness that hinder the movement of wheelchair users and visually impaired. These unevenness were created as an adaptation period in which the station

served the transport of passengers and started receiving a new model train higher than those used at the time the station was built.
Table 1 below shows traffic conditions within the buildings: noting stairs, ramps, circulation areas, toilets, types of doors and floors. The Table summarizes the difficulties encountered in the circulation and use in the buildings:

Table 1 – Inside the Stations

	Estação Leopoldina		**Estação Central do Brasil**	
	Yes	No	Yes	No
Primary access accessible		X		X
Secondary access		X		X
Ramps		X		X
Handrails		X		X
Adapted toilets		X		X
Appropriate doors	X		X	
Anti Slip floor		X		X
Tactile floor		X		X
Obstacles	X		X	

In a quick analysis of the information presented in Table 1, we find that the two stations are in similar situation: they do not have accessibility in their main entrances, because you need to climb stairs to enter the buildings, do not have access secondary, they do exist but are closed to the public, do not have handrails on your stairs, do not have adapted bathrooms, although there are possibilities of adaptation; existing doors are wide that meet the needs of users with special needs, there are no non-slip floors and floor or on the premises podotatil not marked and there are obstacles in both seasons, such as banks and objects on display.
After checking the internal problems of circulation, in the Tables 2 and 3 are showed the current conditions of use at each station.

Table 2 - Conditions of use in Leopoldina Station

	Visually impaired			**Physical disabilities**		
	Orientation	Displacement.	Use	Orientation	Displacement	Use
Access to the building	Difficult to locate. Without appropriate signalizing.	Existence of steps	There is no handrails	Difficult to locate. Without appropriate signalizing	Existence of steps in the entrance	There is no ramps
Environments	Limited mobility, there is no floor podotátil or Braille			Lack of access to the auditorium and multipurpose room	There is no ramps	No specific space to wheelchair users
Circulation	Limited mobility, there is no floor podotátil or Braille	There is different floor levels		No sign plates	There is different floor levels	
Toilets	They are not adapted			They are not adapted		Hampered by the absence of adaptation
Output of the buildings	Without appropriate signalizing	There is no signalizing	Hampered by steps	There are no access ramps	There is no signalizing	Hampered by steps

Table 3 - Conditions of use Station the Central Railroad of Brazil

	Visually impaired			Physical disabilities		
	Orientation	Displacement	Use	Orientation	Displacement	Use
Access to the building	Without appropriate signalizing	Existence of steps	There is no handrails	Inappropriate signalizing	Existence of steps in the entrance	There is no ramps and handrails
Environments	Limited mobility, there is no floor podotátil or Braille				There is no ramps	
Circulation	Limited mobility, there is no floor podotátil or Braille	There is different floor levels		No sign plates	There is different floor levels	
Toilets	Not adapted	Difficult to locate		It is not adapted	There is different floor levels	Hampered by lack of adaptation
Output of the buildings	Without appropriate signalizing Street with heavy traffic	Without appropriate signalizing	Hampered by the stairs	There are no access ramps	There is no signalizing plates	Hampered by the stairs

Table 2 presents the analysis of the Leopoldina Station, where he now runs a Railway Museum, under the aspects of the visually impaired and the person with a mobility impairment. The station is difficult to locate because it is within a parking vehicles, has no nameplate and your building does not have the physical characteristics that easily identify stations. The arrival of the building is through the driveway to the parking restricted area without existing or zoned for pedestrians, or any other type of signaling. Entry into the building is made by stairs, without the existence of handrail or ramp. There are no identifications of the rooms in Braille. The circulation is compromised by the absence of tactile floor, which in addition to guiding the circulation, would cause the objects shown and the differences were flagged, giving greater security to the user. For the user of wheelchairs the situation is similar, there are no ramps for access to the building or boarding platform leading to the auditorium and multipurpose room, which also have only stairs. The audience does not have a specific space for the wheelchair can watch the presentations, they have to stay in circulation areas. There are no adapted restrooms, although one physically able to be adapted. The second floor is closed and access is done by existing staircase in the main hall, there is no platform lift to access the second floor of the building. The conditions of access can be improved with the placement of mobile ramps access secondary of buildings and access the platform, with the addition of a bathroom, tactile floor placement and removal of some seats in the auditorium.
The analysis of Table 3 presents the conditions of use of Brazil's Central Station, from two points of view: the visually impaired and persons with reduced mobility. For the visually impaired: access to building is hampered by lack of outdoor signage, tactile floor and the identification of the building in Braille. Access to the building is via stairs and no handrail that can facilitate such access. In indoor mobility is also hampered by the lack of tactile floor directional and signaling of obstacles, as well as guidance in Braille signage. The building has many rooms interconnected, stair and the proximity of the railway platform to make the installation of this floor is very important to signal the way they should do, as well as provide security in the circulation by the platform. Bathroom does not have adaptation and is difficult to locate because it is in one of the rooms. Access to the building is done by one of the avenues of higher volume of traffic of the city of the city and there is appropriate signage for the movement of people with visual impairments.
In relation to the mobility impairment can conclude: there is no external signage identifying the building, the only access is accomplished by ladder that has no railing, the building has no ramps making it difficult to access for wheelchair users. Inside the building there is only the gap of rooms for the boarding platform, that although the circulation is made by many doors, has no ramp. There is no adapted bathroom, although the existing has enough space for to make necessary modifications. On the outside, along the stairs to the main building, the area of the sidewalk is very narrow, which difficult the movement of people who use wheelchairs
External conditions of access station could be improved with small interventions. Signaling of the building, with its identification; placement of tactile floor at near sidewalks and the creation of a special entries in the secondary entries

that are disabled, with the placement of mobile ramps, as required by law, would cause the building to be accessible to a population that often has no entry by physical culture. Signaling platform on its edge along the rail line is important to promote safety accessibility and safety of users of that space.

3. RESULTS AND DISCUSSION

People used the railroad as transportation and had other benefits with this service, so the railroads echoed strongly in the economic, social, political and military society. Nowadays, we see the buildings of EFCB and E.E.F.L. are being underutilized. This work aims to upgrade the buildings through studies on accessibility and evaluation of space, considering that "the historic areas (...) constitute the living presence of the past that shaped them, (...) and, therefore acquire a value and an additional human dimension" (Cury, 2004).

Because the Stations are of the beginning of the nineteenth century, these were not designed to assist people with disabilities, since these were excluded by society. Today, that vision of society has changed and these people are increasingly embedded in the context of society, including in the cultural field. Accessibility in historic buildings is also important to safeguard the memory of the place, as the buildings are part of the railway history of the city access to them is important, hence the need to adapt these buildings.

At the time of construction, there was concern about accessibility, but today the trend is to undo the existing architectural barriers, create opportunities for access to people with physical and sensory limitations, adapting the buildings to the new social culture and thus facilitate the recovery of memory the railroad. The historic buildings have to conform to new uses and meet the legislation in force, without creating social exclusion.

Equality consists in the Universal Declaration of Human Rights (ONU, 1948), as a fundamental principle, where everyone has the right to access to all goods and services. Referring to accessibility faced with numerous concepts, so this study was restricted to studies of ergonomic rail accessibility in historic buildings. However, "accessibility is not just linked to physical-spatial factors, but also to political, social and cultural aspects that influence the achievement of desired activities" (OLIVEIRA; BINS ELY, 2006).

With the global cultural change, the buildings of the stations studied here, public buildings, it should allow access to all the people, eliminating existing physical barriers without creating distinction. In order to have an improvement in this situation, all must be aware of particularly public agencies.

This paper aims to draw attention to the need for adaptations of rail access to central historic buildings, encourage research in the area of historical and cultural heritage in order to preserve the memory and history of these buildings, where we studied the adaptability. It is intended through these specific goals to make a valuation of assets occur rail, universal accessibility, and the rescue of cultural, architectural and environmental.

The impact of non-adaptation of spaces is only perceived by the affected, the other so-called "normal" not pay attention to these crucial details.

The goal is to make accessibility easy for all people in everywhere, so that its access can be performed alone, without help from another person, but there is the difficulty of inserting political incentive, which is due not to compromise on the part of most, making the deployment of new accesses, hindering the deployment of new access.

4. CONCLUSIONS

It is hoped that this work encourage new researches and consciences, involving professionals and enabling the development of other works in the city's other historic buildings suffering neglect and remain inaccessible to a part of the population.

Thus, the purpose here proposed, was to enable the improvement of urban living through architectural intervention (accessibility) that enables the interaction of the individual, through urban settings concerned with public space, for a better quality of life and user comfort, analyze the environment rail, correlating the data analyzed with the local context in order for a strategy to revitalize these degraded areas of Juiz de Fora, stimulating and encouraging their sustainability.

With such reflections, providing access for all people and concurrently enabling ergonomic improvements and built environments, will be generated an improvement in quality of life of people with special needs, contributing to the diversification of uses, enhancing the building and reducing the dropout of these areas. Moreover, it is worth noting that the issue of use of these spaces is not restricted only to physical accessibility. The stigma created by the abandonment of buildings reduces access to stations. Accessibility is a tool, but it should be noted for the personal interests and also contributing to make accessible spaces that become underutilized by the simple fact that there is an assignment of a value (cultural, historical or even sentimental) by this the public.

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A survey of ergonomics in a group of Portuguese and Chilean small and medium-sized enterprises.

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ABSTRACT
Small and Medium-sized Enterprises (SMEs) are a key source of employment. However, it seems that for several reasons workers in SMES may be exposed to less favourable working conditions, particularly in what concerns the risk of developing work-related musculoskeletal disorders (WMSDs). The main objective of this study was to analyse and characterise working conditions, with a special focus on ergonomics and work-related musculoskeletal disorders (WMSDs), of a group of Portuguese and Chilean enterprises. The applied method consisted in the application of an online survey, which was sent to companies using 4 different databases. The 639 received answers show, among other things, that 85.1% of the answers came from SMEs, and that only 23.6% of enterprises had a register of WMSDs. Nevertheless, 27% of the respondents have reported that, in the 2 last years, they had some lost working days due to WMSDs. Finally, 75% of the respondents have reported that they are available to spend some of their time to implement an ergonomic strategy. In conclusion, it is possible that the low value of reported WMSDs may be underestimated, as the majority of companies did not have a reliable WMSDs control and register. Moreover, this situation seems to be associated with an inadequate organisation structure and knowledge.

Keywords: SMEs, Ergonomics, Work-related musculoskeletal disorders, Portugal, Chile.

1. INTRODUCTION

Micro, small and medium-sized enterprises (SMEs) are the “engine” of the European economy. They are an essential source of jobs, create entrepreneurial spirit and innovation in the EU and thus are crucial for fostering competitiveness and employment (European Commission, 2005). Also, it is possible to argue strongly that almost all South American countries give great importance to SMEs, in terms of developing their economies (Hiba, 1997). Table 1 shows some data supporting this. Despite the differences between Portugal and Chile in terms of SMEs classification, which is verified mainly in the annual turnover criterion, the scenario is quite similar.

Table 1 – Resume of the situation of the SMEs in Chile and Portugal

Country	SMEs		
	% of total enterprises	% of Employment	% Gross Domestic Product
Chile	99.0	80.0	21.7
Portugal	99.6	75.1	56.8

Despite this economical relevance, it seems that for several reasons workers in SMEs may be exposed to less favourable working conditions, therefore are subject to higher risk than the workers in large enterprises (Hasle & Limborg, 2006; Hiba, 1997; Malchaire, 2006; Sørensen, Hasle, & Bach, 2007).
On the other hand, work-related musculoskeletal disorders (WMSDs) are the single largest category of work-related illness, representing a third or more of all registered occupational diseases in the United States, the Nordic countries, and Japan (Punnett & Wegman, 2004).
The main aim of this study was to analyse and characterise working conditions in SMEs, with a special focus in ergonomics and WMSDs, from a group of Portuguese and Chilean enterprises.

2. METHOD

2.1. Participants

Given the goal of the study, the used sample tried to represent the largest amount of enterprises in Chile and Portugal. It should be noted that this was a sample of convenience obtained from two electronic databases for each reported country. It is important to mention the use of an exclusion criterion, which was the need to ensure that no contact was made previously with the enterprise through OSH Practitioner.
In Chile, one of the used databases correspond to the PRO Chile (2009), an agency that belongs to the Directorate General for International Economic Relations of the Ministry of Foreign Affairs of Chile. The other used database was the website for SMEs Chile (Pymes de Chile, 2004), which serves as a online guide on a diverse group of topics such as: management, productivity, business opportunities, human resources, etc.

One of the used databases in Portugal was a database enterprises belonging to the University of Minho. However, to reach a greater number of enterprises, the database of the Agency for Investment and Foreign Trade of Portugal was also used (AICEP Portugal Global, 2009).
Also important to mention is the inclusion of large enterprises in the sample in order to compare and check the differences between them and SMEs.
As presented in Table 2, the used databases contained 11372 e-mail addresses. However, this number should be "corrected" with the number of error messages received, which totalised a value of 1817 and those messages that were not delivered to the recipient (for incorrect/outdate addresses, full e-mail boxes, etc.). Thus, the message had the potential to reach 9555 addresses and representing a same number of potential answers.

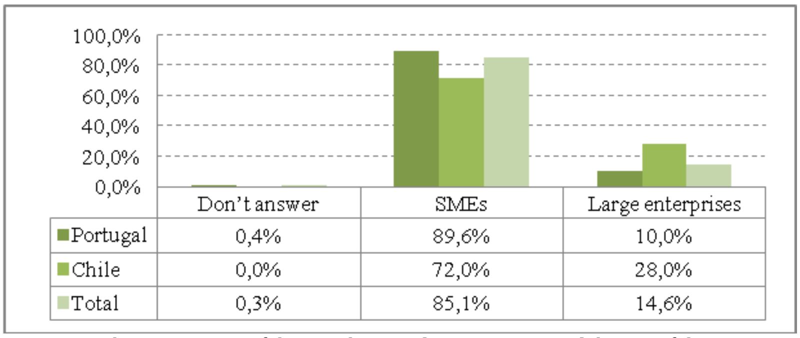
Table 2 – List of the formats to be used in the manuscript.

Country	Database	E-mails	Possible Answers	Answers	Answer Rate	
					Database	Country
Chile	PRO Chile	4395	3670	149	4.1%	4.2%
	Pymes de Chile	189	179	12	6.7%	
Portugal	UMinho	1401	828	51	6.2%	8.4%
	Aicep	5387	4878	427	8.7%	
Total	--	11372	9555	639	6.7%	6.7%

2.2. Characteristics of the survey
Associated with the difficulty of applying the survey in two countries, for practical reasons and treatment of responses, it was decided that two web platforms should be developed, thus allowing collecting answers online through a specific website for each country separately.
In order to encourage the response to the survey, it was decided that the survey should be as simple and short as possible. These characteristics allowed an estimated response time between 6 and 8 minutes.
Before applying the survey, a preliminary study with a group of about 25 people in each country was conducted. The group was formed by workers, entrepreneurs and other people with different basic backgrounds such as Ergonomics, Engineering, Law, Occupational Safety and Health (OSH), and others. This test intended to check their understanding of the language used, to obtain an estimate of the time that would take to respond, the suitability of the questions and to evaluate the functioning of the automatic data collection system.
The structure adopted in the developed survey, based on the 4 dimensions that were intended to be addressed: the characterisation of the enterprise, the quantification of the problem of WMSDs, existing knowledge about ergonomics and, finally, how enterprises had approached the working conditions in relation to ergonomics.
In the last part of the survey, it was referred the possibility to receive additional information, namely the overall results of the survey. Thus, by indicating the e-mail, enterprises could ask the sending back of information about the final results of the survey, the final report of the project, or both. This option was included considering that there is a recurrent request for answering electronic surveys and therefore, giving feedback was, or intends to be, an element of motivation to fill in the survey.

2.3. Statistical analysis
All data were entered into Microsoft Office Excel 2007 and analysed using SPSS v16.0. Categorical data were summarised using percentages and analysed using the chi-square test (cross table) with 95 % confidence interval, which was performed for testing the independence between the variables and the enterprises size.

3. RESULTS AND DISCUSSION
3.1. Characterisation of the enterprises
Based on 639 responses from the 2 countries, figure 1 shows the distribution of enterprises according to their size. Comparing the sample with the economical reality of these 2 countries, mentioned above and described in table 1, it can be stated that the sample is somehow biased. However, there is a difference in the "gap" between both countries, being more pronounced in the case of Chile, while the Portuguese sample is more representative of reality. This situation may have been caused by the fact that the Portuguese sample (478 responses) is considerably higher than the Chilean sample (161 responses).

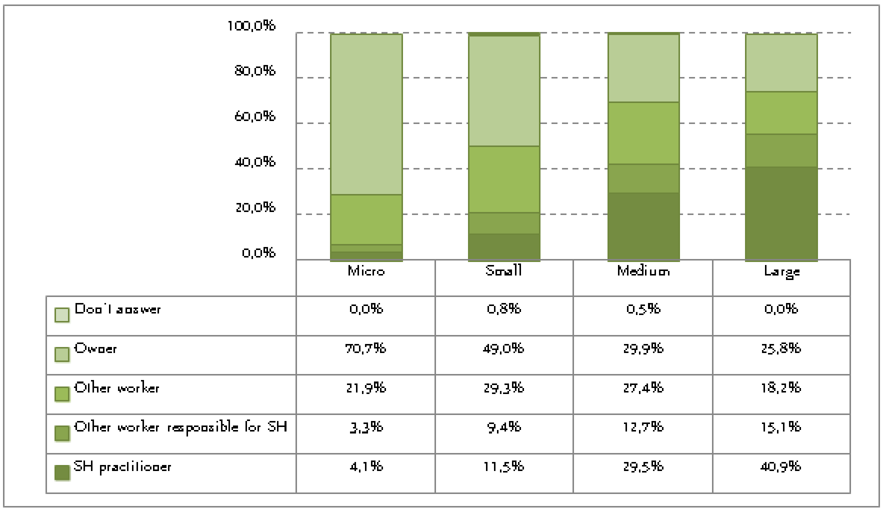


	Don't answer	SMEs	Large enterprises
Portugal	0,4%	89,6%	10,0%
Chile	0,0%	72,0%	28,0%
Total	0,3%	85,1%	14,6%

Figure 1 – Characterisation of the sample according to country and the size of the enterprise

Considering the variable "person who answers" and "the size of the enterprise", figure 2 shows 3situations that would be, in some way, expected. The first one is related with the large number of owners of the enterprise that answered the survey in micro enterprises, which decreases as long as the size of the enterprise increases. The other 2 cases are the increase of responses of "OSH Practitioner" and "other worker responsible for SH" as long as the size of the enterprise increases.

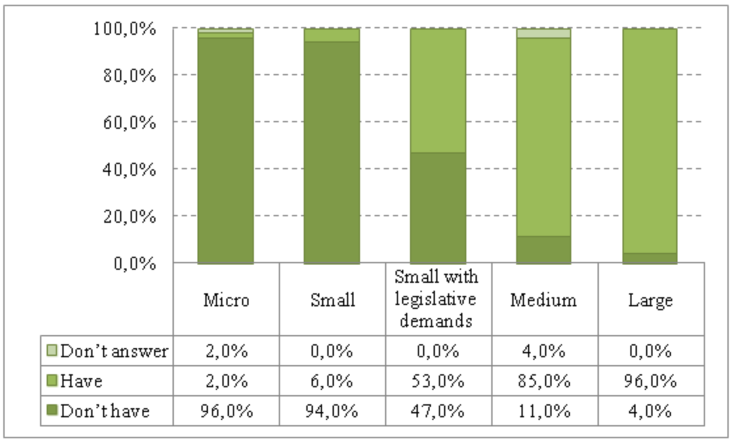
These trends, previously noted, were tested for statistical significance and the obtained result (X2 =1.044; p <0.05) has shown that these 2 variables are statistical dependent.



	Micro	Small	Medium	Large
Don't answer	0,0%	0,8%	0,5%	0,0%
Owner	70,7%	49,0%	29,9%	25,8%
Other worker	21,9%	29,3%	27,4%	18,2%
Other worker responsible for SH	3,3%	9,4%	12,7%	15,1%
SH practitioner	4,1%	11,5%	29,5%	40,9%

Figure 2 – Characterisation of the sample according to the person who answers and the size of the enterprise.

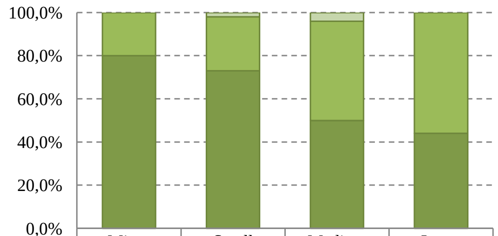
From the analysis of the data in figure 3 it is possible to see an increasing number of enterprises with workers commission, as the size of the enterprise increases, with a significant "jump" in the categories with different requirements in the Chilean law. This condition suggests that the law can be an important factor of influence. This situation was also found during the implementation of the Workplace Assessment (WPA), where complying with legislative demands was the basic motive of management to initiate the process (Jensen et al., 2001).



	Micro	Small	Small with legislative demands	Medium	Large
Don't answer	2,0%	0,0%	0,0%	4,0%	0,0%
Have	2,0%	6,0%	53,0%	85,0%	96,0%
Don't have	96,0%	94,0%	47,0%	11,0%	4,0%

Figure 3 – Characterisation of the Chilean sample according to the existence of "workers commission" and the size of the enterprise.

In what regards Portugal use data, in figure 4, even if there is an increase of “workers commission” in relation to the enterprise size, it is not possible to see a clear "jump. However, as in the Chilean sample, these variables are dependent and this dependency is statistically significant (X2 =36.371; p <0.05).
Considering those situations it is possible to conclude that the presence of “workers commission” is not simply influenced by legal requirements, but also by the size of the enterprise.

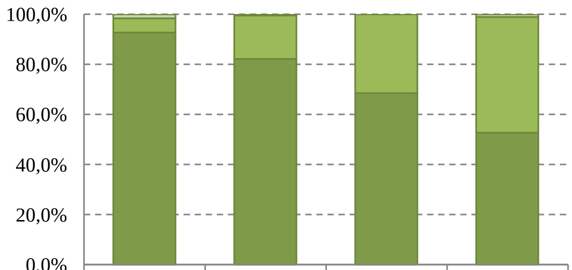


	Micro	Small	Medium	Large
Don’t answer	0,0%	2,0%	4,0%	0,0%
Have	20,0%	25,0%	46,0%	56,0%
Don’t have	80,0%	73,0%	50,0%	44,0%

Figure 4 – Characterisation of the Portuguese sample according to the existence of “workers commission” and the size of the enterprise.

3.2. Quantifying the problem of WMSDs

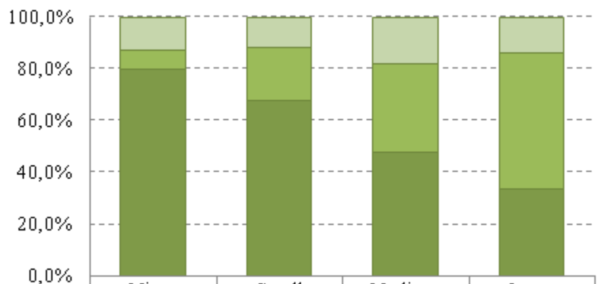
Before the analysis between the considered variables of this area and the size of the enterprises, it is important to mention that only 23.5% of enterprises had a register of WMSDs occurrence. Nevertheless, 27% of the respondents have reported that they had some lost working days due to WMSDs.
Regarding to the variables “size of the enterprise” and “register of WMSDs occurrence”, represented in figure 5, it is possible to determine a statistical significant association between them (X^2 =59.543; p <0.05), which may be caused by the low number of responses in micro enterprises. As already stated, there is an increase on the WMSDs registry as the size of the enterprise increases.



	Micro	Small	Medium	Large
Don’t answer	1,6%	0,4%	0,0%	1,1%
Have	5,7%	17,4%	31,5%	46,2%
Don’t have	92,7%	82,1%	68,5%	52,7%

Figure 5 – Characterisation of the sample according the register of WMSDs occurrence and the size of the enterprise.

Figure 6 shows a directly proportional relationship between the variables “existence of lost working days due to WMSDs” and the size of the enterprise, which is more obvious in large enterprises. This relationship shows significant differences, determining that the variables are dependent (X2 =77.747; p <0.05).



	Micro	Small	Medium	Large
Don’t answer	13,0%	11,6%	18,3%	14,0%
Have	7,3%	20,5%	34,0%	52,7%
Don’t have	79,7%	67,9%	47,7%	33,3%

Figure 6 – Characterisation of the sample according to the existence of lost working days due to WMSDs and the size of the enterprise.

In conclusion, it is possible that the low value of reported WMSDs (figure 6) may be underestimated, as the majority of enterprises, in particular SMEs, did not have a reliable and systematical WMSDs control and register. Moreover, this situation seems to be associated with an inadequate organization structure and knowledge.

3.3. Knowledge of ergonomics

Considering the variables “existence of worker with training in ergonomics” and “the size of the enterprise” (Figure. 7), it was not possible to detect any particular influence of the size of the enterprise in the workers` training between the micro and small enterprises. However, this influence can be somehow observed in other categories, which present a greater number of workers with training. The application of a statistical test shows that these variables are statistically dependent (X^2 = 57.387, $p < 0.05$).

This result is in accordance with previous studies (Lehtinen, 2006; Stuart-Buttle, 1999), in which was referred that the workers in small enterprises have low level of educational and vocational training and that their knowledge about occupational safety and health is low or practically inexistent.

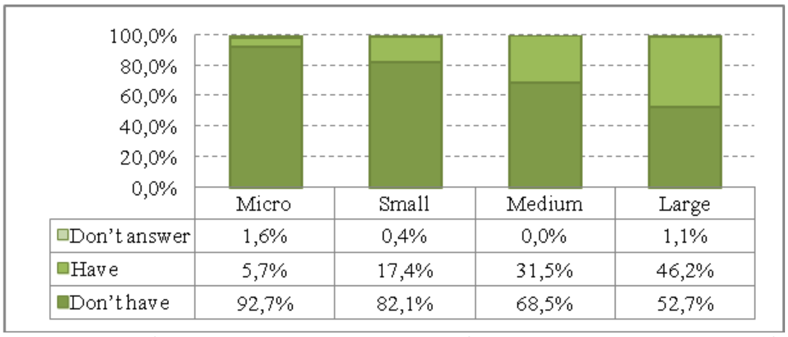


Figure 7 – Characterisation of the sample according the register of WMSDs occurrence and the size of the enterprise

From the carried out statistical analysis, it is possible to verify that there is a statistically significance dependency between the variables "person who answer" and "knowledge of the legislation of WMSDS” (X2 =84.449; $p < 0.05$). Figure 8 shows, as would be expected, less knowledge of the legislation by the owners of enterprises and superior knowledge in the categories of "another worker responsible for the OSH”. This value is even greater in the OSH Practitioner category.

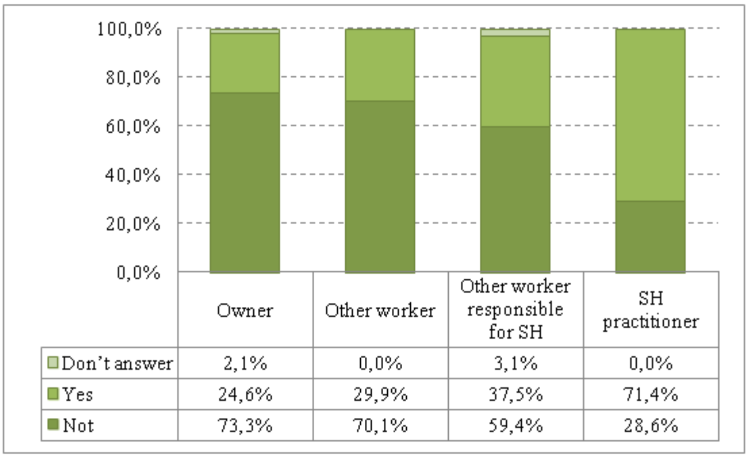


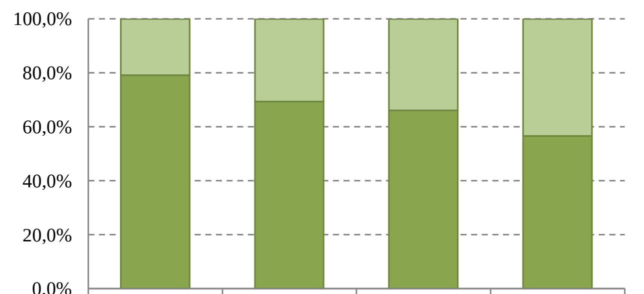
Figure 8 – Characterisation of the sample according to the knowledge of the legislation of WMSDS and the person who answer.

If one considers a number of factors, such as the legislation regarding the obligation of the existence of OSH Practitioner, the enterprise's employees with low training in Ergonomics and the fact that the owners have little knowledge of the legislation regarding WMSDs, it can be concluded that SMEs are at a disadvantage when addressing the problems associated with working conditions in general and those of ergonomics in particular.

3.4. Ergonomics interventions

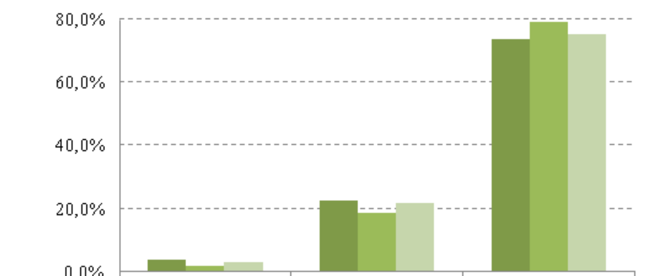
Considering the obtained results of the variables “size of the enterprise” and “the total number of implemented improvements” (Figure 9), it is possible to determine an increased number of improvements implemented as the size of the enterprise increases. The obtained results show that there is a statistical significant dependence between these 2 variables (X^2 =1.311; $p < 0.05$). This situation can be associated with the lack of time and economical resources in smaller enterprises (Jensen, 2001).

Finally, the respondents were asked whether they will to participate in the implementation of an ergonomic strategy, with the aim of improving working conditions. The results (Figure 10) show a large number of enterprises that are willing to participate in an ergonomic strategy. Despite the greater number of positive responses in the Chilean sample, the difference between the two countries is not statistically significant (X2 =1.339; p> 0.05).



	Micro	Small	Medium	Large
Yes	20,9%	30,6%	33,9%	43,4%
Not	79,1%	69,4%	66,1%	56,6%

Figure 9 – Characterisation of the sample according to the total number of implemented improvements and the size of the enterprise.



	Don't answer	Not	Yes
Portugal	3,6%	22,6%	73,8%
Chile	1,9%	18,6%	79,5%
Total	3,1%	21,6%	75,3%

Figure 10 – Characterisation of the sample according the willingness to participate in an ergonomic strategy.

4. CONCLUSIONS

This study intended to generically analyse and characterise the working conditions, with a special focus in Ergonomics and WMSDs, of a group of Portuguese and Chilean enterprises, based in online survey sent to 9555 enterprises.

According to the obtained data, it can be concluded that there are not great differences between the 2 countries. However, between SMEs and large enterprises, it was possible to observe a significant number of differences. These results corroborate the idea that SMEs are at a disadvantage regarding to the working conditions and, moreover, the implementation of actions to correct and improve inadequate work situations will be more difficult. Nevertheless, there are a greater number of large enterprises with lost days due to WMSDs when compared with other categories, but it is important to notice, that without a real quantification of them, the number of WMSDs in SMEs may be underestimated.

A final result that needs to be highlighted is the fact that 75.3% of the respondents expressed willingness to dedicate some of their time in the implementation of an ergonomic strategy to improve working conditions. Considering all the information, it is important to apply an Ergonomic Strategy that keeps the control of WMSDs, using simple procedures, and adequate external support. It is also important to execute specific training programmes and give information with low cost ideas to improve SMEs working conditions.

5. ACKNOWLEDGMENTS

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Biological hazards in dental clinics: Ascertainment of exposure to health workers

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ABSTRACT
Health workers in dental clinics are exposed to several biologic hazards through contact with body fluids such as blood, saliva or aerosols, so it is important to assess the frequency that accidents occur with these fluids. Both directly and through sharps, the type of exposure, the number of accidents and the affected body parts. The way to avoid infection and illness from these accidents with biological material can be influenced by hand washing and the use of Personal Protective Equipment. The sample consisted on 71 health professionals from dental clinics chosen for convenience and studied by a questionnaire. The study was Level II and descriptive and correlational. It was found that there were more accidents with biological material at the level of the mucous membranes (50%), the more frequent biological materials were blood and aerosols with 30,6%, the most affected body part were the eyes (57,5%) and the most common treatment after the accident was washed with water and saline (50%). It was also found that more accidents occurred in men (56,25%) and the category of highest number of accidents was the dentist (33,8%). We have reached the conclusion that there is still the occurrence of a high number (22,5%) of accidents with biological material in dental clinics.

Keywords: Health workers; Dental Clinics; Biological Hazards; Fluids; Work accident.

1. INTRODUCTION

The health of professionals is an area of Public Health acting through its own procedures for the promotion and protection of health in work performance (CARDOSO et al, 2009).

For several years, studies have been conducted in order to ascertain the frequency of occurrence of accidents with biological material in dental clinics and their relation with the development of diseases.

The practice of dentistry may cover a wide variety of procedures with different levels of complexity. Generally it implies contact with secretions of the oral cavity, such as saliva, blood and other secretions, such as the ones from the upper airway, in addition to aerosols, which are preponderant risk factors in the transmission of infections between patients and professionals. The exposure to body fluids is characterized by contact with mucous membranes or non-intact skin; through the contact with intact skin when there is involvement of large areas for a long period of time and through percutaneous via caused by a contaminated needle or some sharp object (CARDOSO et al, 2009).

Several microorganisms can be transmitted after the occurrence of occupational exposure to biological material, but they are more commonly associated with cases of transmission of Hepatitis B Virus (HBV), Hepatitis C Virus (HCV) and Human Immunodeficiency Virus (HIV) (SASAMOTO et al, 2010).

Despite the risk involved in dental practice of acquiring or transmitting infectious diseases, there are means for controlling the transmission of pathogenic microorganisms, such as the use of personal protective equipment (FIGUEIREDO, 2006).

According to LARSON (1996), and in order to prevent infections, hand washing must be taken into account, since hands are a major vector for transmission of infections. Hand washing is the single most important action for the prevention and control of these infections associated with healthcare.

Hands should be washed whenever they are visibly soiled, before putting gloves on and remove them, before and after procedures with all patients and after contact with material, equipment or surfaces potentially contaminated (HOEFEL, 1996).

In studies conducted in the United States of America it was found that, among professionals and students from four clinical of dental teaching, there is an incidence of 3,53 accidents per 10.000 medical assistance cases, and in Brazil it was verified that 26% of the dentists surveyed suffered sharps injuries in the six months preceding the survey and 75% had already suffered them some time during their professional life (CARDOSO et al, 2009).

A major concern with the risk of transmission of HBV and HIV among patients and dental practice professionals has been found in other studies, despite this possibility of transmission being considered low (Centers for Disease Control, 1990). Some reports of transmission of HIV and HBV from patients to professionals have been published without, however, clearly identifying routes of infection (BEEKMANN et al, 1994).

The injuries caused by puncturing objects or needles still remain the greatest risk of transmission of these diseases to health professionals in general and dental professionals in particular, through contact with blood (CLEVELAND et al, 1997).

The aim of this study was to determine the frequency of occurrence of accidents with biological material in dental clinics' healthcare professionals, the more usual forms and routes of exposure and the relationship of the practice of hand washing with the reduction of infections associated with healthcare.

2. MATERIAL AND METHODS

The target population consisted of 71 health professionals in the following categories: dentists, dental assistants, hygienists and lab and prosthesis technicians, divided by six dental clinics located in Figueira da Foz, Porto, Setúbal, Lisboa, Leiria and Pombal, representing the universe of health professionals in dental clinics. The type of sampling was non-probabilistic by convenience, because the sample may not be representative of the entire population. The study was of level II and of descriptive and correlational type. The nature of the study was transversal.

To collect the data necessary for the study it was used a self-administered questionnaire. The questionnaire was divided into three parts, focusing first on description of the personal data of participants, then on the "Hand washing" and its relation to the development of Healthcare Associated Infections (HAI) and, finally, on "Biological Hazards" to which health professionals are in dental clinics are exposed.

The questionnaire was adapted from questionnaires previously tested and used in similar investigations.

As for the structure of the questionnaire, the first part called "Personal Data" allowed to identify the characteristics of participants such as gender, age, professional experience and occupation. The second part sought to identify the hand washing procedures performed by health professionals and included questions 5, 6, 7 and 8. Finally, the third part sought to identify the occurrence of accidents with biological material and the procedures that health professionals have after those accidents, and included questions 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18.

The statistical treatment of data was done using the SPSS 17 software, through statistical tests of Chi-Square of Independence, of Student t-test for independent samples and of descriptive and simple measures.

3. RESULTS AND DISCUSSION

After the statistical analysis of the 71 health professionals studied, it was possible to verify that 16 suffered occupational accidents in the course of their duties.

The most frequent type of exposure in the accidents with biological material were the mucous membranes (50%), as can be seen in Table 1, which is contrary to studies cited by SASAMOTO et al (2010).

Table 1 – Distribution of percentage of the types of exposure in accidents.

Types of Exposure	n	Percentage
Percutaneous	4	20%
Mucous membranes (eyes, mouth, nose)	10	50%
Skin (only contact, without perforation)	6	30%
Total		100%

In fact, the study cited above states that the most affected body area were the hands (80%), which may explain the fact that the most common type of exposure is the percutaneous; however, in this case it was verified that the most affected body area were the eyes (57,5%), as can be seen in Table 2, hence the type of exposure being at the level of the mucous membranes.

Table 2 – Distribution of percentage of the body parts affected in accidents

Types of Exposure	n	Percentage
Fingers	4	21,25%
Other areas of upper limb	4	21,25%
Eyes	11	57,5%
Total		100%

These results may also be explained by the fact that the injured had more than one type of exposure and more than one body area affected in the same accident, which is not observed in the study mentioned above.

The types of biological materials most frequently verified, in the 16 accidents occurred, were the blood and aerosols, both with the same percentage (30,6%), and saliva was the less frequent (16,9%), as shown in Table 3.

Table 3 – Distribution of percentage of the types of biological materials present in accidents.

Types of biological material	n	Percentage
Blood	7	30,6%
Saliva	4	16,9%
Aerosols	7	30,6%
Unknown (found in residues)	5	21,9%
Total		100%

Comparatively with the study reported by SASAMOTO et al (2010), blood and saliva together were the most common materials in accidents, with 42,5%, not referring the type of aerosols. This is a very frequent biological material on exposure, which is why it is one of the most frequent types present in the accidents studied. The study subsequently

divides the percentage only for saliva and blood, considering blood as the less frequent biological material (7,5%), contradicting this study in which the biological material less present in accidents was the saliva. Again these results can be explained by the fact that in each accident there was more than one type of biological material present. In the case of the comparative study, it were studied the accidents with blood and saliva mixed, but each type of biological material was differentiated.
If the development of a disease is verified only in one professional, hepatitis B can be explained by the fact that this professional may not be using the proper personal protective equipment (PPE) at the time of the occurrence of the accident with biological material, thus not avoiding direct contact with the virus.
As for hand washing and the development of Healthcare Associated Infections (HAI), it was possible to verify that there is no relation in this study, as can be seen in Table 4, because the individual who contracted the disease used the technique of hand washing and other individuals that did not wash their hands didn't develop any kind of infection.

Table 4 – Relation between hand washing and the development of diseases.

		Any disease contracted	
I wash my hands before and after the implementation of treatments.		Yes	No
	Yes	0(0%)	4(26,7%)
	No	1(100%)	11(73,3%)
I use gloves, I don't wash my hands.		Yes	No
	Yes	0(0%)	5(33,3%)
	No	1(100%)	10(66,7%)
I wash my hands whenever possible.		Yes	No
	Yes	1(100%)	6(40%)
	No	0(0%)	9(60%)

However, it is possible to explain these results, because although the individual who contracted the disease washed his hands, he only did it when he had conditions or opportunity.
The age of the studied dental clinics' health professionals and the use of PPE at the time of accidents with biological material showed no relation, because there was no significant difference in the mean of the ages, as it is established in Table 5.

Table 5 – Relation between the professionals age and the use of PPE during the occurrence of accidents.

PPE		**n**	**Mean**	**Standard Deviation**
Age	Yes	6	36,00	11,136
	No	10	37,50	11,138

These results can be explained because younger workers tend to neglect the use of PPE, out of ignorance or insufficient information, while the older workers, also because of their larger professional experience, think they are already familiarized with their activities and do not require so much the use of the proper protective equipment.
The gender that was verified to suffer more accidents with biological material was the male with 56,25%, while the female gender only suffered 43,75%, as it can be seen in Figure 1.

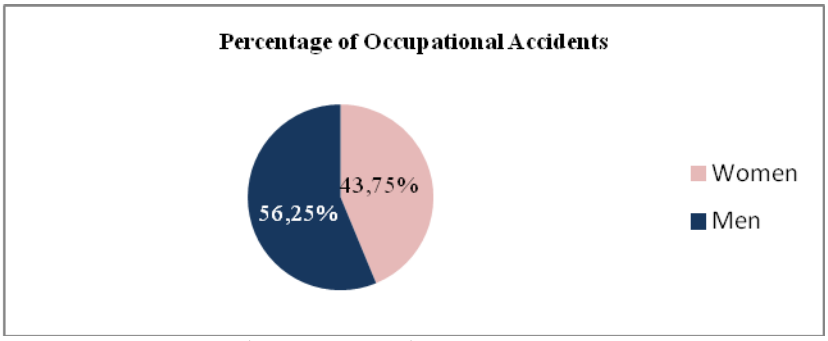

Figure 1 – Distribution of the percentages of accidents with biological material by genres.

These results are in disagreement with most of the studies found, because those claimed that women suffered more accidents, with values for females of 64,8%, 75,5%, 51,2%, 97,1% and 53,7%2,10,11, respectively. These results can be explained by the fact that the professional group that has suffered more accidents was the one of dentists with 33,80%, as shown in Figure 2, and these are mostly men, and because of that it was verified a number of men suffering accidents superior to the one of women. The following category with higher frequency of accidents was verified to be the one of dental assistant with a percentage of 28,2%, which can also be explained by the fact that this category, together with the one of dentist, are the ones with the highest number of people among the 71 dental clinic professionals studied, and because of that these are the categories where the occurrence of accidents was higher.

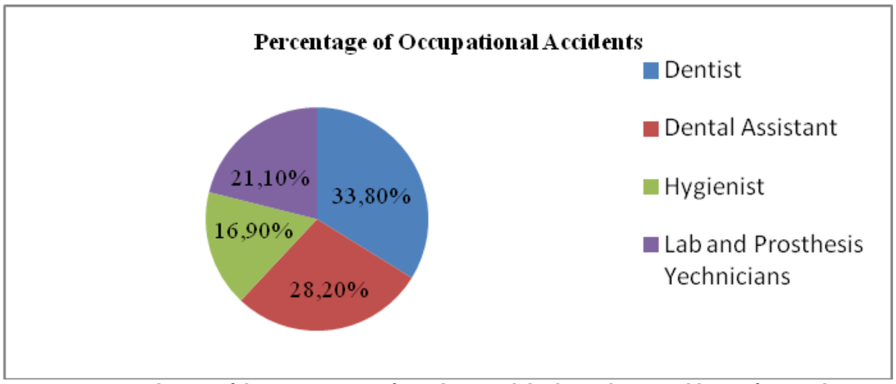

Figure 2 – Distribution of the percentages of accidents with biological material by professional areas.

It was possible to notice that there is no relation between Professional experience and the occurrence of accidents, because there is no great difference in the average of professional experience eyears, as seen in Table 6.

Table 6 –Relation between professional experience and the occurrence of accidents with biological material.

Occupational Accidents		n	Mean	Standard Deviation
Professional Experience	**No**	**55**	**10,62**	**7,233**
	Yes	**16**	**12,72**	**10,056**

In the study by TEIXEIRA et al (2008), on the other hand, it is found a certain relation, because it is shown that among respondents, those who had more than 10 years of training and subsequent experience (62%) had more accidents than those who had less than 10 years. The result obtained in this study may be explained by the fact that the professionals that have more experience working sometimes neglect some work methods because they are already so accustomed to their activities and there is a lack of attention to routine tasks, and in the case of the less experienced professionals because they still have not acquired all the necessary expertise and because they are still getting used to the tasks that they have to perform, creating work methodologies.
The most commonly used prophylactic measures after the occurrence of an accident were, respectively, washing with water and physiological solution with 50% and washing with soap and water with 31,25%, as demonstrated in Table 7.

Table 7 – Distribution of percentages of prophylaxis used after the occurrence of accidents.

Prophylaxis	n	Percentage
Washing with soap and water.	5	31,25%
Washing with water or physiological solution.	8	50%
Starting medication early.	2	12,5%
Did not answer.	1	6,25%
Total	16	100%

Comparing with the studies of CARDOSO et al (2009), the most common treatment was washing the wound with soap and water (73,3%), because most of the accidents occurred through percutaneous via, while in TEIXEIRA et al (2008) the most used prophylaxis was washing the affected site (69,5%) without specifying the used material. In this case, washing the wound with water and physiological solution was the most used measure because, as explained above, the body part most affected in the 16 accidents with biological material were the eyes and the physiological solution is the best treatment for this type of accident in mucous membranes.

4. CONCLUSIONS

The results presented allowed to conclude that there is still a high number of accidents with biological material suffered by dental clinics' health professionals, being necessary to apply preventive measures to reduce this number of accidents.
It was observed that many health professionals still do not regularly use the appropriate personal protective equipment in their work, contributing largely to this frequency of accidents in the branch of dentistry.
As for hand washing and the development of HAI, and despite the fact that no relation is demonstrated in the results, it was verified that health professionals neglect the practice of hand washing as a way to avoid the appearance of certain

infections, since they mention the lack of such practice or its realization only when they have means close to their workplace.

In this sense, and to improve this kind of situation, the dental clinics must place greater emphasis on information and training of health professionals regarding the importance of using PPE and the practice of hand washing during activities that encompass the risk of contact with biological materials.

As a final conclusion, because it was verified that most accidents among dental clinics professionals were at the level of the mucous membranes, including eyes, and because it was perceived, as it was already stated, that professionals do not use the PPE required for their activities, in this case the glasses, it is important to provide more information about this specific PPE and also to enable their use in dental clinics, which is not always the case.

The study had limitations, such as the small size of the sample, because it might have been interesting to study a larger number of health professionals in more dental clinics in order to reach more meaningful conclusions, and also the fact that some questions in the questionnaire were not answered, without having any reference in the questionnaire to do so, limiting the reached results.

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Human behavior under fire situations – portuguese population

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ABSTRACT
Among possible emergency situations, those that very likely will mostly affect human behavior are the ones related to fire, due to the many reasons associated with its initiation.
This paper summarizes a case-study on the human behavior under fire situations, based on the analysis of data collected through a questionnaire, applied to the Portuguese population nationwide. There were 14 questions related to fire, to which 225 answers were obtained. Within these 225 answers, 50 originated from people that actually experienced or were involved in a fire situation.
The study was already able to point out some trends in the behavioral analysis. However, it is not ready to fully support the development of a simulation model capable of estimating the pre-movement time. With this purpose, other questionnaires are being designed.

Keywords: Action, Answer, Behavior, Evacuation, Reaction.

1. INTRODUCTION

The analysis and the prediction of human behavior in response to a fire situation require an integrated system that involves people, the building and the fire. People respond in a distinct way to different fire situations, depending on several factors.
Although there is some randomness in the human behavior in a fire situation, it is possible to implement standardization according to some factors.
The knowledge of human behavior under a fire situation may be attained by resorting to the following methods:

- appropriate questionnaire;
- fire drill analysis;
- artificial intelligence, particularly serious games.

In the following chapter, the main conclusions of this first phase of the study are summarized, both about the sample's characterization and the actions/reactions of the respondents. (Cordeiro, 2010)

2. SUMMARY OF THE INVESTIGATION ANALYSIS

2.1. Characterization of the sample

In this first phase of the study the sample in question, formed by 225 respondents, has some characteristics that, in a way, are adjusted to the Portuguese reality, namely gender, age group and fire safety training.
Thus, relatively to gender, the sample is formed from 49,33% of women and 49.8% of men (1.78% didn't identify the gender). Relatively to the age of the respondents, it is verified that they are between 17 and 78 years old, with an average of 35.96 years old, meaning that the sample is in accordance with the national trend (in the last census, the national average was 39.09 years old). On the other hand, in the universe of the 225 respondents, only 72 have training in fire safety and just 19 make an annual recycle, fact that is also in accordance with the Portuguese reality.
It must be noted that there are some aspects of the sample that deviate from the Portuguese society characteristics. Regarding education levels, the sample does not represent the country's reality, because more than 50% of the respondents have university education, a percentage that far exceeds the national reality.
It will be necessary to evaluate, in later stages of the study, if this incongruence with the actual population influences the final conclusions and seek which new surveys reflect with more reliability the education level of the national population.

2.2. Knowledge of the evacuation plans, escape routes and emergency

The implementation of certain procedures in matters of organization and management of the fire safety in buildings that the country is now entering upon as well as an increase of training, may be reflected on the behavior of the occupants in the fire safety, so were asked some questions regarding this matter.
Thus, trying to understand whether the respondents are aware of the evacuation plans of buildings that they attend, it was found that 141 responded negatively, with a percentage very similar to the masculine and feminine gender.

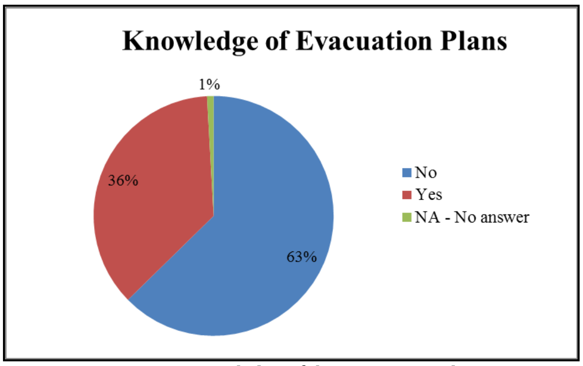

Figure 1: Knowledge of the evacuation plans

Regarding the relation between knowledge of evacuation plans and training in fire safety verifies that, regardless of whether or not training in fire safety and their gender, a little more than 35% are aware of evacuation plans.
The same applies to the knowledge of escape routes; there is no great difference between respondents who have training in fire safety and those without.
On the other hand it was found that 97% said that can identify the emergency exits, that percentage drops significantly with regard to its location in the buildings that they attend, since only 56% declared to have this knowledge.

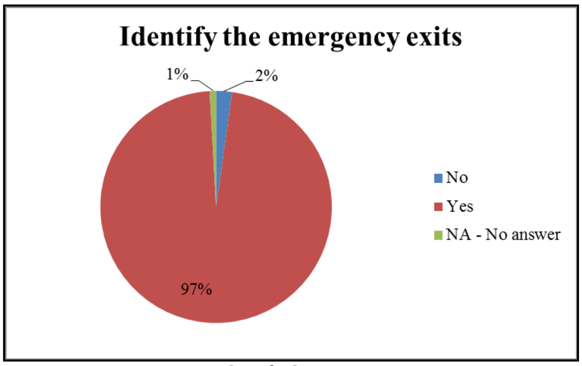

Figure 2: Identify the emergency exits

Trying to understand if the respondents are concerned to identify the emergency exits when entering a building, the survey had a question on this subject. The conclusion reached was that when respondents have no training in fire safety, only 37% the female gender and 38% the masculine gender have this concern. When respondents have training in fire safety such percentages increase significantly, reaching 70% the female gender and 50% the masculine gender.
Trying to understand if there is any relationship between the concern to know where to locate emergency exits and knowledge of escape routes, it appears that 76% of respondents seeking to identify emergency exits know the escape routes and 63% of respondents who do not know the escape routes do not bother to identify them.
In this study it was verified that of the 72 respondents with training in fire safety 36 choose, in an emergency situation, the path they use in normal situations. Of the 153 respondents who haven't training in this area, 79 also choose the path they normally use to leave the building. These results seem to indicate that the influence of safety training in the fire behavior is not decisive, in the choice of escape routes in an emergency situation, because about 50% of respondents would choose the paths that make usual, independent they have or not training.

2.3. Panic and spirit of helping others in a situation of emergency

The result of some news related to incidents that occurred panic, makes the idea that it is very common and widespread. However, some researchers consider that, in a significant number of emergency situations, such it is not verified. (Rita et al, 2009) (Keating, 1992) (Sime, 1984)
According to the results obtained on the survey, 93.33% of the respondents consider that in a fire situation there will be panic.
In order to evaluate the influence of the characteristics of the occupants relatively to this interpretive ability an additional analysis was made by gender, making the intervention of the fire safety training, age, education levels, previous experiences with a fire, concluding that the influence of gender, education level and training in fire safety only slightly alter the percentage of responses prevails always, unmistakably, the conviction that the panic will be present.
The possibility of panic in a fire situation among the respondents is confirmed by the answers given by those who have experienced it, having stated that the trend is very similar to the one before. In fact, from the 50 respondents that had already experienced it, 48 mentioned that people panic.

Helping others can be crucial especially for disabled occupants. From the overview of the answers to this question reveals that 61% mentioned that it exists, while 38% think that is not the case.

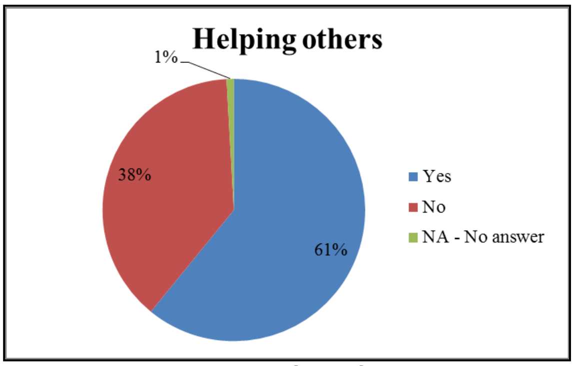

Figure 3: Helping others

Trying to evaluate the occupants' characteristics on this interpretive capacity, an additional analysis was made on the basis of gender, training in fire safety, education level and also the previous experience with fire, comparatively to the answers obtained with the resultants from the overall analysis.
This additional analysis showed that 67% of the female respondents with training in fire safety and 50% of men consider that in a fire situation there is the spirit of helping others.
Regarding the influence of education level it appears that, regardless of these, more than 50% of the respondents consider that there is a spirit of helping others, with emphasis on the female gender who expresses a greater belief in that spirit than men, especially when the education level corresponds to the high-school level.

2.4. Influence on the reactions of the relation of the respondents with the building
In this first phase of the study a general analysis to the answers received was conducted. An additional analysis was also carried out in which the influence of certain characteristics of the respondents (gender, age, fire safety training and education levels) was evaluated.
Before initiating this study we had the idea that the reaction of the occupants during a fire could be influenced by the relation they have with the building, fact which was not confirmed in this first phase of the study, because 53% of the respondents said they would have the same behavior, while 44.00% stated that it would be different.
Regarding the respondents that had already been involved in a fire, 54% reported that their reaction would be the same, even if they were on the building they lived, or in the one they worked or in any other building.

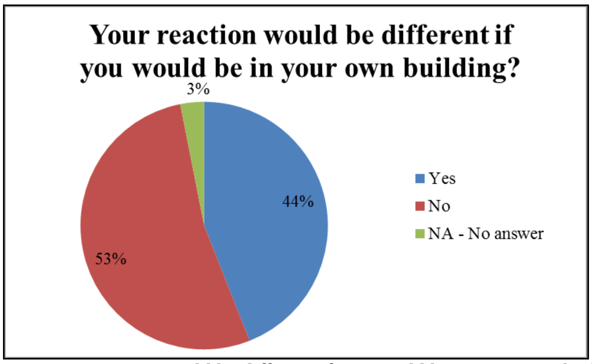

Figure 4: Your reaction would be different if you would be in your own building?

2.5. Ways to know about the fire referred by the respondents
One of the objectives of the survey was to know how people are aware of the existence of a fire. From the overall analysis of the respondents it was found that the most mentioned factor was the "Smell of smoke", with 36%, followed by the "Alarm", with 29%, while the third was concerned with the "Visualization of smoke", with 15%, and finally, the "Unusual movements of the occupants" and "Strange noises", both with 10%.

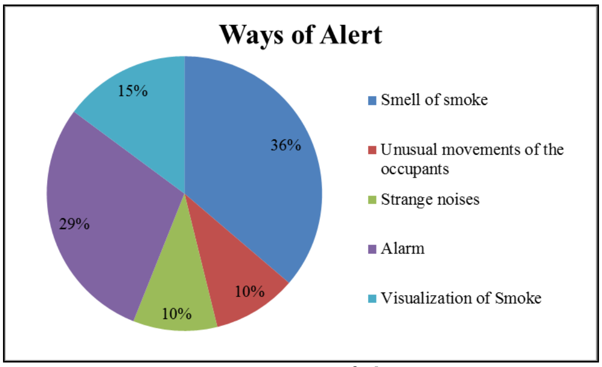

Figure 5: Ways of Alert

With reference to the three most frequent responses in the overall analysis was conducted an additional study, relying on the several characteristics of the respondents.
That analysis shows that the most frequent answers are the same, regardless of gender and of previous experience with a fire, varying only the percentages relative to each one of them.
The same is not verified when the analysis is done regarding the training, revealing a change on the results of the overall analysis for the third most referred answer, that, for the respondents with training, is “Strange noises” instead of “Visualization of smoke”.
The analysis by age has also introduced some changes to the sequence obtained in the overall analysis, namely the respondents aged up to 20 years old and those between 30 and 40 years old. Thus, for the age of 20 years, the “Alarm” was the most referred (35%), followed by “Smell of smoke” (31%) and “Visualization of smoke” (17%). For the age of 40 years there is a change regarding the overall analysis, verifying that the “Alarm” is in first place (41%), followed by “Smell of smoke” (36%) and “Visualization of smoke” (18%).
Regarding the possible influence of education level it is noticed that, for the respondents with high school qualifications, the second and third most frequent responses are, respectively, “Visualization of smoke” (27%) and “Alarm” (18%).

26. Interpretation of the alarm signal

The existence of alarm signals is now becoming widespread in many Portuguese buildings, but for these systems to represent an additional help it is crucial that occupants can identify the hazard associated to this alarm.
From the general analysis of the responses given, it is seen that 40% of the respondents indicate “In the uncertainty it’s considered as fire”, whilst 27% presume being before an “Exercise of Evacuation”, 13% that the alarm is the result of “Operations of Maintenance” and 12% that it is due to a “Real fire”.

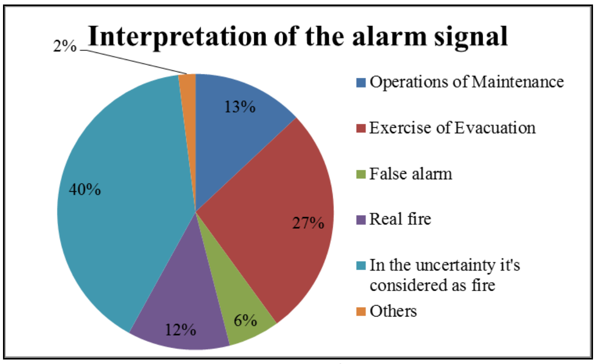

Figure 6: Interpretation of the alarm signal

In order to evaluate the influence of the characteristics of occupants on this interpretive ability an additional analysis was carried out introducing variables such as gender, fire safety training, age group, education levels, and previous experience with a fire.
This way, with reference to the three reactions most mentioned in the overall analysis, it was found that gender, fire safety training and previous experience with a fire do not introduce any change to the order previously obtained only varying the percentages of each interpretation. Regarding the influence of age it is seen that there is a change compared to the overall analysis by respondents aged 30 to 40 years old, who indicate as the first interpretation "Exercise of Evacuation" followed by "In the uncertainty it’s considered as fire."
The analysis regarding the education levels shows a difference compared to the overall analysis, as for the respondents with high school qualifications the second most pointed interpretation was “Real fire”.

2.7. Reaction of Respondents to the Alarm Signal

The efficacy of an automatic fire alarm and detection system depends not only on the correct interpretation of the signal, but also on the reaction that the occupants have to the alarm.

From the general analysis of the responses given, it is seen that the predominant reaction was “Find out what is happening”, with a percentage of 65%, which far exceeds all others , followed by “Leave the place to leave the building”, at 15%. All other responses have merely residual frequencies.

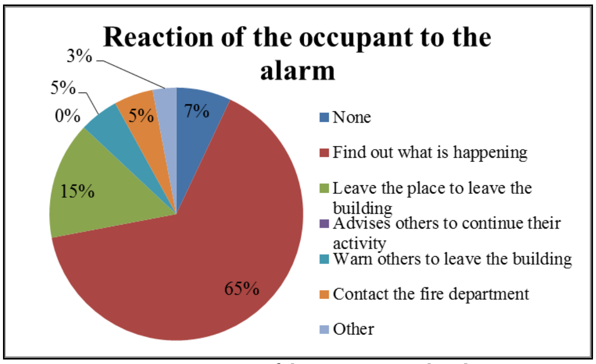

Figure 7: Reaction of the occupant to the alarm

In order to evaluate the influence of the characteristics of occupants on their reaction to the alarm signal, an additional analysis was carried out introducing variables such as gender, fire safety training, age group, education levels, previous experience with a fire, having as reference the two most given responses.

This additional analysis showed that gender, age group, and previous experience with a fire have no significant influence on the responses, with just a slight change in the percentage frequencies. The most significant variations are relative to the residual actions, but, as such, these are not significant on the overall results.

Regarding the influence of education levels, it is seen that the second response most given is, for those with high school qualifications, “None” (14%).

2.8. Action of the respondents to the alarm

Another issue of the survey is to identify the reactions of the occupants after being aware that something unusual is going on, not knowing if it corresponds or not to a fire.

From the analysis of the responses it was observed that 36% refer “Investigating what was happening”, while 33% indicate “Leave the place on his own initiative”. Followed by “Warn others” with 27% and “Wait to be told what you should do” with 3% and, finally, 1% said “Continue to do what he was doing”.

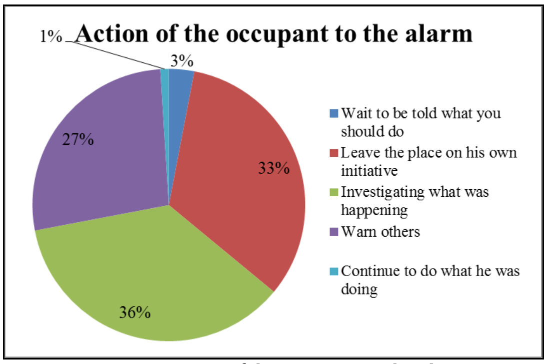

Figure 8: Action of the occupant to the alarm

An additional analysis of the data showed that the gender has no significant influence on the responses, with the general analysis unchanged, albeit with some slight changes in the percentages.

Regarding the influence of age groups it appears that this factor is significant in some cases. For the respondents aged 20 to 30 the most given response was “Leave the place on his own initiative” (34%), followed by “Investigating what was happening” (32%) and “Warn others” (32%). For the respondents aged 30 to 40, the most given reaction was “Leave the place on his own initiative” (38%), followed by “Investigating what was happening” (34%) and “Warn others” (21%).

Regarding the influence of education levels, it is noted that respondents with high school education point “Warn others” as first reaction (36%).

Previous involvement in a fire also showed significant influence as those who have experienced it pointed "Investigating what was happening" (43%) as first reaction, followed by "Warn others" (30%) and only then "Leave the place on his own initiative" (23%).

2.9. Reactions of respondents due to the presence of smoke

In order to understand the influence of low visibility on evacuation pathways, due to smoke, on the behavior of occupants, the inquiry contained a question on this matter.

Only 204 respondents answer to this question. Of 204 responses given, 65% show as most frequent reaction "Try another way to get out of the building", followed by "Investigate to fight the fire" with 26%, with all other responses having merely residual percentage frequencies.

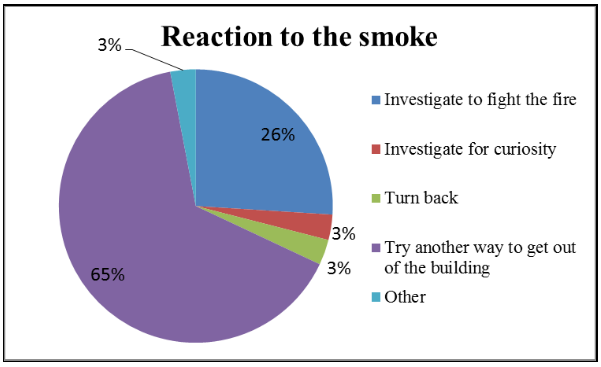

Figure 9: Reaction to the smoke

In this question, it is noted that gender, age group, education levels and previous experience with a fire do not have a significant influence on the responses given.

Respondents with fire safety training have some different reactions, when compared to the overall analysis of responses. 56% of those with training gave the response "Try another way to get out of the building", while 32% preferred "Investigate to fight the fire". Regarding respondents without fire safety training, the most given response was also "Try another way to get out of the building", with 70%, and in second place "Investigate to fight the fire", with 23%.

Regarding the education levels, it is seen that respondents with high school qualifications, present a pattern of responses significantly different from all the others, but that might be due to the small number of such responders in this particular question.

2.10. Reactions of respondents face to a direct contact with the fire

The behavior of people when confronted directly with a fire will not be, most likely, the same as when they only know about the fire by hearing an alarm signal, by somebody else's warning or even by seeing smoke or flames.

Trying to evaluate such influence on behavior, the inquiry had a question on that matter. It is seen that 57% of respondents would react to that direct contact by "Try other way to get out of the building", followed by "Ask for help" (22%) and "Fight the fire" with 17%.

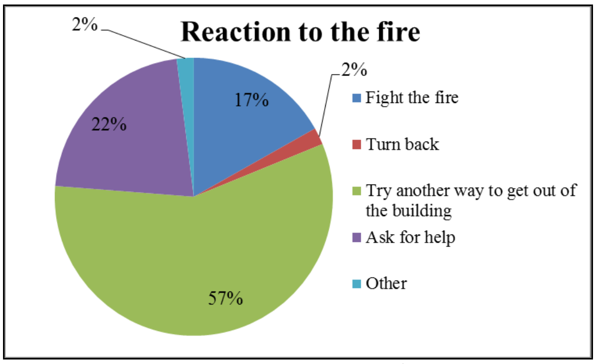

Figure 10: Reaction to the fire.

The additional analysis shows that gender, fire safety training, age group and education levels have little influence on the responses given to this question, whilst gender and previous experience with a fire show more influence.

Regarding gender, it is seen that the most given response by the female gender is "Turn back", followed by "Ask for help" while for the male gender it is "Fight the fire" followed by "Try another way to get out of the building".

3. CONCLUSION

When knowing that a fire is taking place, not all occupants decide, immediately, to leave the building, rather having reactions whose consequences will increase the evacuation time.

However, although this behavior is well known, there haven't been studies to determine the time lost due to such actions, in spite of the fact that some simulation models try to consider this issue introducing a time delay at the beginning of the evacuation, which nonetheless is not supported quantitatively by any evidence on scientific studies.

Human behavior is an important key in the building evacuation. If it is not considered the influence of the occupant's behavior in the development of a fire, the safety conditions may be too optimistic or unnecessary, that may lead to excessive costs or insufficient security conditions.

For the development of a simulation model that quantifies this time delay, it is necessary, even with the uncertainty there is, that the behavioral pattern of occupants be understood, being this study the first step in Portugal towards such goal.

This initial phase of the study is focused exclusively on the analysis of an inquiry to people used to office buildings (workplaces), and it shows several patterns on the Portuguese population, some of them different from those expected, which are now enumerated:

- Little influence of fire safety training on the knowledge of evacuation pathways.
- Little influence of fire safety training on the choice of evacuation pathways during a fire.
- Little influence of fire safety training on certain reactions by occupants during a fire.
- The high probability of panic occurring during a fire.
- Little influence of the fact that the occupant knows the building or not on their reactions during a fire.
- Little influence of previous experience with a fire.

The study of people's behavior in a fire situation is extremely important when it comes to predicting the time of evacuation of buildings. Knowledge of the evacuation time will allow the adoption of performance-based approaches when evaluating the fire resistance of buildings.

The results presented here must be read carefully, because they only represent the actual state of the study and are therefore still far from what can be considered to characterize the Portuguese behavior in relation to fire safety, being clearly insufficient to achieve the desired simulation model of people's behavior in case of fire and not to quantify the time wasted on the actions developed by the occupants before deciding to leave the building.

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The State of Working Conditions: "We", Portugal and Europe. Comparative Analysis

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ABSTRACT
This article presents a reflection on the results of the INSAT application – *Inquérito Saúde Trabalho* (Health and Work Inquiry) in the Municipal Services of Water and Sanitation from Oeiras and Amadora, comparing them with the results obtained at European and national levels, in the 5th European Survey conducted in 2010 by the European Foundation for the Improvement of Living and Working Conditions (Eurofound, 2010a). The subject of the study was environmental constraints, physical, work pace, autonomy and initiative, relationships at work, contact with the public and work characteristics. The results show that there is a high exposure to certain constraints characterized as penalizing the health and well-being of workers, compared with the averages found in Europe and Portugal. From these results the exposure to constraints of work organization, including pace of work, and physical constraints stands out. On the other hand, from the responses, it appears that the type of work, with high scores, and the constraints of autonomy and initiative, with low results, are motivating the daily activity, contributing to the development of skills. This discussion emphasizes the need for a continuous review of working conditions, particularly the risks arising from work organization.

Keywords: Working Conditions; Constraint; Comparative Analysis; INSAT.

1. INTRODUCTION

Health in the workplace is often considered a second individualized approach, of a normative-prescriptive and reductionist character, limiting the health problems to those that are likely to be medically described, (Davezies, 1994) ignoring other consequences of working conditions on health.

It is this perspective that leads the health of people at work to be, almost exclusively, measured using indicators such as absenteeism due to diseases or incapacity for work. However, there is evidence that, even without a diagnosed disease, health problems can cause a decrease in productivity at work, with important economic implications (Alavinia et al., 2009).

The results of the *European Working Conditions Survey* (EWCS) developed and applied by Eurofound (European Foundation for the Improvement of Living and Working Conditions - http://www.eurofound.europa.eu/surveys/index.htm) have also shown the relevance of analyzing a wider range of variables, other than those that are traditionally used for identifying the officially recognized occupational diseases, allowing for a more complete set of factors affecting health and the quality of work life. In Portugal, instruments have been developed that meet this problem, benefiting from the extensive experience gained by the French research teams involved in the design of surveys, mainly the SIT survey (Barros-Duarte, Ramos, Cunha & Lacomblez, 2002), conceived in 2001, and in 2007, when the first version of INSAT – *Inquérito Saúde Trabalho* (Work and Health Inquiry) (Barros-Duarte, Lacomblez & Cunha, 2007) was completed and is being applied in different industries.

The Division of Human Resources Management (DGRH) of the Municipal Water and Sanitation Services (SMAS) from Oeiras and Amadora, being aware of these emerging risks, decided to initiate a project to monitor the health-work relationships. The application of INSAT - Work and Health Survey (Barros- Duarte & Cunha, 2010) was carried out in partnership with the Faculty of Human Kinetics, Technical University of Lisbon. Applying this instrument was intended for reflecting both the constraints of work and the degree of discomfort associated with them, and measure the self-assessment of health status using the Nottingham Health Profile, which is considered one of the best predictor instruments of health. The aim of this paper is to benchmark the municipal services with the data obtained at the 5th European survey conducted in 2010 by the European Foundation for the Improvement of Living and Working Conditions (Eurofound, 2010a) with respect to the European and Portuguese average.

2. METHODOLOGY

The INSAT was applied at SMAS in collective class sessions, with a maximum of 10 employees. The completion of the survey was individual and anonymous, under the guidance of researchers from the different entities involved. In a universe of 404 workers, 351 participated in this study, mostly male (67%) with a mean age of 46 ± 9.5 years.

In an effort to provide reliable and comparable data on working conditions across Europe, Eurofound has developed a methodology and a system of unified quality assurance. The survey is based on a questionnaire, conducted in person at respondents' homes. For the analysis of data available on the Survey of Eurofound, 2010, it was not possible to

characterize the age and gender in the target sample size in Europe (27 countries). The target sample size in Portugal was 999 people, with 52.4% of them female. The most representative age group (51.8%) is between 30 and 50 years.
The availability of information on the Eurofound website does not allow a comparative analysis question by question, not covering all the topics presented in the INSAT survey. Thus, the analysis presented is subject to the availability of data from the website of the European Working Conditions Survey, 2010 (http://www.eurofound.europa.eu/surveys/smt/ewcs/results.htm). Results are presented according to constraints groups organized in the INSAT, (1) environmental, (2) physical, (3) work pace, (4) autonomy and initiative, (5) work relationships, (6) contact with the public, (7) work characteristics.

3. RESULTS

3.1. Environmental and physical constraints

With regard to environmental constraints, the exposure to vibrations, loud noise, agents or chemicals substances, and materials that can be infectious (corresponding to biological agents in INSAT) was considered.

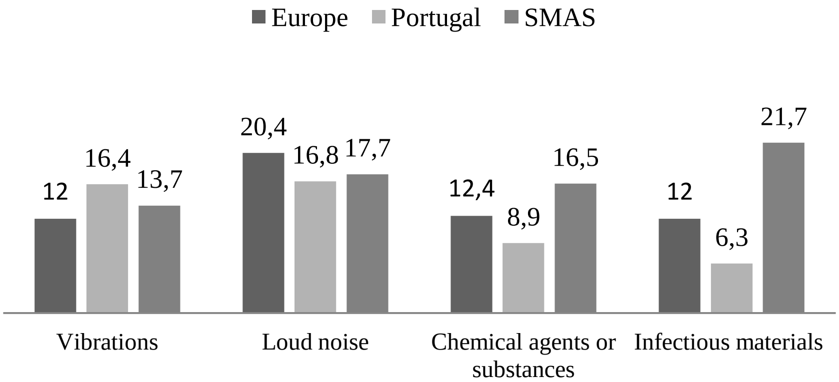

Figure 1 - Percentage of workers exposed to environmental constraints (Europe, Portugal, SMAS)

Through an analysis of Figure 1, we can see that the percentage of workers exposed to vibrations, at SMAS (13.9%), is slightly above the European average (12.0%), but below the national average (16.4 %).
With regard to exposure to loud noise, both the values for Portugal (16.8%) and for SMAS (18.1%) is below the European average (20.4%), however, the results found in INSAT reveal that the percentage of workers exposed to loud noise in SMAS, is slightly above the national average found in the 5th European survey.
Considering the exposure to chemical agents or substances, and infectious materials, we can see that the percentage of workers exposed to these two constraints is higher in SMAS (respectively 17.2% and 22.1%), and concerning the exposure to infectious materials, it is far above the results for Europe (12.0%) and Portugal (6.3%). In the case of physical constraints, we considered the exposure to painful or tiring positions, carrying or moving heavy loads, and repetitive movements of the hand or arm.

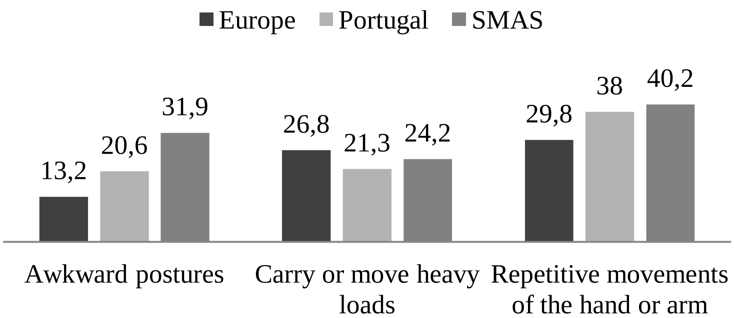

Figure 2 - Percentage of workers exposed to physical constraints (Europe, Portugal, SMAS)

In the previous Figure (Figure 2), we can observe that exposure to awkward postures is higher in SMAS (32.7%) than the European and national (20.6%).averages (13.2%).
For exposure to carrying or moving heavy loads, we verified that the results obtained by SMAS (24.8%) are above the national results (21.3%), but below the European results (26.8%).

With regard to exposure to repetitive movements of the hand or arm, similar to what happens in the tiring or painful positions, the value obtained at SMAS (40.5%) is much higher than the European average (29.8%) and the national average (38.0%).

3.2.Constraints of pace and autonomy and initiative

With regard to the constraints of work pace, the exposure was considered depending on the work done by colleagues, depending on requirements of customers, users, depending on production goals, and depending on the speed of a machine, or the movements of a product, working with the computer, and solving unforeseen problems without help.

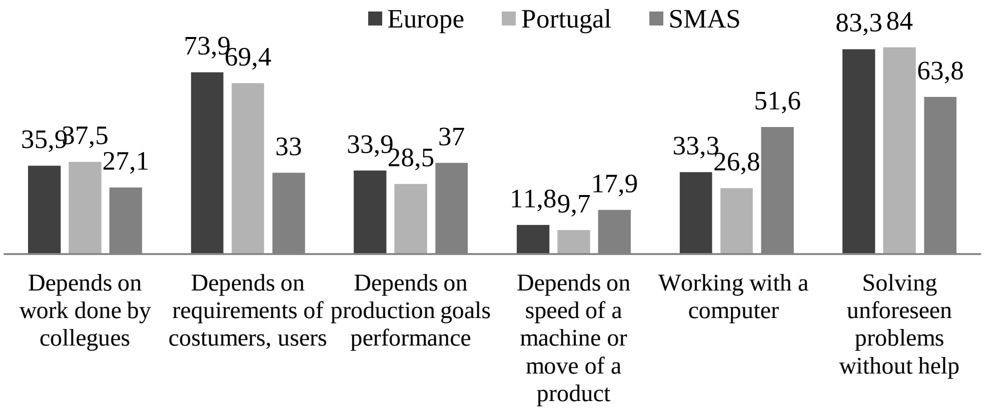

Figure 3 - Percentage of workers exposed to work pace constraints (Europe, Portugal, SMAS)

As you can see from the previous Figure (Figure 3) in the constraint depending on work done by colleagues, it is possible to see that SMAS, with 27.5%, obtained results much below the European average (35.9%) and the national average (37.5%). The same applies to the constraint depending on the requirements of clients, users, with 33.7%, less than half compared to the European (73.9%) and national (69.4%) results. In the constraint solving unforeseen problems without help, the difference is not as pronounced as in the previous case, but still, the workers of SMAS (64.7%) revealed to be less exposed to this constraint, unlike the European average of 83, 3% and national one of 84.0%.

Unlike what has been said so far, regarding the remaining constraints of work pace, SMAS has a more exposed percentage of workers than the other two considered groups.

As to the constraint “depending on production goals performance” the difference is not very pronounced, with 38.0% of SMAS workers reporting they were exposed to that constraint compared to the 33.9% for Europe and 28.5% for Portugal. In the case of constraint depending on the speed of a machine, or movement of a product, 18.2% of SMAS workers report being exposed to this constraint, and at the European level the percentage of exposed workers is 11.8%, and at national level 9.7%. Finally, the constraint on working with the computer, because the three functional areas of SMAS (Office workers, Executives and Technicians) cover more than half of the population that responded to the survey, and the activity in these areas is performed using the computer, we have a percentage of workers exposed to this constraint of 52.3%, while in Europe the percentage of exposed workers is 33.3%, and 26.8% in Portugal.

Regarding autonomy and initiative, (Figure 4), there were four constraints considered: I can choose or change the order of tasks, I can choose or change methods of work, I can choose or change the speed or pace of work, and I can make a break whenever I want.

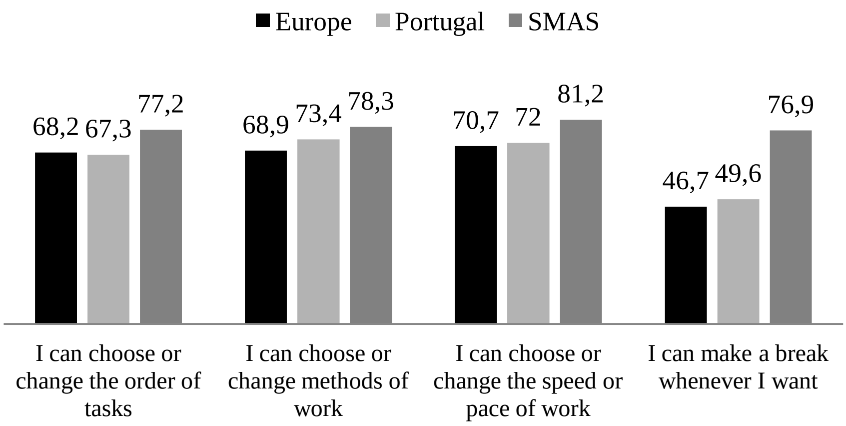

Figure 4 - Percentage of workers exposed to constraints of autonomy and initiative (Europe, Portugal, SMAS)

In all the constraints of this group, SMAS has a higher percentage of exposed workers than the other two groups (Europe and Portugal).
Of those four constraints, the ones where the difference is more evident are, "I can choose or change the order of tasks" with 78.0%, against 68.2% of European average and 67.3% of the portuguese average, and "I can make a break whenever I want", 76.7%, against 46.7% in Europe and 49.6% in Portugal.

3.3. Job characteristics and constraints in the contact with public
Regarding job characteristics, four aspects are analyzed: monotonous tasks, complex tasks, learning new things, and rotation of tasks that require different skills.

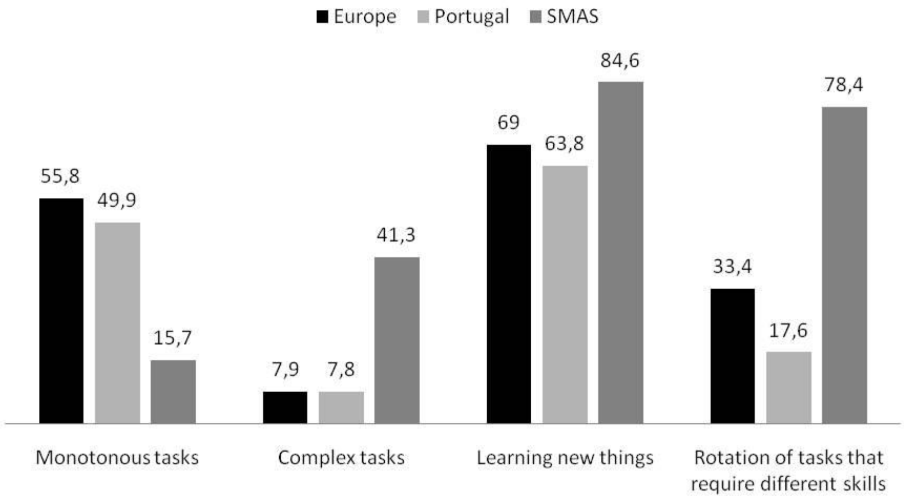

Figure 5 - Percentage of workers exposed to job characteristics (Europe, Portugal, SMAS)

For the constraint monotonous tasks, we can check through the previous Figure (Figure 5) that the percentages of workers exposed to this constraint is high in Europe (55.8%) and Portugal (49.9%), however, only 15.7% of SMAS workers report being exposed to this constraint.
In the case of the constraint complex tasks, we can infer that in SMAS, the percentage of workers is very high (41.3%), contrary to what happens in Europe (7.9%) and in Portugal (7.8%).
84.6% of SMAS workers, report being exposed to work where they have to learn new things. For this constraint, the other two groups show lower values, 69.0% for Europe and 63.8% for Portugal.
Unlike the previous case, for the rotation of tasks that require different skills, the percentage of workers in SMAS is extremely high (78.4%) compared to Europe (33.4%) and Portugal (17.6%).
In the group of constraints in the contact with the public, we considered only two constraints, direct contact with the public and contact with angry customers.

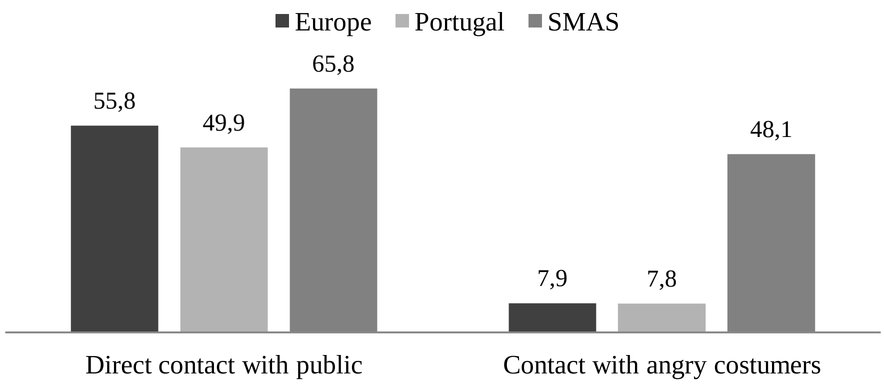

Figure 6 - Percentage of workers exposed to constraints in contact with the public (Europe, Portugal, SMAS)

In the previous Figure (Figure 6), we can see that for the direct contact with the public, SMAS has a high percentage of workers exposed to this constraint (65.8%), higher than Europe (55.8%) and the Portuguese average (49.9%).
Regarding contact with angry customers, SMAS has a much higher percentage of workers exposed to this constraint (48.6%), compared to the European survey results, specifically for Europe and Portugal (7.9% and 7 8%, respectively).

4. CONCLUSION

The comparative analysis between the European, national and SMAS averages, shows that this institution presents results that reflect both the negative aspects as well as the positive aspects in the health and well-being of workers. The fact that there are values higher than the European and national constraints with painful features for the worker is considered negative, on the other side, some values below these same constraints and higher values in the constraints that have benefits for daily activity is a positive fact. If, on the one hand, these results suggest that workers are exposed to environmental, physical and work pace (work intensity) constraints, that cause a negative impact on health and well-being, on the other hand, the constraints of autonomy and job characteristics identified by the workers, are beneficial for promoting wellness in the workplace. Considering the nature of the activities performed by these workers, we were not surprised by the results achieved in the environmental constraints. The results obtained for chemical agents and substances, and for infectious materials, are important percentage values and cannot be overlooked in terms of objective analysis in working conditions. One explanation for this may be related to the existence of professionals, who are constantly in the presence of chemicals and infectious materials, including laboratory professionals and sewage workers. It should be noted that, although the results of SMAS were slightly below the European results, exposure to high noise levels may have consequences, not only for the health and safety of workers, but also for business productivity (absenteeism, turnover, costs associated with medical expenses, etc..), so there should be periodic assessments in work situations most affected, in order to reduce / minimize the existing noise levels.

The results achieved in the physical constraints, clearly put in evidence the characteristics of the activity developed in the SMAS. In the case of a service of water supply and sanitation, many of its field activities are conducted at ground level or within ditches, which may explain the results found with the painful or tiring positions. On the other hand, different administrative activities require the sitting posture, posture which may, due to prolonged time, be associated with pain. In addition, it is often associated with repetitive movements, such as entering data into computer. It is therefore important to do a profound reflection, in order to reduce exposure of workers to these constraints.

There is, at SMAS, a much higher percentage of workers who perform work on the computer, compared to European and national data, which makes it necessary to give particular attention to this activity, since it brings together a set of dangers and risks that may lead to the occurrence of a large number of lesions (Brand, 2008). Taking into account that computer work involves certain risks, at the musculoskeletal, visual, psychosocial levels, etc.., we must pay special attention to this constraint, so that we can intervene in good time, by reducing / eliminating the risks and associated consequences.

We found that the results of SMAS are higher for all constraints of autonomy and initiative, which translates into an extremely positive aspect because it reveals that they have more autonomy, so you can manage your activity according to their capabilities. On the other hand, the results from the constraints in the work pace, although the values are below the values of Europe and Portugal, this constraint should be explored in greater detail to allow these situations to be reduced. As stated by Gollac (2010, in Eurofound, 2011B, p. 7) "There are two ways to increase productivity: increasing the effort or increasing the efficiency of effort." When a worker has to solve an unforeseen problem without help, the effort required is higher, which may in the medium / long term have consequences for the worker (occupational health and safety) but also for the company (reduced productivity). If the employee has help, the effort is less than the benefits for the worker and for the company. It should be noted that what was mentioned above will depend on the severity of the problem, continuing to be relevant once it seriously questions the organization of work, making the challenge to reflect and analyze the methods of work organization adopted by SMAS trying to seek to reverse this trend embryo intensification of work obvious.

For the group of constraints of the work characteristics, we recorded high percentages in exposure to complex tasks, learning new things, rotation of tasks that require different skills. The existence of complex tasks may be advantageous when the worker is competent to carry them out, the freedom to decide how to conduct and support, both from colleagues and the leadership, to deal with unforeseen problems. It is still a motivating feature for workers, allowing them to increase their abilities / skills. Also learning new things is an important point, because it means that it allows for the development of skills by workers. However, for this learning and development of competences to be positive, workers must be trained and have autonomy in order to learn the best way, otherwise it can become an embarrassment (Eurofound, 2011a). On the other hand, the low percentage of exposure to monotonous tasks, is a positive aspect, since these tasks can contribute to job dissatisfaction and lack of motivation which may have certain consequences not only for the worker, concerning health, but also for the company such as reduced productivity.

Enhancing the autonomy of workers in response to the obstacles of day-to-day work, demonstrating the responsibility that each has on his own and the safety of others, and the promotion of active participation in issues of safety, hygiene and health, has been a fundamental element in the policy of preventing occupational hazards.

These results demonstrate that employees are made aware and sensitized to the risks inherent in their daily activity, in the result of the bet made by the SMAS in training their workers, not only in the issue of safety, hygiene and health, but also in the context of organizational training, as time management and team management. However, for the results to be fully satisfactory, we should continue to invest in the Internal Training Plan, and in training projects in context (Costa & Silva, 2010), with the aim of promoting awareness of the risks and their relationship to health, in order to contribute to the health and well-being of workers.

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Ergonomic evaluation of the job of the blacksmith of civil construction in brazil

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ABSTRACT
Occupational accidents undertake economic productivity and account for asubstantial impact on the social protection system, accounting costs and influencingthe level of worker satisfaction. This makes an occupational health concern in the modern world, worthy of study to solve the existing problems in the workplace, to improve the lives of workers without reducing their productivity. The construction industry favors the emergence of musculoskeletal disorders due toergonomic hazards favored by the activity. The postures assumed during the ironmonger activities (cut, folding and bracing) is one of the factors responsible for the work physical load, confirmed by the interview when the worker points out the pain sites and the conclusion of the REBA, through the identification of the risk degree medium,but with intervention need. Important points observed sobre the postures assumed during the ironmonger activities. The ergonomic evaluation carried out in the construction blacksmith job was based in the Ergonomic Analysis proposed by the Regulatory Rule Application Manual – NR 17. It was done a job situation diagnosis and after we applied the ergonomic tool REBA (Rapid Entire Body Assessment) with the aim to evaluate the biomechanical level risk. Finally we suggested changes for the job improvement.

Keywords: Risks Ergonomic; REBA; Blacksmith; Civil Construction.

1. INTRODUCTION

The Construction Industry (CI), in a global world context, constitutes one of the greater sectors of national economy, bringing various Jobs and great business opportunities and favoring the country economical and social development process. With the aim of endowing this industry with more competitive devices is necessary that a broad vision of the innovation idea occupies spaces in a sector that, despite that giant numbers, still needs organization and technology changes to answer to new quality and efficiency patterns of required by the market.

Differently from other industries, the productivity in the construction is much more sensitive and depends on the worker arm. In particular, the production process communications are, for the most part, of man-man kind, where the work human management is more determinant than the work technical management. It means that the work rhythm and quality depend almost exclusively on the worker

. This way, the sector also detaches itself by precarious practices work superposition and by the absence or Security and Work Health (SWH) plans lack of efficiency, that can be confirmed with high work accidents numbers, in which are inserted the occupational diseases.

In this scenery, the Ergonomics is showed as great "link" between the man and the work environment, searching to adapt the work to the man and for that, according to Iida (2005), part of the man knowledge to make the work, adjusting it to their capacities and limitations, preserving this way the health.

At first, in a sector with work accidents risks as construction, where serious and fatal accidents still worry, the Ergonomics might be seen with more vigour.

The study professional, the blacksmith, is included in one of the more used constructive phases in construction, which is the concrete structure. His work is used in foundation, pillars, beams and flagstones, where these workers are quite some required to develop their activities. They are responsible for the transport, cut, mounting and placement of the bracings where will be done the structure paving, assuming this way various postures.

This way it is searched in this work to evaluate the blacksmith job, joining to this the ergonomic knowledge, aiming to propose better work conditions to this professional.

2. MATERIALS AND METHODS

This research can be classified as for nature as basic, once it doesn't involve the predictive practical application, despite having the pretension of generating new and useful knowledge. Regarding to the objectives it treats of a descriptive-exploratory study, once it aimed to observe the blacksmith activity phenomenon characteristics, as well as to identify his performance by the ergonomics point of view. Concerning to the approaching the research is of a qualitative type, considering to answer particular questions, without using statistical methods and techniques.

Regarding to technical procedures the research is bibliographic/case study. It is bibliographic because was elaborated from materials still published (books, papers, site) and a case study once it is based on a detailed evaluation of a specific job.

The research instruments used were activities direct observation, photographs, besides an interview carried out with the worker and posterior biomechanical risk analysis using the ergonomics tool REBA (*Rapid Entire Body Assessment*) (HIGNETT & ATAMNEY, 2000).

A follow-up was done *in loco* during all the activities carried out by the worker (blacksmith) in his job, in order to get familiar with the work process itself, to subsidize an evaluation from the ergonomics point of view, based on Work Security and Health (WSH) recommendations established by Work and Job Ministry (WJM) through the regulatory rules: NR – 17 (Ergonomics) e NR-18 (Work and environment Conditions Construction Industry) (BRASIL, 2011).

3. RESULTS AND DISCUSSION

The ergonomic evaluation carried out in the construction blacksmith job was based in the Ergonomic Analysis proposed by the Regulatory Rule Application Manual – NR 17**.** It was done a job situation diagnosis and after we applied the ergonomic tool REBA (*Rapid Entire Body Assessment*) with the aim to evaluate the biomechanical level risk. Finally we suggested changes for the job improvement.

3.1 Company global analysis:

The ergonomic evaluation was done in a small construction company acting for 10 years in Paraiba market, constituted of about 50 employees distributed in two works presently.

This company works with vertical and horizontal buildings of residential and commercial use. The construction site studied dealed with a renovation and addition of a building with two floors for service delivery.

Regarding to the administrative structure, the company counts with two managing partners who are aided by a building technician, a foreman and some warehouse keepers.

Generally, the building company presents a small employees turnover. It is constituted of signed workers and, depending on the need, accomplishes the subcontracting for specific works execution. Regarding to the technology met in the construction site were verified traditional forms to construction work.

3.2 Blacksmith Profile

- ✓ The profile was obtained through an interview (attached) applied to the worker.
- ✓ Age: 39 years
- ✓ Anthropometrical Characteristics: 1,79 m and 80 kg.
- ✓ Schooling: elementary school
- ✓ Marital Status: married
- ✓ Work time: twelve years
- ✓ Company work time : eight years
- ✓ Turnover: it varies according to the workforce need for the bracing structure.
- ✓ Work Journey: from 7:00 to 17:00 with an interval of 1 hour for lunch from monday to Thursday. On Friday the journey is from 7:00 to 15:00.
- ✓ Food: is given by the company and did in the construction site.
- ✓ Symptoms after work journey : a lot of tiredness with pains in the neck, spine, arms and legs.

3.3 Activity Description:

The worker in the study is the blacksmith, who keeps on the construction in the foundation and structure phases. The activities carried out by these workers are: storing, cut, fold and structure iron bracing.

The blacksmith is oriented about the way of proceeding by the Foreman, who does the project reading, taking doubts that occasionally can appear. He also orients about the pieces that must be manufactured. After the project interpretation the blacksmith meets the exact measures of cut and fold that composes the structure. It is common to separate time periods to cut, fold and mount the pieces.

For the purpose of the work we observed just the piece transport, cut and fold.

According to the observations carried out in the work environment the blacksmith does the following activities sequentially:

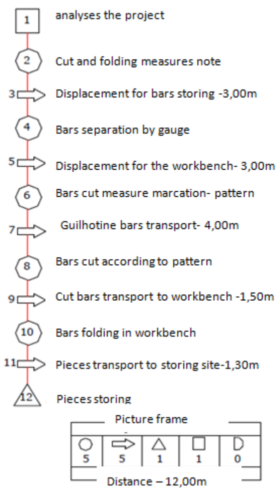
1) Analyses the structural project and takes notes of pieces cut and fold.

3) Separate the gratings by gauges according to the pieces manufactured.

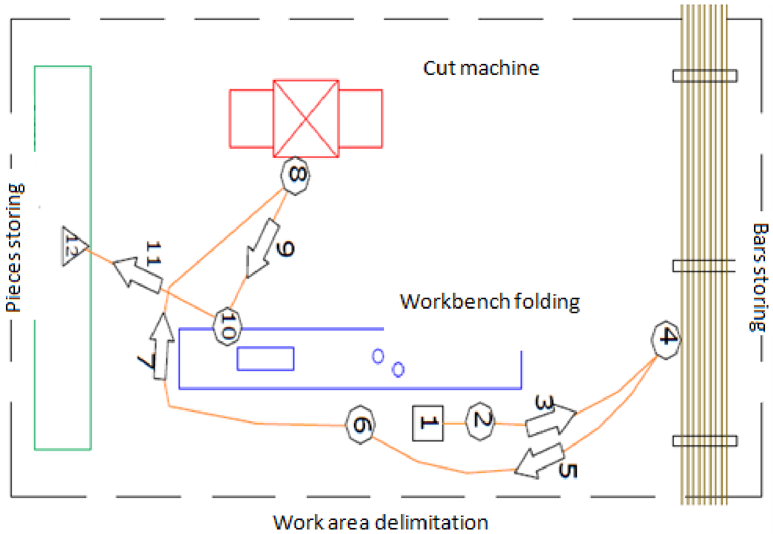
4)The pieces cut is done through the guillotine. With the guillotine on the floor the blacksmith becomes hunched, positions the iron according to the pattern and with one hand presses the metallic crowbar downwards to make the cut.

5) With the pieces of iron cut the blacksmith goes to the workbench to make the fold. The dominant posture during the fold is standing up. In the construction site we visited the fold was done by hand in the workbench. In manual folding the intense physical effort and the repeatability can provoke worker muscles, spine and hands injuries. In this process can occur finger compressing. For the folding activity the workbench height is fundamental and must be proper to the worker to guarantee comfort and productivity.

The sequence of activities carried out by the worker can be represented through a flowchart represented by symbols.



To take the job blacksmith displacement visualization easy we used the flipshart according to job layout



3.4 Job characteristic dimensions

To carry out the activities the worker has got an area of about 24,00 m², being the tools distributed along this area. This way, is possible to identify a specific space for bars storing, cut machine, folding and pieces storing workbench.

Bars storing: In this site was possible to identify that, contradicting all the recommendations of the rule, we observed packs of bars with imminent risk of turn down, beyond this, ironware exposed to bad weather without protection in the extremities.

Cut machine and unroll key: The guillotine used for cut was supported in a board inclined on the floor. The equipment didn't present any kind of maintenance, including a blade that wasn't in good conditions. Other aspect observed was the metal lever length that was inadequate.

Folding workbench: The workbench observed was of stable wood, supported on a resistant surface. The workbench support basis was formed by two vertical lumbers sticked on the floor tied to another in horizontal position, the work area width is of 0,30 m and the height is of 1,03 m.

3.5 Biomechanical risk analysis:

The blacksmith postures were evaluated during the activities execution, with basis on the ones that were more extremes and, consequently, that offer greater biomechanical risk. For that, it was used, as mentioned before, the REBA. The REBA method was developed by Hignett and McAtamney (2000) to estimate the body disorders risk to which the workers are exposed. It is a tool that serves to evaluate forced postures quantities in tasks with persons manipulating any kind of load.. In it, are included dynamic and static posture load factors in person-load interaction, in a concept named "*the assisted gravity*" for upper limbs posture maintenance, it means that there is gravity help to keep the arm posture where it I more difficult to keep the arm upright than hanging down (COLOMBINI, 2005; HIGNETT, 2000).

During the blacksmith cut (Picture 1), which is done with a guillotine supported on the floor, the blacksmith stays with the trunk inflected, positioning the iron according to the pattern and with one of the hands pressing down the metal lever

till do the cut. The REBA tool application showed that during this activity the worker is exposed to a degree of risk considered medium, nevertheless, an intervention is necessary.
This fact is confirmed when we verify that it is a work that requires trunk flexion for moderate and long time periods, that favors the intervetebral disk displacement. According to Ferreira Junior (2000), the back pain, to get an idea of its clinical and epidemiological importance, is present in about 80% of the persons lifelong, and it is the greater short and long duration incapacity among workers.
The back pains can occur basically by two causes being the commonest the pain because of muscle contracture, resulting from repeated effort. Other motive is the pain by radicular compression, associated to pressure increase or intervetebral degeneration, cause that is related, mainly, to overload in the activity.

Picture 1: Cut activity

After the blacksmith is CUT the assembler goes to the workbench to do the folding. In this posture the REBA tool also showed a medium risk, but necessary. The dominant posture during the folding is standing up.
The folding was done manually in the workbench turning it an activity that required an intense physical effort and the repetition, being a risk factor for the worker spine and hands injuries. In this process still occurs the risk of typical accident as finger compressing. In RANNEY (1995) study it was verified that muscle pain and sensibility was the grater problem, as much in the neck, shoulder (31%) area as expected as in the forearm , hand (23%), a site declared previously. The majority of the forearrm problems was met in the extensor side.

Picture 2: Folding activity

3.6 Improvement Suggestions
Considering the observations carried out in the blacksmith job, appeared some hypothesis that were formulated and described below:
The postures assumed during the blacksmith tasks execution (cut, folding and bracing) is one of the factors responsible for the work physical load.
The physical conditions in the blacksmith job for transport, cut, folding and positioning of the ironware interfere in postures assumed during the workers activities.
Prolonged duration in constraining postures to do the preparation activities (cut and mounting of the ironware, girders and pillars) and mounting (forms positioning and the stone slab positioning)
Execution of tasks alone that could be done with the help of one more worker, as in the folding of thick iron;

- ✓ Long work journey (nine hours) to do the activity that requires a constant physical effort.
- ✓ Toward all the factors observed related to the task we can present the following recommendations for the work environment and activity execution according to the resources available.

a) Equipments:

We suggested for the cut service to use a polycut machine, once it offers less problems in spine, a second opinion.

Picture 3: Polycut Activity

Picture 4: Activity with guillotine

It would be the lengthening of the lever handle that actuates the guillotine for it remains in a height of utilization that doesn't damage the worker spine during the service execution or support the guillotine on a workbench of adjustable height to be adequate to the worker or still the acquisition of cut rebars avoiding this way inadequate postures and repetitive efforts.

The acquisition of workbenches with adjustment of height in the trestles of sustenance and benches for the blacksmith to work seated during the rebar folding.

b) Work hours and workers number

We suggest pauses of 15 minutes in the work journey in the interval of two and two hours for relaxing and interruption of the activity routine. According to o Couto (1998) the pause mechanism helps to prevent injuries by three mechanisms, being these: when occurs a statical muscle effort, with lactic acid production, the pause will promote a normal blood flux that will "wash" the acid of the muscle, preventing possible injuries, when the task requires repetitive movements, during the pause, there is a tendon relax and lubrication by the synovial liquid reducing, this way, the friction among the structures required.

Other suggestion is to contract an assistant for the ironmonger so that it would reduce the service load over him causing a better task distribution, taking to a productivity improvement and better service quality.

4. CONCLUSIONS

The postures assumed during the ironmonger activities (cut, folding and bracing) is one of the factors responsible for the work physical load, confirmed by the interview when the worker points out the pain sites and the conclusion of the REBA, through the identification of the risk degree medium,but with intervention need. Beyond this, the job physical conditions, as well as the equipment and work tools conditions interfere in these postures. It becomes still evident that it treats of a prolonged duration in constraining and incorrect postures form the ergonomics point of view.

Other important points observed were the activities carried out by a unique worker, that in fact could be receiving help of an assistant, mainly in the folding of the thick iron, in which great physical effort is required. The work journey, according to the interview, is long (nine hours) for the activity execution that needs a worker constant physical effort.

At this, it is recommended some improvements in the work environment and activities execution, prioritizing the resources available:

Use of polycut machine, that is technologically more efficient requiring less of the worker, offering this way less spine problems. A second option, financially more viable would be taking advantage of the tool, but lengthening the lever handle that puts in action the guillotine, for that it stays in a utilization height that doesn't damage the worker spine during the service execution. A third option would be to support over an adjustable workbench adequate to the worker or the acquisition of cut rebars. avoiding this way inadequate postures and repetitive efforts. Beyond this, it is suggested the acquisition of workbenches with regulation of height in the sustenance trestle and benches for the ironmonger to work seated during the rebar folding. during the rebar folding.

1. We also suggested interruptions of 15 minutes in work journey in two hours and two hours intervals for relaxing and activity routine and monotony interruption. And also the ironmonger assistant contract to reduce the service load over him causing a better tasks distribution taking, possibly, to an improvement of the productivity and service quality.
2. Finally, is important to detach that the economical increase mustn't superpose the workers life and health. And through an analysis or programme that uses the precepts of a method focused in the worker health and security, is possible to create a viable way for diagnosis of probable errors and also a way of discovering good ergonomic practices for isk elimination or at least these ones reduction.

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Complementarity of risk assessment methods

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ABSTRACT
Although fully consolidated as regards the scope of its application, different methods of risk assessment, whenever possible can and should be applied together. This approach aimed to demonstrate the advantages of the sequential application of different methods of risk assessment, demonstrating both the feasibility and complementarity, proven in obtaining meaningful data, in a gradual way and legitimizing its use as risk factors. The methods have been naturally selected over the type of situations for which they were conceived and originated pairs of different factors.
These specific pairs of factors, helped delineate risk formation, initially as secondary risk factors, then combined in cascade using two-dimensional matrixes with constant curves using the proportional method and culminating as direct constituents of probability and damage (primary factors), with real impact on existing risks assessment.

Keywords: Risk Assessment; Complementarity Methods; Vulnerability Analysis; JHA; FMEA; Risk Factors.

1. INTRODUCTION
Recurrent on Occupational Safety and Health (OSH), risk assessment is still characterized by technical deficiencies, due to ignorance or by lack of operational credibility, i.e., it's not recognized its potential as an effective technical tool, to improve OSH goals.
More frequently than desirable, the occupational hazards evaluation and control activity, results in inaccurate approaches in the methodological plan, which can generate imprecise results and therefore limiting on the practical plan, dedicated and effective actions. This happens when we think that we are carry out properly the different stages of hazard identification, evaluation and reduction of associated risks, not making use of the appropriate technical resources (William & Mostia, 2009).
It is known that the choice and use of solid elements in any action is more likely to originate solid results. Obtaining valid results in an appropriate way is directly dependent on the relevance and significance of the elements used, of course, always dependent on the subjectivity of those making it. The different methods of risk assessment, although duly consolidated, both in its application as well to the expected results, when possible can be applied together in a complementary manner, demonstrating and validating a set of real and effective data. The intention to create a bridge between the academic and professional aspects was the motive for this approach, dedicated to supply heavy-duty vehicles with Compressed Natural Gas (CNG) on a public transport company, in order to prove the potential risk present in a human-system interaction, configured in the use of a substance with a significant energy potential.

1.1 Purpose of study
The nature of public transportation implies that vehicles' refuelling is a continuous and daily activity, this reality and OSH insufficient procedures motivated this study. Issues such as lack of risk analysis and subsequent steps in the Natural Gas (NG) refuelling system, the inexistence of technical trainings about safety and health on refuelling task, the prior knowledge about the improper use of a refuelling accessory, the reduction coupler, motivated the technical approach on the supply system and two of its subsystems in particular, the natural gas compression and the refuelling task. The current fleet of vehicles powered by CNG is composed of two segments of vehicles in a total of 57 vehicles, one of these segments is divided into two different series, the first of these having different technical characteristics, with emphasis on the filling nozzle diameter corresponding to that used in light vehicles, classified as (NGV1), while the second series and another vehicle segment are accordance with the diameter determined for heavy vehicles classification (NGV2).

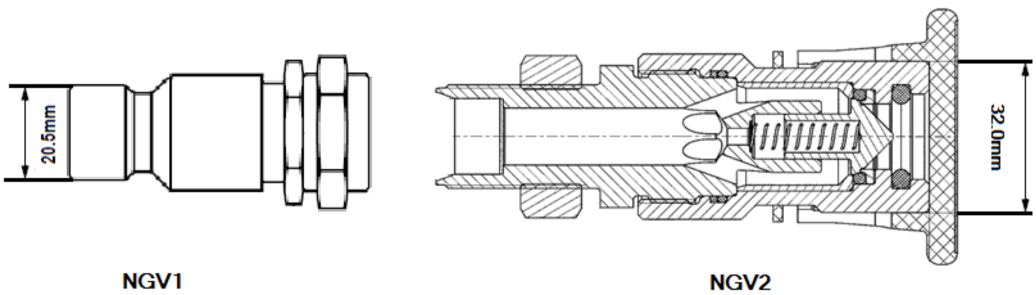


Figure 1 – Profiles of filling nozzles

The use of the reduction coupler aims to bridge the gap between the diameter of the fuelling hose, in accordance with NGV2, and the filling nozzle of the first series vehicles, with features NGV1. Reservations by the internal areas involved in the activity of supply, inevitably responsible for safety conditions expected for the entire course of the work process, refer to outsourcing (service providers) as being responsible for advising and providing the reduction coupler, supposedly provisional.

Figure 2 – Reduction coupler (emphasis on union elements)

The other subsystem is a NG compression unit, with highlight to the different stages of compression and correspondent physical components. We analyzed the preventive maintenance scheduled actions, and their respective interventions. It should be noted that besides the domestic fleet, there is also an external flow of vehicles into the refuelling station, justifiable by the still insignificant CNG distribution network, thus extending the field of safety responsibility.
The existing risk assessment, of global and transversal nature, doesn't differentiates the approach mode to company's different activities, necessarily differents to the level of its working processes and risk components, and does not consider or recognize, among others, as priority action elements the variables here in study, reiterating thus the inappropriate use of technical resources in OSH procedures.
Regarding to explosions prevention, the formation of an explosive atmosphere was not considered, when its responsibility in technical and organizational terms is attributed to the employer, according to specific national legislation in force.
The nature, the diversity of risk situations and respective extension, also results in the concept that there are no fixed rules to preside risk assessment activity (Roxo, 2004).
Given these shortcomings and the need to provide visible and believable data that could later produce effective changes in the organization, thus changing the work processes in accordance with measures dictated by OHS action criteria, the option for joint use of various risk assessment methods arises spontaneously and recovers the composite methodology concept, often ignored by direct and simple methods.

2. METHODOLOGY

2.1 Collect, gathering and analyze information

Steps such as collect, gather and analyze information are the starting point of any risk assessment process. To carry them out the following tools were used:

Document analysis

Consultation of a work instruction, directed to refuelling vehicles activity (not considering the use of the reduction coupler) and corresponding to only one CNG fleet segment. Analysis of an internal norm aimed at defining a methodology for identifying hazards, assessing and controlling OSH risks, with few references to the risk factors presents in company activities. Analysis of maintenance manuals of the natural gas compressing units, realized by outsourcing firms;

Personal contacts

The exchange of information with the refuelling operators was significant in obtaining data, later combined with other information, allowed the obtaining of real and relevant data. The proximity to the operators created conditions for an open dialogue, without fear of the impact of their words, thus facilitating the transmission of reliable information and leading them to recognize their direct contribution in the subsequent corrective actions. The worker that has been consulted before being processed any changes to any system, accept them willingly, because recognizes them as a direct contribution of his opinion (Ridley, 2008).
Technical information on the compressing units maintenance given by outside experts, responsibles for that activity, indicated vulnerability factors with potential to affect all the whole supply system.

Observation on-job

The observation of a working process through an attentive and sensitive look, allows obtaining real-time relevant data, as opposed to static information. Under these conditions the observable becomes intelligible when the whole of these variables relates itself according to the precepts of OSH. Again, if carried out by an element close to the operators, it allows the development of those tasks in a natural way, without any constraints or restrictions.

2.2 Tools

The option for qualitative methods, was due to the evidence that they are one of the most solid starting points, in order to carry out a risk assessment process, even if ultimately evolves into a semi-quantification, which corresponds into a “valuation in discrete levels, of risks present in a production process” (Oliveira, 2010).

The targeted application of each method, was distributed over three distinct, yet inter-dependent phases: the identification phase, based on data observed and collected in the field (risk activities, risk factors, products and equipment) , key variables for the development of any method; The evaluation phase in order to qualify and / or quantify the risk, made under deterministic and probabilistic methods, major contributor to analyze possible consequences in the light of the information collected in the first phase, thus enabling the interiorization of potential events, in order to be duly considered; The phase of the hierarchy on a scale, that reflects the results obtained in previous phases. The resulting hierarchy will reflect on a scale the results obtained in earlier phases, in order to highlight the risks whose control should be a priority (Tixier et al. 2002)

In order to highlight the complementary use of different methods we decided, based on the variables under study, to use the Vulnerability Analysis (simple qualitative method) associated to the CNG supply. This analysis provided guidance on the following methods (qualitative what-if), outlining the Job Hazard Analysis (JHA), which in addition to the human evidence, allowed the identification of material factors that "forced" the use of Failure Mode and Effects Analysis (FMEA) “qualitative evaluation technique that can be quantifiable and as such may be considered qualitative or quantitative" (Nunes, 2009).

The expression of this reasoning applied to the reduction coupler use, was adapted as follows: The application of the vulnerability analysis in the refuelling system showed the means of materialization of this same vulnerability, their causes and consequences for the production process, “which will result in destruction or dysfunction, significant inconvenience or even cessation of company's activity” (Oliveira, 2009); Driven by the vulnerability analysis, the use of JHA became justifiable and it was applied on the refuelling vehicles task, highlighting possible causes of human error “at a frequency higher than desirable, human error is associated at work related accident that occur in areas including not only human systems, but also semi-automated and automated systems” (Matthews et al. 2000), well as material causes arising from the misuse of the reducing coupler, which awakes to the conflicting duality between operational and security objectives. This feature, enabled by their characteristics split the task into subtasks, then submitted to the different stages of a JHA, including the identification of hazards and / or risk factors, causes, consequences and corrective actions; Finally FMEA's use, justified by the need to define the failure modes and respective effects associated to the reduction coupler's use, potential risk factor identified by the application of JHA.

2.3 Outlining risk factors

The sequence described above, allowed to isolate the most relevant primary risk factors (damage and probability) whose significance began with the definition of secondary risk factors (second-rate), made separately for probability formation factors with the choice of two pairs *fpi* (*fp*1 e *fp*2) driven by FMEA and *fp’i* (*fp*’3 e *fp*’4) based on JHA. Supported by these secondary elements, each pair outlined an intermediate matrix, α and β, which in turn originated the secondary risk factors (first-rate), *fp*α and *fp*β, then combined on a probability final matrix.

The formation damage factors, limited to type and impact, were a constant over the three methods used, resulting in a single pair *fd* (*fd*1 e *fd*2) directly combined on a damage matrix. The final product, as primary risk factors, probability and damage, were then combined on a risk matrix culminating in its assessment.

Figure 3 represents this process and summarizes the following expressions: P=Π*fpi*; D=Π*fdi*.

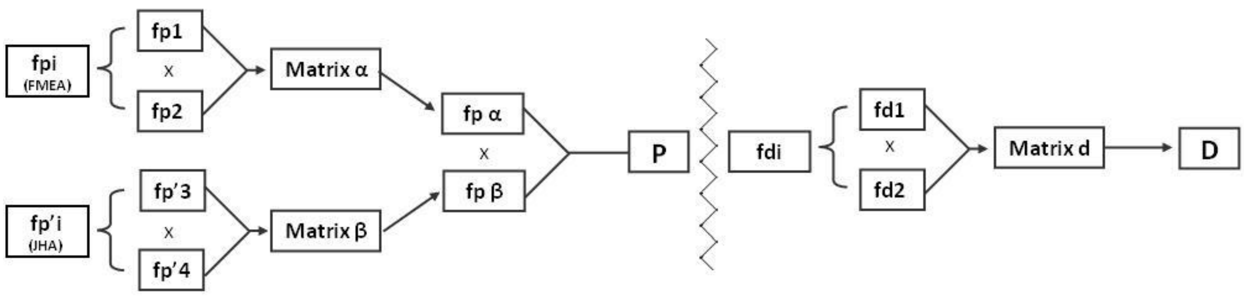


Figure 3 – Cascading matrices

In order to obtain the expected accuracy and because each factor highlighted through these qualitative methods is also unique and therefore with a different significance, the scales that characterize them were made individually and according to the technical criteria of those who made them, also the reduced complexity of the scales was decided in function of the study’s purpose, whose primacy was to demonstrate the advantages of a composite methodology.

For *fp*1, the probability and its quantitative level, comes from the periodicity of the refuelling task. For *fp*2, probability is given according with the procedure of coupling / uncoupling , that despite being internalized and consolidated, sometimes is not fulfilled due to action errors such as memory lapse, just as documented in internal documents, specific to incident records. Both factors can be observed in tables 1 and 2.

Table 1 – fp1 scale

Periodicity (*fp1*)	Probability	Level
The operation occurs several times a day.	High	9
The operation takes place once a day.	Average	6
The operation occurs occasionally.	Reduced	3

Table 2 – fp2 scale

Procedure (*fp2*)	Probability	Level
Procedure nonexistent.	High	3
Existing procedure and missed occasionally.	Average	2
Procedure in place and enforced compulsorily.	Reduced	1

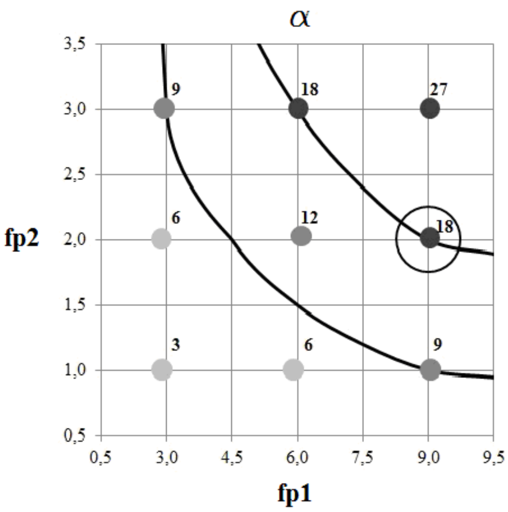
The construction of the intermediate and final matrices, due to their relative simplicity, has been made with the use of geometric simple proportional method, allowing the division and categorization of the variables under study, by assigning levels of valuation k according to the formula in Equation 1, in which R(Risk)min = p(probability)min . d(damage)min and Rmax = pmax . dmax.
When applied to the calculation of others intermediate and final matrices, operators should change:
$P_{ci} = P_{min} + i \,.\, ((P_{max} - P_{min})/k)$; $D_{ci} = D_{min} + i \,.\, ((D_{max} - D_{min})/k)$.

$$R^{c}i = R_{min} + i \,.\, ((R_{max} - R_{min})/k)$$

Equation 1 - Calculating the curves of constant risk

2.4 Matrices construction

By setting the value to assign to each level and through the Excel tool, was created the graphical representation of the various functions considered in the study, fpα=fp1xfp2, D=fd1xfd2,… calculating constant factors curves, a process that enables a range of values at discrete levels and their subsequent characterization.
Note in Figure 4 intermediate probability matrix α (*fp*1=9 e *fp*2=2). It should be noted that each matrix required the development of a table that allowed, the correspondence between any found value and a qualitative reference range, thereby cancelling the initial disparity between groups of factors resulting from the natural difference between them, in terms of it contribution to the formation of the final risk.



Value	Probability	Level
≥ 18	High	3
≥ 9 <18	Average	2
< 9	Low	1

Figure 4 – Intermediate probability matrix α and levelling table (reduction couple)

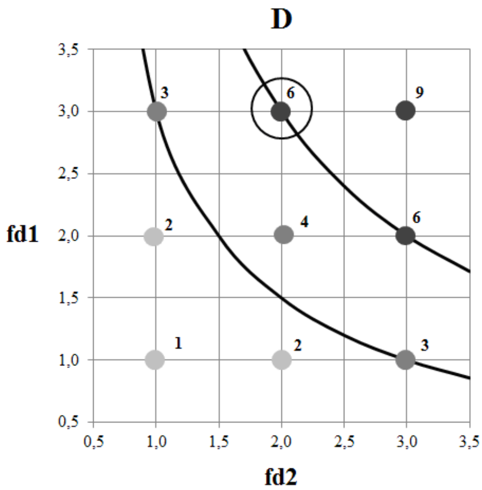
To calculate the damage, the process was similar, differing only with the choice of the two factors, limited to personal and / or material damage, as seen in tables 3 and 4. Again to level the significance of the inputs used in the final calculation of risk, similarly as used for *fpα* as well as the totality of all the factors during this study, it was used a levelling/characterization table as shown in Figure 6.

Table 3 – fd1 scale

Repercussions	Damage	Level
Serious injuries that may have permanent effects.	Significant	3
Injuries with temporary total or partial disability.	Moderate	2
Superficial injuries (small cuts, irritation, discomfort,...)	Light	1

Table 4 – fd2 scale

Repercussions	Damage	Level
Partial destruction of the system, complex repair and high costs	Significant	3
Need to stop the process operating to carry out the repair	Moderate	2
Damage negligible	Light	1



Value	Damage	Level
≥ 6	Significant	3
≥ 3 < 6	Moderate	2
< 3	Light	1

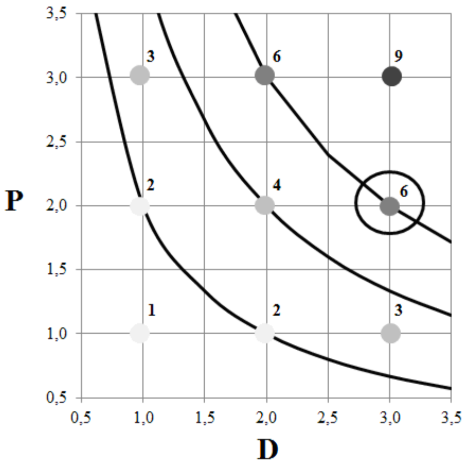
Figure 5 – Damage matrix and levelling table (reduction couple)

The choice of developing a representation in discrete valuation levels, with a semi-quantitative method matrix, arises from the need to create a perceptible risk representation to stakeholders, in order to facilitate a cognitive recognition, just because the first and only way to avoid or minimize risk is to fear it. As we only perceive what we measure, this procedure is vital to represent its real threat.

3. RESULTS AND DISCUSSION

Whatever the risk level, its character is not definitive, its dynamic component implies that risk should be monitored frequently. The conditions prevailing at a given time undergo changes that inevitably could alter the relevant variables. These changes can be positive, when resulting of adopted control measures as part of security activities, and on an opposite perspective, causing the deterioration of work conditions, through a new events sequence with higher risk potential. The amounts calculated in the previous steps and here presented, determined primary risk factors in the reduction coupler's use as P=2 and D=3 to a final value R=6.

The risk characterization thus calculated as considerable, according to its level of characterization with suggestion to modify the existing work processes, was something already expected *a priori* and without any surprise. The empirical knowledge of the triangle of risk factors involved (material, human and organizational) allowed to anticipate the obtained level.



Value	Level	Characterization	Corrective action
> 6	4	(Risk) High	Critical situation. The materialization of the risk is imminent. Urgent intervention and correction.
> 4 ≤ 6	3	(Risk) Considerable	Further action by changing the existing work processes.
> 2 ≤ 4	2	(Risk) Moderate	Correct measures and adapting existing risk control.
≤ 2	1	(Risk) Residual	It does not require immediate intervention. However vigilance must be constant and enhance any corrections.

Figure 6 – Risk matrix and characterization table (reduction couple)

The use of this methodology, allowed the reference to ignored risks in previous approaches, such as the likelihood of combustion, originated by CNG leak through connecting element in the reduction coupler, observed on-job, originated by mechanical loads as: Tension and Bending, through gravity's action in filler pipe, with an high point of origin and without any support when in extension, with incidence of the forces involved in the coupler that works in a lower plane; And a twisting force, caused by the applied axial load action, either by handling or by the impulse of the passage of gas during filling, which occurs in cycles of injection. These two factors lead to the connecting elements' relief, causing a pressurized gas leak.

Figure 7 – Reduction coupler operating

Originating from the same element and during the supply hose's decoupling, the absence of a return duct, means that the equipment remains with an internal pressure of 200 bar, situation that requires the fulfilment of a sequential procedures series by operators, in order to relieve the internal pressure, not documented and whose failure causes a violent whiplash movement that can reach the operator or the vehicle. The absence of a risk management program helps explain the use of such an accessory. The use of a risk analysis tool, like a Preliminary Hazard Analysis (PHA) before the validation of this procedure, could help prevent the materialization of the risk through early identification of relevant risk factors, such as those present in this process.

Although approached in the study, but without reporting specific results in this document, natural gas compressing units were associated to safety performance deficient indicators. The maintenance activity although developed as recommended by the manufacturer, is not made according to criteria of quality and accuracy, neglecting points that in case of failure could compromise the normal functioning of the system and endanger the human and material environments. The general state of maintenance and specific operational failures can facilitate structural weakening of key components and/or increase the probability of harmful events due to components failure.

Consider as an example, not to perform the annual calibration of pressure storage transducers. In this case considering that the pressure transducer indicates a value below the real, the compressor to fill the gap requires a power proportional increase, and with capacity to reach a maximum 1480 min-1 the overload over the remaining components can lead to a breakdown.

Under these conditions, and according to the outsourcing technicians, the lubrication circuit may not be able to fulfill its function, the inability of the main pump to absorb the speed increase, leads to breakage and in sequence causes the secondary pump failure, or at analysis, because the system is not designed to operate continuously at high regimes, as it derived from a overload, it collapses causing a sudden release of harmful energy.

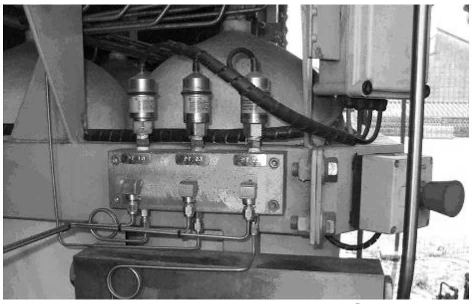


Figure 8 - Storage pressure transducers

However, the basic purpose of this project was to elucidate the feasibility of joint use of various risk assessment methods, regardless of the sequential procedure, and applying them to a specific work process. The choice of these methods and their subsequent conjugation did not arise randomly, not only technically supports the conclusions of the previous, but also adds relevant variables, as verified on the reduction coupler's approach.

Besides viable, this concept was also verifiable by the gradual strengthening of the variables under analysis, validating its use in obtaining pertinent risk factors, reaching a final result closer to reality. Also creates a more solid basis to determinate appropriate control measures, most commonly inadequate as a result of misuse and/or incomplete methodological resources available for the purpose.

Although with the purpose in demonstrate the complementarity of methods and above all the contribution of secondary factors in the formation of risk, it is important to note that this approach does not consider the totality of the variables that constitute the activity at the level of human, material and organizational potential interference, independents or while system, a clear contrast to the ideal risk management, systemic, structured and dynamic with good OHS performance indicators. This decision does not mean that this project has fallen short of its goals, on the contrary, the chosen variables were applied into the correspondent methods, resulting on a real OSH activity. In this sense, information must not be only documented, we have to assure that it's transmitted to workers and employers with the efficiency to create a change in its professional attitudes. Both working classes have to acknowledge that incidents and occupational illnesses are not caused by destiny or coincidence, they are directly related to breaches of safety rules.

4. CONCLUSION

The results validate the choice made, the final value and their significance to the identified risk do not represent the goal, but the starting point of the next stage, their subsequent verification and monitoring, motivated by the dynamic nature of the occupational risk in the wake of continuous improvement. The type of risk identified should be kept as low as possible on a constant effort, following the trend ALARP – As Low As Reasonable Practicable (Melchers, 2001).

The direct and presential approach with the study performed, allows between the volume of information gathered and confirmed, highlight events of near misses as defined by the OHSAS 18001:2007, which eventually escapes from the clutches of occupational safety, prompting to a misreading of its respective indicators. The absence of any harmful occurrence in a professional organization at a certain period does not reflect the effectiveness of a risk management system, in relation to another organization, which has accounted for the same period harmful occurrences. Neither the continuation of this positive state of reduction conveys the true state of the organization moved by productive goals and hiding the indicators of occupational safety (Cadieux et al. 2006).

It was intended to awaken in regular users of these and other methods, the notion that their use does not have to be individualized, but must create new challenges negating the trend, according to which a risk assessment it is often considered as a boring step, imposed by laws and norms which can lead to selective and convenient approaches, affecting the reliability of final results.

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Patient Handling: Applying the DINO Method among Portuguese Nurses

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ABSTRACT
In the literature a patient transfer has been defined as a work task where nurses assist or lift a patient from one location to another or from one position to another. Using a safe work technique during patient handling is considered as one prevention strategy when integrated in multidimensional interventions. This study aimed to characterize nurses performance when accomplishing patient transfers applying DINO (Direct Observation Instrument for Assessment of Nurses' Patient Transfer Technique). It was also intended to identify critical factors that influence nurses' performance by using opinion questionnaires for professionals and patients. After the participants informed consent we carried out 40 observations in eight adult wards. Immediately after the observation of each transfer and the filling out of the DINO checklist, we applied the questionnaires to gather information about the nurse's and the patient's opinion of the carried out transfer. The DINO results can be observed in the final scoring between a minimum of 8 and a maximum of 15. The average result was 11,28 points (sd=4,99), which can suggest that the way in which the technical transfer was carried out might not have been the safest. The main results showed that in 35 observations there were enough space to the transfer performance (87,5%); in 9 of the transfers we noticed that the equipment to which the patients were transferred were not correctly positioned and blocked (22,5%); and in none of the observations the height of the bed was considered as being correct, as none of the beds height could be regulated. These last two factors contributed to a lower final DINO score. 63,6% of the patients considered that the transfer was carried out very safely, 81,8% considered that the transfer was very comfortable and 90,9% considered that during the transfer their dignity and privacy were maintained.

Keywords: Hospital Ergonomics; DINO; Intervention Evaluation Tool; Patient Handling; Work Technique; Nurses.

1. INTRODUCTION

Working within the health care sector is generally considered physically demanding (Dawson et al, 2008; Johnsson et al, 2002). For nurses patient handling tasks are performed daily and repeatedly during a work shift, which makes it strenuous and a major cause of musculoskeletal disorders (Kjellberg et al, 2000; Johnsson et al, 2002).

In the literature a patient transfer has been defined as a work task where nurses assist or lift a patient from one location to another or from one position to another (Kjellberg et al., 2000). It can then be concluded that patient handling is a complex task and that it is an interaction between two or more individuals. In this interaction the nurse who will perform the transfer and the individual who will be transferred are present (Hignett et al, 2003; Johnsson et al, 2002). Different aspects of work technique and its importance in its relation with musculoskeletal disorders have been widely discussed (Hignett et al, 2003; Schibye et al, 2003), but it was Kjellberg et al (1998) who defined work technique as composed by two elements: the method chosen to carry out the task and the individual performance of the task.

Using a safe work technique during patient handling is considered as one prevention strategy when integrated in multidimensional interventions (Bos et al, 2006; Dawson et al, 2008; Hignett et al, 2003). Although interventions can vary greatly in design and in content, when considered together there is moderate evidence supporting their efficacy in preventing back pain in nurses and musculoskeletal symptoms (Bos et al, 2006; Dawson et al, 2008). Nevertheless, comparing the effectiveness of these interventions has been difficult due to the different outcome measures used to evaluate success (Fray & Hignett, 2009). So, to study work techniques Johnsson et al (2004) developed an instrument called DINO (DIrect Nurse Observation instrument) where nurses' work technique during patient transfers is assessed based on observation and Fray and Hignett (2009) developed an evaluation tool that allows comparison across all healthcare areas for future patient handling interventions called IET (Intervention Evaluation Tool) that includes 12 parts corresponding to previous evaluation tools. One of its parts is DINO.

This study aimed to characterize nurses performance when accomplishing patient transfers applying DINO (Direct Observation Instrument for Assessment of Nurses' Patient Transfer Technique) (Johnsson et al, 2004). It was also intended to identify critical factors that influence nurses' performance by using opinion questionnaires for professionals and patients.

This study is part of a wider project to adapt and evaluate the applicability of IET to Portugal (Fray e Hignett, 2009; Cotrim et al, 2011). Integrated in this project the first application of DINO was carried out in Portugal, as well as its translation and cultural adaptation (Cotrim et al, 2011).

2. MATERIALS AND METHOD

In this study was used the observational method by means of DINO (Johnsson et al, 2004) for characterizing the nurses performance during the transfer of patients and two questionnaires were applied with the objective of characterizing the

nurse's opinion about the task and the patients' opinion about the safety, comfort and privacy during the transfer. All the tools are an integrant part of IET (Fray e Hignett, 2009; Cotrim et al, 2011).
DINO is an instrument to be used in a direct observation in order to assess how nurses transfer a patient, using a verification list with 16 items related to the preparation and carrying out phases and their consequences. In the Preparation Phase the answers have been through a dichotomic scale of Yes (criterion observance) and No. In the Performance Phase the answers have been through a scale in which the minimum value is 0 and the maximum value is 4. Zero value means that a nurse does not comply with the criterion that is being assessed and 4 value means that the nurse totally complies with the criterion being assessed. In the Results Phase the answers are again given by means of a dichotomic scale of Yes and No. The DINO result is a score that can vary between 0 and 16 points. The best score (16 points) corresponds to the carrying out of a safe technique (Johnsson et al, 2004).
After the participants informed consent, 40 observations in eight adult wards were carried out: Cardiology, Gynecology, Hemato-oncology, Medicine I, Medicine II, Medicine III, Orthopedics and Traumatology. In each ward five patient transfers were observed. In these eight wards there exist a total of 179 nurses. Each transfer was carried out by two nurses or by one nurse and a nursing aide orderly.
Immediately after the observation of each transfer and the filling out of the DINO checklist, were applied the questionnaires to gather information about the nurse's and the patient's opinion of the carried out transfer.

3. RESULTS AND DISCUSSION

3.1. CHARACTERIZATION OF THE TYPE OF PATIENT AND TRANSFERS

Characterizing the patient's dependency degree was carried out by resorting to the ARJO gallery integrated in IET (Fray & Hignett, 2009; Cotrim et al, 2011) (table 1).

Table 1 – Type of patients.

Patient Categories	Description
A	Mobility autonomous, independent but can use a cane for support as tires easily.
B	Can keep the balance and autonomous mobility to some degree, walker or similar uses.
C	Has some trunk stability and can withstand they weight partially in the lower limb, walks in a wheelchair, dependent on others.
D	It has no ability to support its weight independently, does not hold, and walks in a wheelchair.
E	Totally dependent, can be completely bedridden.

Patients were classified from A (autonomous) to E (totally dependent). Most of the observations were carried out in type B patients (partially dependent, who can walk on their own under supervision). Only 27,5% of the patients were totally dependent belonging to types D and E (table 2).

Table 2 – Distribution of the type of patient.

Patient type	Freq.	%
A	0	0%
B	20	50%
C	9	22,5%
D	4	10%
E	7	17,5%

Regarding the Type of Transfer carried out, we registered 5 different types of transfers: "Bed" – Arm Chair"; "Bed – Wheel Chair"; "Bed – Bath Chair"; "Bed – Standing" and "Arm Chair – Bed". The transfer "Bed" – Arm Chair" was the most observed one (45%), whereas the transfer "Arm Chair – Bed" was only observed in 17,5% of the time (table 3).

Table 3 – Distribution of the type of transfer

Type of transfer	Freq.	%
Bed – Arm Chair	18	45%
Bed – Wheel Chair	3	7,5%
Bed – Bath Chair	7	17,5%
Bed – Standing	5	12,5%
Arm Chair – Bed	7	17,5%

3.2. DINO RESULTS

The DINO results can be observed in the final scoring between a minimum of 8 and a maximum of 15. No result under the average value of scale (8) was found. The average result was 11,28 points (sd=4,99), which can suggest that the way in which the technical transfer was carried out might not have been the safest. When analyzing the results in more detail we verified that 65% of the observations had a satisfactory score (table 4), but 50% of the transfers were carried out with B type patients.

Table 4 – Distribution of the DINO scores

DINO scores	Freq.	%
8-10	3	7.5%
11-13	26	65%
14-15	7	17,5%

In the first phase of the task's preparation a number of items that make up 43,8% of the DINO's final score are assessed. In this phase, results showed that only in 2,5% of the transfers the patient was not encouraged to cooperate. In 35 observations there were enough space to the transfer performance (87,5%). In 9 of the transfers we noticed that the equipment to which the patients were transferred were not correctly positioned and blocked (22,5%) and in none of the observations the height of the bed was considered as being correct, as none of the beds height could be regulated. These last two factors led to a reduced final DINO score. Were still assessed the use of technical aids, and in 18 observations these were used and in all of them their use was the correct one (100%) (table 5). Frequently major barriers to safe patient handling are lack of adequate lifting equipment and lack of adequate space on patient care units (Bos et al, 2006; Dawson et al, 2008; Hignett et al, 2003; Schibye et al, 2003).

Table 5: Distribution of the preparation phase results.

Preparation phase items	Yes		No	
Is the patient encourage to cooperate?	39	97,5%	1	2,5%
Is enough space prepared for the transfer?	35	87,5%	5	12,5%
Are whellchair, and other objects that the patient is transferred between, positioned and locked in a correct way?	31	77,5%	9	22,5%
Is the heigh of the bed correct?	0	0%	40	100%
Are transferring aids used?	18	45%	22	55%
Are transferring aids used correctly?	18	100%	0	0%
Are there enough staff?	40	100%	0	0%

In the task's next phase (Performance Phase) we examined the factors related to team work, communication and interaction with the patient, back and shoulder load and the nurse's balance. These factors make up 37,5% of the final DINO score and are scored by means of a numerical scale the values of which vary between 0 and 4, the levels 0 and 1 corresponding to an unsatisfactory score and the levels 2, 3 and 4 corresponding to a satisfactory score.

The results showed: a good balance of the nurse in 39 observations with a satisfactory level (97,5%); a good team coordination in 39 observations with a satisfactory level (97,5%); and a good economy of movement effort with a satisfactory level in 39 observations (97,5%). The shoulder and back load was assessed as satisfactory in 35 observations (87,5%). The criteria for communicating and interacting with the patient was accomplished in a satisfactory way in 39 of the observations (97,5%) and the patient was allowed to totally participate or almost totally in the transfer according to his capability for carrying out voluntary movements in 39 observations (97,5%) (table 6).

To note that 12,5% of the care providers had an unsatisfactory score (≤1) for the item shoulder and back load. This can indicate that the patient transfers were done in awkward positions, thereby exposing these nurses to increased risk of musculoskeletal disorders.

Table 6: Distribution of the performance phase results.

Performance Phase items	Results				
	Median	Mean	sd	min	máx
Good balance	4,00	3,63	0,74	1	4
Good coordination	4,00	3,53	0,78	1	4
Good movement economy	4,00	3,38	0,87	1	4
Load on the back and shoulders	3,00	3,00	1,01	1	4
Are communication and interaction with patients criteria fulfilled?	4,00	3,40	0,87	1	4
Is the patient allowed to participate according to his ability to perform voluntary movements?	4,00	3,90	0,50	1	4

In the task's result phase we made an assessment of factors related to the patient, such as a display of the patient's pain, fear or uncertainty during a transfer, or if the patient remained in a functional position. The items made up 18,8% of DINO's final score. From the obtained results were verified that in 38 observations the chosen technique for carrying out this task did not cause any pain to the patient (95%) and in 37 observations the chosen technique did not cause feelings of fear or uncertainty (92,5%). But only in 25 observations did the patient remain in a functional position at the end of the transfer (62,5%) (table 7). The results of this last item are relevant because when patients don't remain in a functional position at the end of the transfer, staff has to reposition them again, representing an additional effort for them.

Table 7: Distribution of the result phase results.

Result Phase				
	No		Yes	
Did the transfer technique cause any pain to the patient?	38	95%	2	5%
Did the patient transfer technique cause any feelings of fear or uncertainty to the patient?	37	92,5%	3	7,5%
Is the patient in a functional position at the end of the transfer?	15	37,5%	25	62,5%

In what concerns the Patient's Opinion Questionnaire, that includes three questions regarding safety, comfort and dignity, only 22 answers were gathered, as the remaining patients were not oriented or did not manage to understand the questions.

The results showed that 68,2% of the patients considered that the transfer was carried out very safely and in a trustworthy way (figure 1), 81,8% considered that the transfer was very comfortable and with no additional discomfort and 90,9% considered that during the transfer their dignity and privacy were maintained to the highest degree. Nevertheless, 13,6% of the patients didn't perceive the transfer as safe (figure 1) and 9,1% reported it as uncomfortable. These results are in agreement with those collected by the task observation. Safety and comfort are aspects that patients rate frequently in transfer situations (Owen et al., 2002) and Kjellberg et al. (2000) state that there is a relationship between the work technique of nurses and patient perception of safety and comfort.

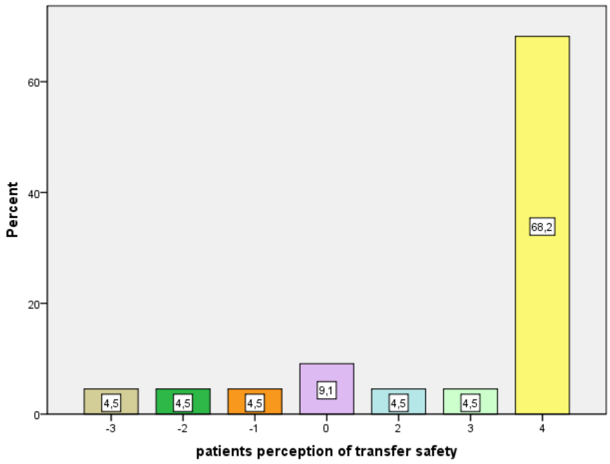

Figure 1: Distribution of patients' perception of transfer safety.

Regarding the Opinion Questionnaire of the Nurses who carried out the transfer, 97,5% of them considered that the transfers had been satisfactory and according to plan.

4. CONCLUSIONS

It is important to assess that nurses comply with safe working techniques (Hignett et al, 2003; Johnsson et al, 2004). DINO can be used to identify and assess an unsafe work technique and to register what items in the three phases are not performed in a safe way by nurses (Johnsson et al, 2004). Moreover, results from other studies indicate that by following the recommended technique one may expect a reduced risk of low-back disorders during patient handling tasks (Hignett et al, 2003; Schibye et al, 2003).

Considering the results obtained in the final DINO score we can conclude that this assessment was positive but several aspects were identified for improvement. These improvements will essentially depend on the variables with the lowest scores identified as critical factors influencing the final results. Other factors that might have influenced the results were the Type of Transfers, Type of Patient and Type of Ward in which the transfers were carried out.

As video recording of the patient handling tasks was not allowed, it was not possible to assess reliability, namely intra and inter rater reliability. In future studies reliability of the Portuguese version of DINO should be evaluated. Also, there were limitations with respect to representativeness of the sample and potential for bias.

To encourage safe patient handling it is needed assessment programs but also follow up training in order to meet the demands of the increasingly complex patient care needs and the changes in the workforce, explicitly the ageing process. As noted before, training when used independently have failed to reduce work-related injuries in nurses (Bos et al, 2006; Dawson et al, 2008; Hignett et al, 2003) but it is certainly an important strategy to take in account in a multidimensional intervention.

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Relationship between intensification of the activities and the work accidents on construction sites

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ABSTRACT
Currently, the construction companies are subject to enormous pressures to achieve the objectives of time and budget. However, this situation can result in the workplace unsafe and prone to work accidents because often, with the purpose of fulfilling the deadlines, is relegated to the background the implementation of measures of prevention of occupational hazards. In order to discuss the relationship between intensification of the activities and the work accidents on construction sites, a gathering process of the views of various construction stakeholders (public owners and private owners, contractors and designers/consultants) was performed, as part of a national survey on construction delays. It was found that the most respondents from stakeholders agree with the growing evidence of this problem. However, much believes that it is possible to conciliate the growing pressure imposed by compliance with deadlines, with the essential requirements for quality and safety through a more efficient coordination.

Keywords: Construction Management; Construction Delays; Activities Coordination; Construction Safety; National Survey; Stakeholders Perception.

1. INTRODUCTION

The failure of deadlines is a problem affecting a large part of construction projects and one of the reasons often suggested for the lack of competitiveness in the Portuguese construction and for which there is still no solution, probably because of its enormous complexity.

The consequences of failure to meet the deadlines are often severe and difficult to solve. Generally they cause injury to users, often reducing the profitability for the promoters, and a worsening of security conditions in the works.

Currently, the construction companies are under enormous pressure to achieve the objectives of time and budget of the works, since the market situation does not allow them to have a gap to overcome them. There is therefore a need to put a great effort in controlling the parameters conditioning costs and duration of construction work, which often involves the implementation of measures to recover delays, by strengthening human resources and intensive use of equipment. However, those measures could lead the workplace unsafe and prone to accidents at work because, often, for the purpose of compliance with deadlines intervals, if relegated to the background of the performance measures for the prevention of occupational risks. In addition, are known cases of high pressure on the contractors who often are not adequately prepared to manage the work under these conditions, leading to waste of resources in excess, failure of resources, issues of quality by negligence, disregard for the conditions safety of workers, etc. It follows therefore, that in many cases is at the expense of a great effort from the developer and main contractor that deadlines are met in the works. Unfortunately, often the most elementary rules of safety and health of workers are sacrificed in favour of deadlines compliance (Couto 2008).

In order to clarify this point, they have been gathering the views of main stakeholders in the construction (owners of public and private work, contractors and designers/consultants), under a national survey on the failure of time, in the program of a PhD thesis on construction project delays. It was found that most respondents of all groups of stakeholders agree with the growing evidence of this problem and considers the period of less supervision the most propitious to accidents. However, much believes nevertheless that it is possible to reconcile the increasing pressure imposed by compliance with deadlines, with the essential requirements for quality and safety through a more efficient coordination.

2. CONSTRUCTION SAFETY – STATE OF THE ART

In Portugal, the lack of security in the building construction remains a serious problem. There are still many shortcomings in the construction sites with dramatic consequences for workers and for society in general. Indeed, the social costs of accidents and health problems of workers is a load for future generations that it is imperative to minimize. In addition to the social harm of such high casualties, the cost of these accidents is enormous for workers, employers, for insurers and for the society in general (Sousa & Teixeira 2004). To the direct cost associated with it - including the medical treatment and financial compensation to which workers are entitled under the insurance or social protection systems - that will add indirect costs, which according to some studies may vary between 2 to 20 times the direct costs (Usmen 1994).

It is thus firmly ensuring that the costs of "lack of safety" and its effects not always easy to calculate, are one of the factors contributing to the lack of competitiveness of construction enterprises (CSO 2004).

Contrary to what happens with other areas of the construction management, as time, cost and quality, for the area of safety in construction, there is several information available, namely indicators of accidents in Portugal and its comparison analysis with other countries of the European Union. That information comes in big part from the obligations

of the Portuguese State with the International Labour Organization, and consequently from the requirement of the National Authority for the Working Conditions (NAWC), to disclose their activities annually.
Although a substantial improvement in recent years, where there is a downward trend (NAWC 2004), it appears that Portugal still has rates of occupational accidents in the construction industry very high and generally higher than those of other EU partners.
On the other hand, since the investment in safety and health only become visible after some time, it appears that are the Small and Medium Enterprises (SMEs) that have more difficulty in implementing those measures, mainly due to the lack of information and guidance provided to easily understandable, and the lack of capacity and skills to manage health and safety at work, and lack of resources to ensure training in this area (Table 1).

Table 1 – Fatal work accidents according to the company type in 2008 (NAWC) Information updated on December 15, 2008 (NAWC 2008).

Company type	Total	Construction	Percentage
1-9 Workers	48	24	42,9%
10-20 Workers	16	8	14,3%
21-50 Workers	23	12	21,4%
More than 50 Workers	27	12	21,4%
Total	114	56	

But more than the numbers of occupational accidents in construction, it is important to examine and investigate its causes and the ways of combating it. And for that analysis to be effective it is absolutely necessary to understand and characterize the current sector in economic and organizational terms. In particular and according to the NAWC the sector has been characterized by (Reis 2008):
• A proliferation of micro and small enterprises;
• Increased outsourcing;
• A lack of training of decision makers and employees;
• An environment of great economic competition:
  o Cutting costs;
  o Very demanding deadlines / intensification of rhythm and duration of work.
Regarding to labour, for the origin of the accident remains to be identified a combination of various reasons, usually interconnected according to following figure (Couto 2006):

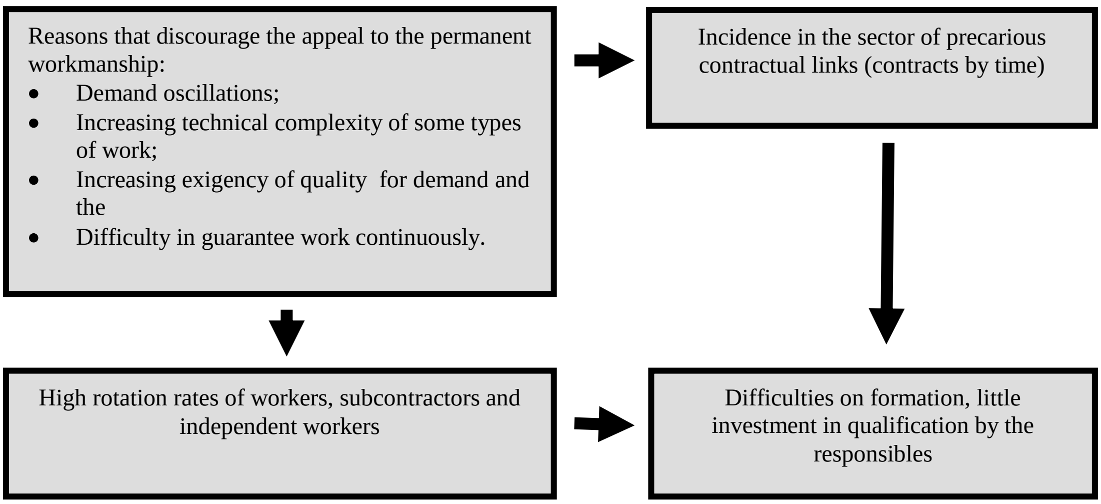

Figure 1 – Interconnection of the motives related with labour.

Similarly, in the agenda is another reason (or justification) that relates to the act of building. That is, each work is an unique product, strongly dependent on market demands, the architectural options and the geological conditions, weather and environmental factors that, therefore, and as such, is unlikely to play another time and place. Here may be one reason for that in the chapter on industrialization Portugal still has a ratio much lower than other EU countries. It is known that the construction and use of prefabrication, among other advantages, minimizes the work either in quantity or in time, and with it the likelihood of accidents.
Moreover, currently, the act of building includes a great diversity of stakeholders in the work, provided by the most diverse companies, to the consultants and staff, which often do not know each other, to the workers, subject to different contractual arrangements. This represents an increased risk of accidents and occupational diseases and has, in practice, to

remove any sense of the idea that prevention is the involvement of all actors in the act of building. But it aims beyond doubt, for the integrated management of safety, since the implementation of the project work to the coordination of effective and independent safety (Vieira 2006).
Besides the above, the NAWC also identifies the causes for work accidents, scheduling the timing inappropriate, the overlap of incompatible work, inadequate equipment and not regularly inspected or inadequate planning and lack of prevention (Reis 2008).

3. NATIONAL SURVEY ON CONSTRUCTION DELAYS

3.1. Survey Context

In Portugal, until recently, it was not known relevant studies on the causes of the failure of time in construction (although are discussed their consequences) (Couto & Teixeira 2005). However, the understanding of the causes can help control the problem.
It was recently carried out a national survey on the failure of time, conducted at the Centre for Civil Engineering, University of Minho, and inserted in the activity program of the doctoral thesis - "Construction projects delays" (Couto 2007).
The central objectives of the survey on construction delays were the analysis, understanding and classification of the causes for the failure of time, to gather and provide information that is relevant to develop and implement measures attenuators, strategies, management techniques and prevision the causes of delays in either stage development of the project during both the control and management, and thus provide more guarantees of success in meeting the deadlines in the construction contributing to the substantial improvement of the competitiveness of the Portuguese construction industry (Couto 2007).

3.2. Structure of the Survey

Apart from the central section on the analysis and classification of the causes of delays on its frequency and impact (Couto 2007) were also included two additional sections, one for analysis of the safety and working conditions with the times and a review of legislation and administrative procedures involved in the sector activity.

3.3. Selection of Respondents and Methodology of Implementation of the Survey

The construction companies were selected according to their classification by the National Office of Real Estate and Construction Markets (NORECM) (body responsible for regulating and issuing the permits). The engineering firms were selected from the list of members of the Portuguese Association of Engineering and Management Consultants (PAEMC), geographical location and speciality. The private owners were selected from the Association of Real Estate Promoters (AREP) and the public owners were selected from the main municipalities of the continent and islands, institutes, and other state agencies. In all processes of selection, it had in mind two things as essential: to ensure that the selection constituted a representative sample of the whole country and islands and, moreover, that would cross to the size range of participants and the works.
The implementation of the survey materialized in the form of a questionnaire sent to 100 contractors, 85 projects / 100 consultants and owners of work. To the respondents who did not respond on time, they were proposed, alternatively, to conduct an interview / survey.
The questionnaire was responded by managers or technicians with management positions in construction companies and owners of public works, engineering and consultancy offices, studios, directors of department of management and works, project managers and senior engineers (Couto 2007).
59 responses were collected from the contractors, 26 from designers/consultants and 79 of the owners of work (62 public and 17 private). It is noted that, as you may see in the following section, not all participants responded to the additional sections: although that, there was nevertheless a very considerable rate of participation.

3.4. Connection of Accidents at Work with Deadlines

This section was intended to clarify and assess the actual relationship of workplace accidents with the pressure to meet the deadlines in construction. Indeed, it was considered appropriate to describe briefly the problem in study, asking the respondents to indicate how far to corroborate it.

> *"Currently, the construction companies are subject to enormous pressures of time and costs which often involves the implementation of urgent measures, including strengthening of human resources and intensive use of equipment. We seek to recover or minimize the objectives set out the periods of delay, thereby causing the workplace unsafe and prone to accidents. Unfortunately it often neglect the issues of quality and sacrifice the most basic rules of safety and health of workers in favour of compliance with deadlines and dates of opening."*

The Figure 2 shows the results for the 56 responses received from contractors, 59 responses from public owners, 16 responses from private owners, and the 26 responses from designers and consultants.

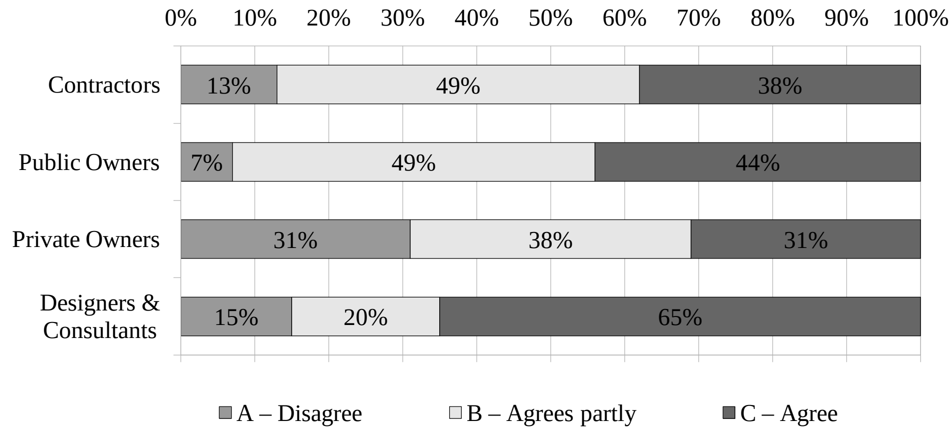

Figure 2 – Opinion of contractors, public owners, private owners and projectors/consultants, regarding to relationship of safety with the deadlines (Couto 2007).

As it can easily be deduced from the observation of the Figure 2, the majority of respondents agree fully or partly with the issue under review. It is also possible conclude that although the percentage of agreement (Agree partly + Agree) is the bigger for the public owners, the percentage of "Agree" is more expressive for the designers and consultants. For the private owners, the relationship of safety with the deadlines has little acceptance.

3.5. Reasons for the Increase in Accidents in the Weekend and Extra Hours

There are records that indicate that the frequency and severity of accidents are intensified in the weekend and in overtime. Asked about the possible causes for that, it was obtained the result expressed in the following chart (Figure 3) for a total of 54 responses from contractors, 61 responses from public owners, 16 responses from private owners and 26 responses from designers and consultants.

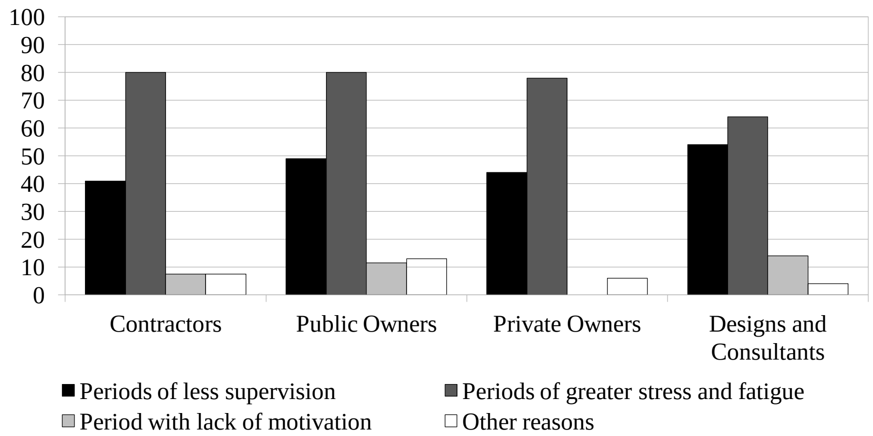

Figure 3 – Causes for the intensification of work accidents from the point of view of four groups of stakeholders surveyed (Couto 2007).

In this question the perception of the four groups is hardly coincidental. The fact that those periods of work resulting in less supervision and more fatigue, are considered the mains reasons for the increased frequency and severity of accidents.

3.6. Compatibility of the Rules of Safety and Quality with Time

In this section, the inquired were asked about if the pressure is increasingly required for compliance with deadlines and simultaneously to fulfil the requirements of quality and safety rules for cross paths conflicting and difficult to combine.
The following graph (Figure 4) shows the responses obtained for a set of 54 contractors, 62 owners of public works, 16 works from private owners and 26 designers and consultants.

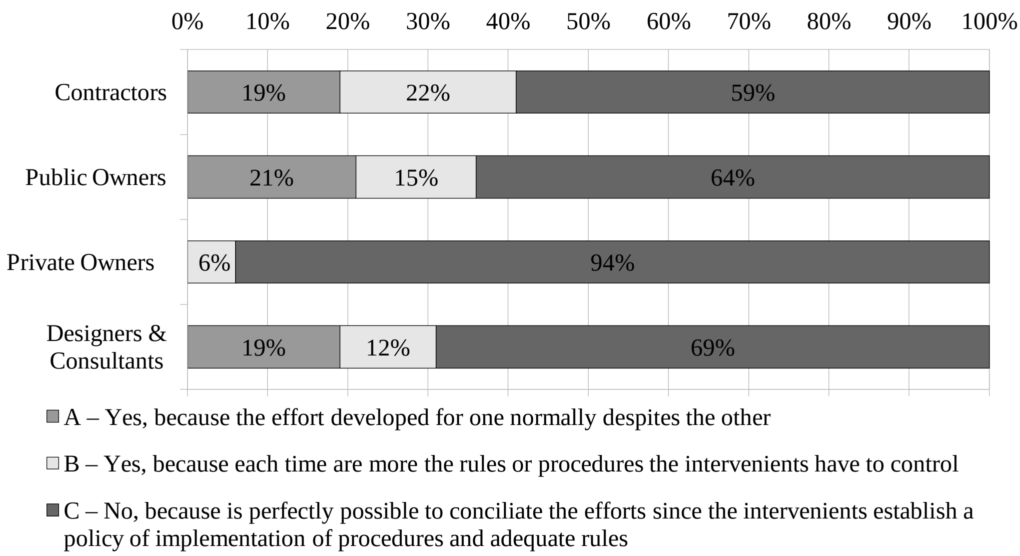

Figure 4 – Opinion of the four groups of respondents regarding the possibility of conciliation deadlines and rules of safety (Couto 2007).

For most respondents of the four groups, with emphasis on private owners (94%) and the designers and consultants (69%), it is possible to conciliate the demands of safety and time, since is established a policy for implementation of procedures and rules concerted and appropriate. It deserves still reference the lowest correlation of contractors (only 59%), probably the result of practical difficulties that have been felt.

4. FINAL REMARKS

The construction sector is strongly marked by a climate of great economic competition, which cuts costs and time very demanding, the intensification of the rhythm and duration of labour, became the determinants of competitiveness and "survival”. Moreover, the failure of time is one of the reasons often suggested for the lack of competitiveness in English building because of damages caused to users and developers.
In the other hand, among the main causes for work accidents, are referred by the local authorities, the phasing and timing inappropriate, the overlap of incompatible work, and lack or inadequate planning prevention.
The results of the study, except some differences "irrelevant" in this context, let possible not only to conclude that the various stakeholders agree that the time requirements influence the safety conditions at construction sites, but more importantly, that using a concerted approach on implementation of procedures and rules, it is possible to reconcile those two requirements.
Thus, in the current context, it is imperative that all stakeholders become aware of the importance of reconciling and combining of efforts to ensure conditions for the effective and widespread improvement in conditions of safety in the construction sites. This will put the country to converge to the levels of fatal accidents of other developed European countries and thus, provide a significant contribute to the substantial improvement of the competitiveness of the Portuguese construction industry.

5. ACKNOWLEDGMENTS

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Causes for the Failures on Safety in the Rehabilitation

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ABSTRACT
The needs of the country have made that in recent decades the maintenance and rehabilitation of cultural heritage, monumental and housing have been preterit to the new construction. However, as a result of a small bet on quality, a large part of the existing buildings shows needs of intervention. Moreover, the recovery and repopulation of the historic centres of cities is a national call. There is the perspective that rehabilitation arises not only as an attractive "market niche" but also as an important way to rationalizing existing resources. However, the rehabilitation projects management is often faced with various challenges and difficulties, to which is important to find answers. This study aims to analyse the main and specific constraints that hinder the fulfilment of safety conditions in the rehabilitation projects, and about which care should focus in order to mitigate the high level of accidents in this type of activity.

Keywords: Rehabilitation Investment; Safety Construction; Construction Management; National Survey.

1. INTRODUCTION

In recent years, to meet the country needs, there was a significant effort to build infrastructure and support housing. The maintenance and rehabilitation of cultural heritage, monumental and housing were long relegated to second plan. However, this effort in New Construction was not accompanied by a bet on quality, both as regards the type of materials and techniques used, whether the systems and processes for design and implementation of works, showing, therefore, now needs to intervene. It is therefore necessary to look to rehabilitation as an attractive "market niche" but also as a way to rationalize the existing resources.

The management of rehabilitation projects is often faced with various challenges and difficulties to which we need to find answers. Besides the unpredictable, often the result of lack of records, the works are normally performed by micro enterprises little prepared for the issues related to quality, environment and Safety and Health at Work (SHW). Since that investments in SHW only become visible after some time, it appears that are Small and Medium Enterprises (SMEs) that have more difficulties in implementing these measures, mainly due to lack of information and guidance provided in an understandable way, the lack of capacity and skills to manage SHW, and the lack of resources to ensure training in this area. The scarcity of resources and low technical skills of the workforce of these small companies, make them perform the work without planning, research and exploration of existing buildings. According to the National Authority for the Working Conditions (NAWC), among the main causes for accidents in construction are the burying and falls, two types of work often associated with activities developed by small contractors.

This work follows a dissertation carried out at the University of Minho concerning the optimal management of rehabilitation interventions, and aims to make a brief reflection on the progress of rehabilitation in Portugal, to warn for the main difficulties found in the management of rehabilitation projects and for the economic and organizational factors that characterize the construction industry and that appear recurrently associated with high accident rates. Based on information collected in a survey carried out among the 57 players involved in refurbishment activities, it is presented their view on main reasons for the lack of safety and proposed measures whose implementation will help to improve safety performance in this type of work.

2. EVOLUTION OF PORTUGUESE INVESTMENT IN REHABILITION

As mentioned above, the excessive construction in recent decades due to the needs of the country has meant that there is some negligence in relation to the quality of construction. According to a study in 2001 in Portugal (NSI 2001), of the constructions carried out between 1996 and 2001, about 10% needs repairs, of which 5.8% shows need for major repairs and 2.5% are very degraded. The same study also shows that, overall, about 1 million and 600 thousand (32%) of existing buildings require small and medium repairs and 326 thousand were very degraded and need for major repairs. This state of degradation is due, as mentioned above, to the poor quality of recent buildings, and mainly to the lack of rehabilitation and maintenance of existing buildings. Thus, if these buildings are not rehabilitated will be abandoned for lack of housing conditions, and thus will create a big problem for society in general.

Despite these evidences, in Portugal, the emphasis in rehabilitation is still low compared to other developed countries and with the average of European countries of Euroconstruct (43.1%), because only about ¼ of total investment in construction was, in 2007, directed to the Rehabilitation and Conservation.

As it can be seen from the detailed analysis in Table 1 and Figure 1, it was invested in the year 2007, 26,315 million for the work construction and rehabilitation, and 19,354 million in new construction, and 6,961 million Euros (26.6%) in Rehabilitation. It is also visible that it was invested more in the rehabilitation of residential buildings (4493 million) (17.1%) than in non-residential buildings (1192 million) and civil engineering works (1276 million) which denotes outset a clear disregard for the maintenance and preservation of non-residential heritage of the country.

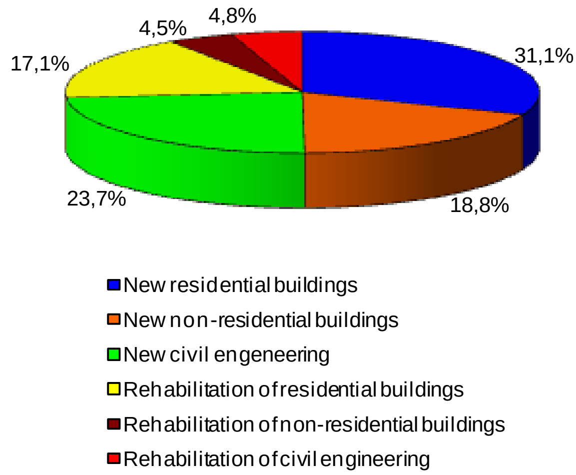

Figure 1 – Productivity of the segments of the construction sector in Portugal in 2007 (Euroconstruct 2008).

Table 1 – Investment in the construction market in Portugal in 2007 (Euroconstruct 2008).

Portugal 2007	Investment in million Euros	Percentage	Total
New Residential Construction	8179	31,1%	
New Non-Residential Construction	4937	18,8%	73,5%
New Civil Engineering	6238	23,7%	
Residential Renovation	4493	17,1%	
Non-Residential Construction	1192	4,5%	26,5%
Civil Engineering Renovation	1276	4,8%	
Total	26315	100%	

Figure 2 shows the evolution of the importance of the Rehabilitation and New Construction in the Construction Sector in Portugal since 2001 until 2010. There is a slight strengthening of the bet in the Conservation and Rehabilitation of Buildings on the New Construction, representing, however, a growth still insufficient to the needs of the country. In the graph is visible, a sharp rise in values between the year 2003 and 2004, which comes from the modification of the formulas for calculating the Technical Institute for the Construction Industry (TICI). By December 2004, the production sector of Rehabilitation was achieved through the sum of the construction of residential buildings, non residential and civil engineering works, on the basis of production reported by the construction companies. Since June 2005, at the Conference in Cardiff, it has been included in the calculation of investment in rehabilitation, other types of construction, including the DIY (do it yourself-self-construction) and the informal economy.

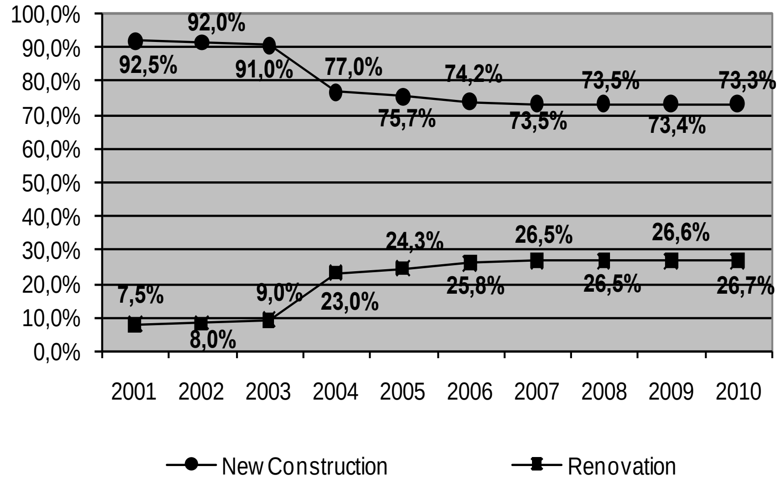

Figure 2 – Evolution of the importance of the Rehabilitation and New Construction in construction sector along the last decade (Euroconstruct 2004 & Euroconstruct 2008).

3. PORTUGUESE CURRENT SITUATION ON SAFETY CONSTRUCTION

3.1. Factors of Accidents. Characterization of Building in Economic and Organizational Aspects

As mentioned earlier, the Rehabilitation has long been a field of construction sector rather underestimated mainly for strategic reasons but also because it requires companies to work with great diversity, unpredictability and advanced technologies. Currently there are few companies specialized in this area. The works are still performed by micro enterprises that usually work for new construction, and are somewhat accustomed to the specific problems of this type of construction. These micro enterprises, in addition to insufficient clearance for the conduct of works of rehabilitation of buildings, are characterized by a reduced concern with issues of quality, environment and Safety and Health at Work (SHW). Lack of resources and low technical skills of the workforce of these small companies, makes them perform the works without planning, research and exploration of existing buildings, causing several problems during later works (Teixeira & Rodrigues 2005).

At the level of safety of workers, lack of exploration and analysis of the work, which involves performing rehabilitation works without conducting a risk analysis of accidents to workers and to adopt solutions and procedures to ensure appropriate safety. A study on the Safety and Health in Construction 2007 (Rodrigues et al. 2009), where was conducted a survey of participants in the rehabilitation works, indicates that only 35% of rehabilitation projects include safety measures to prevent risks in carrying out the work to be done. Thus it appears that there are still many gaps in compliance with existing legislation, leading to failure of appropriate measures to prevent risks at work, right from the design phase.

Moreover, the pressures on companies for to achieve their goals on time and final costs, makes them perform the work in a way too conditioned to these two objectives. The inefficient control of these two objectives requires the implementation of corrective actions to recover delays using more manpower and equipment. These measures, in addition to originate the workplace overcrowded and confused, increase the possibility of accidents and lead to neglect the implementation of preventive measures and safety of workers (Couto 2008).

Another major factor is the diversity of actors in work on behalf of several companies, consultants and technical staff, which often ignore the reality of working conditions of workers and their contractual arrangements. There is also large turnover of labour driven by large fluctuations in demand and growing demand for quality by the demand and difficulty in securing work in progress. Moreover, the construction sector employs many immigrant workers, from Eastern Europe and African Countries, which hampers the communication and enforcement of standards and security measures (Vieira 2006). These aspects have been crucial for a small stake in the business of training and qualification of their workers and staff.

Aiming to organize and systematize the information on this, the Authority for the Working Conditions (NAWC) said recently that the major factors contributing to accidents, and that characterize the construction sector in economic and organizational terms, are:

• The proliferation of small and micro enterprises;
• Strengthening the outsourcing;
• Lack of training of decision makers and workers; and
• The environment of great economic competition.

The last item leads to budget cuts and very demanding deadlines, with the intensification of the pace and duration of work. Besides these factors, the NAWC indicates other causes of accidents at work that characterize the sector, particularly (Reis 2008):

• The lack of security structures;
• The inappropriateness of the timing and scheduling of work;
• The overlap of incompatible work, inappropriate and not the equipment regularly inspected;
• Inadequate planning or the lack of prevention of safety; and
• The lack of protection or the use of false protections.

3.2. Consequences Analysis

Although the occurrence of fatal occupational accidents has been decreasing in recent years, including in the construction sector, as documented in Table 2, it can be seen that this sector continues to have the greater responsibility in such events (Araújo & Couto 2009). The Construction represents still about half of fatal accidents that occur in all sectors of activity in Portugal (see Table 2), highlighting the seriousness and importance of seeking solutions to reduce accidents at work in construction. From 2007 to 2008, there was a significant decrease in fatal accidents in construction but also in general industry. This decrease in the number of fatalities is most likely related to reduction of economic activity in Construction has been reflected in a lower volume of works in progress, while the percentage of fatal accidents in construction is close to 50%, that is, roughly equal to that of recent years.

Table 2 – Fatalities in the construction from 2004 to 2008 (NAWC 2008).

	2004		2005		2006		2007		2008	
	Total	Construction	Total	Construction	Total	Construction	Total	Construction	Total	Construction
Total of 12 Months	197	101	169	86	157	71	163	82	114	56
Percentage of Accidents in Construction	51,3%		50,9%		45,2%		50,3%		49,1%	

Through the analysis of Figure 3, can be verified that the fatalities in construction during the year 2008 were mainly caused by crush, fall height, impact with objects, burial and electrocution. Importantly, which causes such as crushing, drop height and burial are very related to the field of rehabilitation, where are performed activities such as demolition, basements, recovery of parts of the building in height (front), etc.. In general, the risk of work accidents is higher to the New Building (Egbu 1999), because they perform more complex jobs, with greater degree of risk to health and safety of workers.

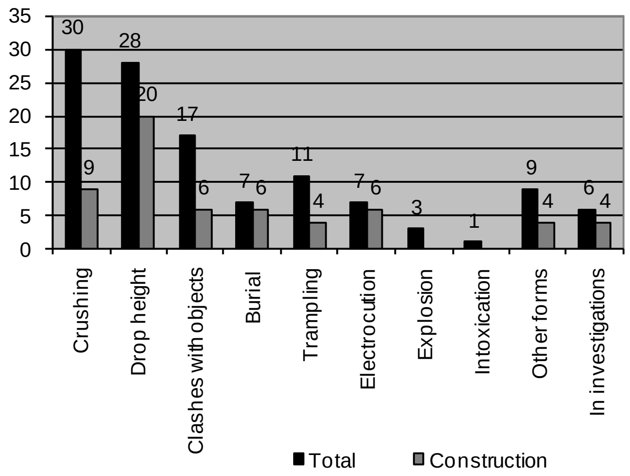

Figure 3 – Fatalities according to the causes, in 2008 (NAWC 2008).

As it can be seen from the analysis of Table 3 is at SMEs where there is the highest number of accidents, and they count for more than half of all fatal accidents that happen in construction. This may be justified by the difficulty in implementing the measures of safety and health due to the lack of information and guidance; to the problems of communication between different actors; to the lack of capacity and competence to manage the SST and the lack of technical resources to ensure training in the area (Couto 2008). As mentioned earlier, the field of rehabilitation is mostly developed by this type of companies, which reinforces the idea that this area is the most problematic in the construction, once all the interest is the development and usefulness of studies on the causes and solutions aimed to the reduction of accidents in Rehabilitation.

Table 3 – Fatal work accidents according to the company type in 2008 (NAWC). Information updated on December 15, 2008 (NAWC 2008).

Company type	Total	Construction	Percentage
1-9 Workers	48	24	42,9%
10-20 Workers	16	8	14,3%
21-50 Workers	23	12	21,4%
More than 50 Workers	27	12	21,4%
Total	114	56	

4. NATIONAL SURVEY ON MANAGEMENT OF REHABILITATION PROJECTS

4.1. Participants View

As part of a Master Degree Thesis carried out at the University of Minho, entitled "Optimizing the management of rehabilitation projects" (Araújo 2009), it was implemented a direct survey on the direct participants in the rehabilitation works. The process of gathering and bibliographic review has confirmed in one hand, the scarcity of national studies on the rehabilitation, probably because it is an area still under development in Portugal, but especially the lack of consistent

information and based on the problems associated with management processes and monitoring of such interventions. It Justified, therefore, a search that would help to understand this problem.
This process of inquiry was aimed to know, to order, and to characterize the main reasons for the failures in order to subsequently provide the basis for developing a set of measures to help to optimize the management of rehabilitation projects. Based on the existing literature on the reasons often associated with the failure of construction projects, and the results of a pilot study previously initiated adjacent to a limited number of participants in such projects, it was weighed and selected a set of 15 reasons considered the most adjusted and specific to such projects.
The survey was carried out to 57 participants in the rehabilitation works, divided by 10 owners, 20 designers and 27 contractors. The respondents occupy positions of leadership and management of enterprises and institutions distributed in mainland Portugal, and involved, especially in the area of rehabilitation.
Regarding the safety, it was set out to know the reasons that different groups of participants consider to be the most influential and important for the failures in that aspect of management. Following on, are ranked in order of importance, the main reasons for each group.

Owners ranking:
• Workmanship little qualified and specialized;
• Shortage of Technical Professionals in the process of work organizing and planning;
• Lack of research and observation of the area of intervention by the Contractor or inadequate inspection of the workplace.

Designers ranking:
• The limitations of the available space for the yard, because of the location of the works in urban areas;
• Workmanship few qualified and specialized;
• Lack of research and observation of the area of intervention by the contractor or inadequate inspection of the workplace;
• Poor coordination and communication between different participants in the work;
• Ambiguous projects, with errors, omissions, inadequate details, inconsistencies between different specialties, wrong design, etc.;
• The shortage of technical professionals during the planning and organization of work.

Contractors ranking:
• Workmanship little qualified and specialized;
• Poor coordination and communication between different participants in the work;
• The limitations of the available space for the yard, because of the location of the works in urban areas;
• The shortage of technical professionals during the planning and organization of work;
• Lack of research and observation of the area of intervention by the contractor or inadequate inspection of the workplace;
• Errors in design of the project due to ignorance of local conditions and the environment or the unpredictability inherent in the conduct of such work.

Table 4 presents a summary matrix with the 3 main reasons for each group of players, built from the data described above, and which allows analyzing and comparing the views of different groups on the subject under study.

Table 4 – Summary of the main reasons for the non fulfilments in the safety by group of participants (Araújo 2009).

Reasons for non fulfilments	Work Owners	Designers	Contractors
Workmanship little qualified and specialized	1	2	1
Shortage of technical professionals during the planning and organization of work	1	6	4
Poor coordination and communication between different participants in the work		4	2
Limitations of the available space for the yard, because of the location of the works in urban areas		1	3
Lack of research and observation of the area of intervention by the contractor or inadequate inspection of the workplace	3	3	4

As can be inferred from the analysis of Table 4, is almost consensual that the difficulties associated with the use of labour-intensive low-skilled, are the main reason for the non fulfilments in the security. However, the limitations of space do not deserve emphasis by the work owners which may indicate some underestimation of this, though for designers and contractors is an important conditionalism. It also highlights the fact that contractors assign the coordination and communication in work which will certainly result in a more effective control of its importance and consequences. The lack of research and observation of the area of intervention by the contractor was also considered important to ensure

appropriate security conditions at work, verifying for this cause a relative agreement between the various participant groups.
Beyond the analysis of the main reasons for the failures of the safety conditions of the works of rehabilitation, were presented to respondents six measures whose implementation will facilitate the objectives of safety in this type of work. It is intended that the respondents validate and rank them importance for the fulfilment of conditions of safety. The measures considered the most important were:
• Qualification of contractors, designers and technical staff in general;
• Diagnosis of the strict conditions of the building;
• Implementation Health and Safety Plans (HSP) specific for each work;
• Coordination of safety and efficiency of the planning and design phase.

5. CONCLUSIONS

In Portugal the emphasis in Rehabilitation is still low compared to other developed European countries, despite an increase in investment obtained between 2001 and 2010. The Rehabilitation works are usually performed by micro enterprises that usually work for new construction and are, somewhat accustomed to the specific problems of this type of construction. Despite the decline in the number of fatalities in the construction and rehabilitation, there is still much work to be done. Although the charges inherent to accidents are considerably higher than the direct costs of investing in measures to prevent the safety, this continues to be contoured or ignored by some companies in the Construction Industry in general and rehabilitation in particular. The benefit that could certainly come from a desirable strengthening of investment in Rehabilitation and preservation of existing assets, can never justify a sacrifice of safety conditions and the consequent increase in accidents. The particular difficulties that the management of Rehabilitation operations evidence must be the motto for a more accurate and thorough by the players. In this context, becomes more important the need for a bet on a policy of effective risk prevention, with the development of preventive and protective measures, and integrated management of safety, involving all participants, since the project to the work execution.

6. ACKNOWLEDGMENTS

The authors acknowledge the valuable and dedicated collaboration of all respondents.

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Occupational noise in buses

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ABSTRACT

The purpose of the present study is to assess the noise levels that the bus drivers are exposed during their activity. At the same time, was explored the influence of factors such as age, brand, occupation and type of windows of the vehicles, on the measured noise levels. It is a cross-sectional study where were measured the levels of LAeq and LCpeak in 35 vehicles that travel in routes in the city of Coimbra and nearby places. The measurements were made using a dosimeter. The mean values of LAeq, LCpeak and Lex,8h were, respectively, 76.59dB(A), 122.22dB(C) and 66.18dB(A). These results show that, on average, the exposure limit and values of action upper and lower, established by the Portuguese legislation (Decree-Law n.182/2006). This study did not establish the existence of a significant relationship between age and the vehicle noise levels. Vehicles with windows that allow the opening appear to be acoustically more comfortable than those whose windows do not allow the opening, but this factor also did not reveal a statistically significant relationship with the noise levels. Spectrum analysis of noise levels per frequency of octave band reveals the predominance of noise in the frequencies between 500 and 2000 Hz (speech) and, the lowest values, correspond to the frequencies of 31.5 to 200Hz and 4000 to 8000Hz (vehicle). The study revealed the existence of a clear relationship between the number of occupants and the measured noise levels. Although the noise levels do not exceed, on average, the limits prescribed by law, were very superior to the values recommended by World Health Organization (WHO).

Keywords: Bus drivers; occupational noise; occupational health; public transport vehicles.

1. INTRODUCTION

To facilitate the carrying of people, the most important services of modern society was discovered: public passenger transport. This apparent commodity transfers all responsibility of the driving to only one element, the driver (Portela, 2008). On this basis, any disturbance that occurs on the health of drivers, will influence their performance and can cause errors that will result in damage to their physical integrity as well as to the ones of passengers and pedestrians (Didon, 2004).

During their working hours, drivers must maintain a permanent state of alert that allows the interpretation of various information simultaneously. One of the peculiarities of the professional drivers career, which is: making it difficult to maintain this continued state of surveillance, is the constant exposure of professional noise from road traffic, which accounts for 80 to 90% of noise pollution (Silva & Mendes, 2005; Santos, Freitas & Picado-Santos, 2006). Professional drivers are highly exposed to high noise levels for extended periods of time (Majundar, Metha & Sem, 2008). These workers are daily exposed to urban noise, thereby enhancing the risk of hearing impairment (Silva & Mendes, 2005; Fernandes, Marinho & Fernandes, 2004).

The lack of maintenance of motor vehicles, the improper sound insulation of engines and exhaust pipes and the state of road pavements are the factors that most contribute to the worsening of the noise produced by the circulation of motor vehicles (Silva & Mendes, 2005; Freitas & Nakamura, 2002).

The noise caused by motor vehicles represents the largest proportion of noise pollution in urban areas (Majundar, Metha & Sem, 2008; Freitas & Nakamura, 2002; Zannin, 2008). It is possible to distinguish three different sources of noise produced by a motor vehicle: the engine, the interaction between the tire and the pavement and the aerodynamics of the vehicle. When traveling at speeds below 50km/h the noise from the engine and aerodynamics are the most significant. When traveling above this speed, the noise resulting from the interaction tire/pavement predominates (Santos, Freitas & Picado-Santos, 2006; Freitas, 2008; Guerra & Ruivo, 2009; Palma, 1999).

Being subjected to high levels of noise or prolonged exposure can lead to lesions of the inner ear. These lesions may have a temporary nature, as is the case of temporary deafness. This type of injury is minor, since the hearing ability is recovered after finishing the exposure to noise. However, the eventuality of more severe injuries may occur. A person continuously exposed to high noise levels may suffer the destruction of inner ear hair cells and this destruction leads to permanent loss of hearing (Majunder, Metha & Sem, 2008; Freitas & Nakamura, 2002; Ministry of Labour and Social Solidarity – Ministério do Trabalho e da Solidariedade Social, 2006).

Noise levels may be more or less harmful according to the frequency band in which they are. Another factor that influences the consequences of exposure to noise is one's sensitivity to this physical factor, since different people may reveal different effects when exposed to the same noise (Ministry of Labour and Social Solidarity – Ministério do Trabalho e da Solidariedade Social, 2006).

A study on bus interior noise, in the city of Curitiba, revealed that all drivers, during their working hours, were exposed to noise levels above 65dB(A). Even though under the legislation this figure does not justify intervention, it is considered uncomfortable (Zannin, Diniz, Giovani & Ferreira, 2003).

Workers exposed to high noise levels may report the sensation of ringing in their ears. This ringing is also called tinnitus, and it reveals a first indication of hearing loss (Ministry of Labour and Social Solidarity – Ministério do Trabalho e da Solidariedade Social, 2006). One third of occupational diseases correspond to hearing loss resulting from exposure to noise at workplaces (Ministry of Labour and Social Solidarity – Ministério do Trabalho e da Solidariedade Social, 2006). This occupational disease is usually called NIHL (Noise Induced Hearing Loss).

The public passenger transport driver career, in urban areas, is considered unhealthy and stressful (Portela, 2008; Zannin, 2008). It is possible to identify, in several studies, the relation between the age of the vehicles and the noise produced by them (Portela, 2008; Didoné, 2004; Zannin, 2008; Zannin, Diniz, Giovani & Ferreira, 2003). These same studies revealed that older vehicles are those that produce higher noise levels, and are therefore more damaging to the workers' health.

Drivers who have this profession for more years present higher levels of noise-induced hearing loss when compared with those who exercise this profession for less time (Majunder, Metha & Sem, 2008; Fernandes, Marinho & Fernandes, 2004; Torres, 2008; Cordeiro, Lima-Filho & Nascimento, 1994; Rodrigues, Filho, Costa, Hoehne, Péres, Nascimento & Moura, 2004).

For a driver, the engine of a vehicle represents the greatest source of noise (Freitas & Nakamura, 2002; Zannin, 2008). Several studies show that the rear engine position to the detriment of the front location is a benefit to the health and well-being of drivers (Silva & Mendes, 2005; Zannin, 2008; Zannin, Diniz, Giovani & Ferreira, 2003).

By comparing audiometric tests of professional drivers with the ones of office workers, it was revealed that the former were subject to more hearing problems caused by occupational exposure to noise (Majundar, Metha & Sem, 2008).

There are already several studies related to the issue in question, particularly as regards the relation between age of the vehicle / noise levels, duration of noise exposure / health effects. However, there are numerous factors that have not been fully exploited, and that may have an important role in this matter. Thus, throughout this study, in addition to the relation age of the vehicle / noise levels, it will also be explored factors such as the number of passengers carried and the existence of windows that can be opened.

Only a reduction of noise or of its excessive exposure can improve the quality of life of these professionals. In order to take measures for the protection of drivers of public passenger transport, it is necessary to first identify potential risk situations and identify the factors that positively and negatively influence the sound pressure levels in this context.

This study aims to assess the levels of noise to which these professionals are subjected during the course of their work, while exploring a number of factors, cited above, and their influence on the measured noise levels.

2. MATERIALS AND METHOD

This was an observational and transversal study, made in partnership with a public passenger transport company existing in the city of Coimbra.

The target population for this study corresponds to the vehicles that have routes throughout the city of Coimbra and nearby villages; the sample consists of 35 different vehicles. For the selection of the sample, it was chosen the convenience sampling method, having been taken into account the route traveled by the vehicle, restricting only to routes that have as their point of origin or destination the city of Coimbra, in particular the stops “Gare” or “Beira-Rio”. It were performed 16 measurements on Renault vehicles, 4 on Mercedes vehicles, 2 on Setra vehicles, 4 on MAN vehicles, 2 on DAF vehicles DAF, 5 on SCANIA vehicles, 1 on a Marcopolo vehicle and 1 on a Volvo vehicle.

To make it possible to determine the level of noise exposure to which drivers of public passenger transport are submitted to, the maximum C-weighted instantaneous sound pressure level (LCpeak), the equivalent A-weighted sound pressure level (LAeq), and the sound pressure levels at different octave band frequencies.

To carry out these measurements, we used a SVANTEK dosimeter, model SV102. Before the measurements, the dosimeter was calibrated, using the SV 30 gauge.

The measurements were performed on several routes, during normal circuits of traffic, all held on weekdays, during a period corresponding to school holidays. Noise levels were measured throughout the time period of the entire journey, from the beginning of the route to the final stop of the same.

The purposes of the study were explained to all employees involved, as well as their role in the development of said study and function of the dosimeter, highlighting the fact that it did not interfere with the performance of their work, and therefore they could carry out their activity normally. The equipment was placed in the assessed driver's shirt pocket and the microphone was placed on the collar, as close as possible to the right ear of the worker. The choice of the placement of the microphone was based on the intention to measure the sound pressure levels inside the vehicle, minimizing the effect of noise from outside.

After the collection of data through the dosimeter, these were transferred to a computer using the software SvanPC+ (version 1.0.21k) in order to allow further analysis.

Taking into account the different durations of the measurement period, depending on the length of the route, and given the need for the use of representative values of a normal working day (8 hours), the daily personal noise exposure

(LEX,8h) was calculated. According to the Decree-Law No. 182/2006 of 6 September, the Lex,8h is calculated using the following formula:

$$Lex,8h = LAeq,Te + 10\lg\left(\frac{Te}{T0}\right)$$

Where T_e represents the measurement time in minutes and T_0 represents the criterion time of 8h.

The Decree-Law No. 182/2006 sets the exposure limit value (Lex8h = 87 dB(A) and LCpeak = 140 dB(C)) and the of upper action (Lex8h =85 dB(A) and LCeak=137 dB(C)) and lower action values (Lex8h =80 dB(A) and LCpeak=145 dB(C)), determining a set of measures in case these values are met or exceeded. These values were used for the assessment of the noise levels measured.
We stress the fact that the value of daily personal exposure to noise is only representative of a working day of eight hours, if the driver, during that period of time, is permanently exposed to a LAeq level equal to the one used for calculations.
The data were processed using the SPSS 17.0 software. The following statistical tests were used for the analysis of the collected data: t-Student for independent samples, t-Student for a sample, Linear Pearson Correlation Test, One Factor ANOVA, all with a confidence level of 95%.

3. RESULTS AND DISCUSSION

Measurements of noise levels were made in different vehicles of different brands. Given the disparity between the numbers of measurements performed on each vehicle brand, it was not possible to apply a statistical test that would relate that variable with the measured noise levels.

Table 1: Vehicles Brands – Noise Levels

		Brand								
		Renault	**Mercedes**	**Setra**	**MAN**	**DAF**	**Scania**	**Marcop.**	**Volvo**	**Total**
LCpeak dB(C)	**Average**	**122.84**	122.78	**131.55**	119.63	119.95	120.84	118.00	117.60	122.22
	Standard Deviation	6.87	3.64	0.64	2.52	0.78	4.01	.	.	5.66
	Sum	16	4	2	4	2	5	1	1	35
LAeq dB(A)	**Average**	77.40	77.00	73.35	**71.78**	**88.15**	74.10	73.40	80.10	76.59
	Standard Deviation	3.95	5.37	4.17	1.48	19.73	0.87	.	.	5.90
	Sum	16	4	2	4	2	5	1	1	35
Lex,8h dB(A)	**Average**	67.13	67.08	64.25	**61.25**	**76.15**	63.20	62.20	70.10	66.18
	Standard Deviation	3.77	5.92	5.44	2.07	19.73	1.71	.	.	5.84
	Sum	16	4	2	4	2	5	1	1	35

Table 1 presents the mean values of LCpeak and LAeq registered in vehicles of different brands and the Lex8h values for the respective drivers, excepting the brands Volvo and Marcopolo, cases in which only the parameter value and not the average is presented. It is possible to verify, by reading the table above, that the LCpeak mean values were 122.22 dB(C), the LAeq mean values were 76.59 dB(A) and the mean values of Lex,8h stood at 66.18 dB(A).
For the LCpeak mean values, the MAN brand shows lower values and the Setra brand shows the highest. The parameters of LAeq and Lex,8h stood out as positive in the vehicles of brands: MAN, SETRA, Marcopolo and SCANIA. The remaining not listed brands of vehicles showed higher mean noise values when compared with those before. The brands MAN and DAF stood out, the first one because of the low values obtained and the second because of the high noise levels recorded.
In the analysis performed by the parameters LCpeak, LAeq and Lex,8h, it was given less attention to the first one, since it refers only to a maximum instantaneous sound pressure.
With the evolution of knowledge on the dangers inherent to the exposure to noisy environments, it have been developed several laws for the protection of human health. In Portugal, the Decree-Law No. 182/2006 specifies the minimum health

and safety conditions concerning the exposure of workers to noise in the workplace. In this statute are defined a set of values (exposure limit value, upper action value and lower action value) which, when reached, represent the need for preventive measures, aimed at safeguarding the health of the worker.

Table 2: Exposure limit values and action values

	N	Significance value	Average	Average difference	Standard Deviation	Reference value
$L_{Cpéak}$*	35	0.00	122.22	-17.78	5.66	140
	35	0.00	122.22	-14.78	5.66	137
	35	0.00	122.22	-12.78	5.66	135
L_{ex8h}*	35	0.00	66.18	-20.82	5.84	87
	35	0.00	66.18	-18.82	5.84	85
	35	0.00	66.18	-13.82	5.84	80

t-Student for a sample | * $p < 0.001$

By reading the data presented in Table 2, it was verified that the average of the obtained values is well below the legal limits established as a reference and there were no non compliance situations. However, through a separate analysis of the results, two measurements were detected in which the values exceeded the exposure limit established legally. In one of the cases the Lex,8h was 90.1 dB(A), in the other case the LCpeak was 142 dB(C). The exceptions made to the compliance of the legal limits were found in two vehicles of DAF and Renault brands, previously identified as the most "noisy" in the global average. However, it is emphasized that, according to World Health Organization, noise levels above 55dB(A) may cause discomfort, and above 70dB(A) may wear the body (Portela, 2008). Considering that the driver's profession requires consistently high levels of concentration, and that it is therefore crucial the full psycho-physiological well-being of the worker, the noise values obtained should not be regarded as excellent. These levels should be lowered as much as possible in order to improve the working environment of these professionals, promoting the comfort of passengers.

Table 3: Age of the vehicle – Noise Levels

		L_{Cpeak}	L_{Aeq}	$L_{ex,8h}$
Age of the vehicle	r	0.06	0.06	0.11
	p - value	0.75	0.74	0.54
	N	35	35	35

Linear Pearson Correlation Test

The noise measurements were made on vehicles with age ranges from 10 to 22 years. Table 3 shows the result that, given that in all cases the significance level was above 0.05, ascertained that there is no relation between the age of the vehicle and the noise levels provided through the parameters: LCpeak, LAeq, Lex ,8h.

Table 4: Age of the vehicle (stratified) – Noise Levels

	Age of the vehicle	N	Average	Standard Deviation	Confidence level of 95%	
					Lower limit	Upper limit
L_{Cpeak}	10 a 13	8	120.99	2.77	118.67	123.30
	14 a 17	17	122.79	6.87	119.26	126.32
	18 a 22	10	122.25	5.42	118.37	126.13
	Total	35	122.22	5.66	120.28	124.17
L_{Aeq}	10 a 13	8	77.51	10.03	69.12	85.90
	14 a 17	17	75.10	4.15	72.96	77.24
	18 a 22	10	78.37	3.73	75.70	81.04
	Total	35	76.59	5.90	74.56	78.61
$L_{ex,8h}$	10 a 13	8	66.70	9.57	58.70	74.70
	14 a 17	17	64.69	4.38	62.44	66.95
	18 a 22	10	68.30	3.74	65.63	70.97
	Total	35	66.18	5.84	64.18	68.19

One Factor ANOVA

The results for the different age groups of the vehicles show no statistically significant differences between groups, due to p>0.05. However, by analyzing Table 4, there is a slight tendency for the average noise levels to be higher in older vehicles, when compared to newer vehicles, including the parameters: LAeq and Lex,8h.

The lack of maintenance of vehicles associated with the age of the fleet, and the lowest technological development which characterizes older vehicles, contribute to an increase in noise levels. Until now several studies have been done that verify an association, more or less notorious, between the age of the vehicle and the noise levels it emits (Portela, 2008; Didoné, 2004; Zannin, 2008; Zannin, Diniz, Giovani & Ferreira, 2003). As in the study by Portela (2008), the results did not allow a clear statement of the relation between noise levels and age of vehicles. However, by comparative analysis of the mean values of LAeq, it was possible to perceive a widespread tendency to obtain higher values of LAeq in older vehicles when compared to newer models.

A variable characteristic of public passenger transport vehicles is the passenger windows configuration. Although all vehicles have windows, only a few have windows that can be opened. Table 5, relating to this characteristic, presents a comparison between the average levels of noise (for the parameters LCpeak, LAeq, Lex,8h) and the type of windows (that can be opened "Yes" or "No").

Table 5: Windows that can be opened – Noise Levels

	Windows	N	Average	Standard Deviation
L_{Cpeak}	Yes	25	121.86	6.03
	No	10	123.14	4.81
L_{Aeq}	Yes	25	75.58	3.58
	No	10	79.11	9.35
$L_{ex,8h}$	Yes	25	65.20	3.76
	No	10	68.63	9.046

t-Student for independent samples

Table 5 shows that the noise values for the parameters (LCpeak, LAeq, Lex,8h) in average are always higher in vehicles in which it is not possible to open the windows. That is, the average noise levels measured in vehicles with windows that can be opened is lower to the one of vehicles with windows impossible to open.

Although the data revealed had no statistical significance, it was found that models without opening windows, when compared with those with window opening devices, presented a more uncomfortable acoustic environment. This observation has generated some controversy, since, due to the lack of literature on this subject, the comparison of the results was performed using a study on the noise-induced hearing loss in bus drivers. In his study, Freitas (2004) detected the occurrence of NIHL in these professionals, being more significant in the left ear, which corresponds to the window side. This study allowed to attribute to the existence of windows opening to the outside the relation with outside noise, derived from traffic, vibration and movement of air masses.

The justification of this result may lie in a fairly common acoustic phenomenon, the reverberation. In closed areas with reflective surfaces, the sound waves emitted by the source are reflected reinforcing the original sound. For vehicles of public passenger transport, their "walls" are mostly made of glass (a smooth, hard, highly reflective surface) contributing to the occurrence of the refraction phenomenon (Matthew, 2008). For vehicles with windows that can be opened, there is a "breach" of that reflecting surface and the opening of the window represents a possibility of scattering sound waves to the exterior, therefore avoiding the cumulative effect of noise.

In studies related to noise in public transport vehicles it is not desirable to focus all attention on the characteristics of the vehicle, driver, roads, ignoring one of the factors that may contribute more to the results – the passengers.

Table 6 presents the results of the correlation between the variables: number of vehicle occupants and noise levels within the parameters LCpeak, LAeq, Lex,8h. By occupants of the vehicle we mean the number of passengers who were in the vehicle during most of the route. During the measurements the number of occupants ranged between 1 and 30. All noise parameters assessed (LCpeak, LAeq and Lex,8h) had higher mean values in vehicles with higher occupancy rate, which may be due to the dialogue developed between the various passengers.

Table 6: Relation Occupants – Noise Levels

		L_{Cpeak}	L_{Aeq}	$L_{ex,8h}$
Occupants	R	0.39	0.47	0.53
	p - value	0.02*	0.01*	0.00*
	N	35	35	35

Linear Pearson Correlation Test | * p < 0.05

It is possible to affirm the clear correlation between the number of occupants and the noise levels detected, since p<05 in the various parameters assessed.
Graph 1 illustrates the relation between the average noise levels (expressed in dB(A)) and its octave band frequencies (expressed in Hz). It is verified that in the frequencies of 31.5 Hz to 125Hz and in the frequencies of 4000 Hz to 8000 Hz are the lowest levels of noise and in the frequencies of 500 and 1000Hz are the higher noise levels.

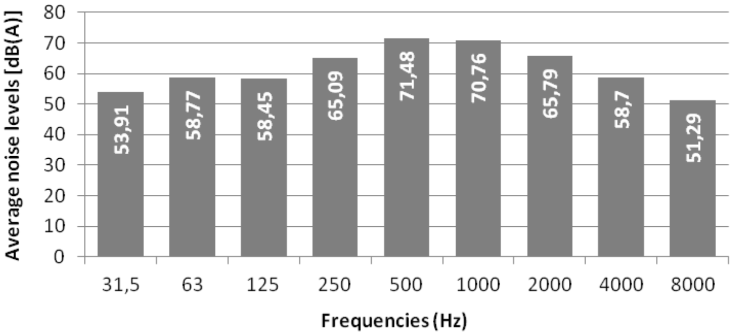

Figure 1: Noise levels in octave band frequencies

The analysis of noise levels by octave band showed higher values in the frequency range of speech, that is, from 500 to 2000 Hz (Medeiros, 1999). This result is consistent with the positive correlation between the number of passengers and noise levels recorded. However, it was not possible to establish any relation between the occupation of the vehicle and the levels of noise in the mentioned frequencies or in any of the other octave band frequencies.
Table 7 presents the results relating the noise levels in each frequency of an octave band with the age of the vehicle. It appears that at frequencies of 31.5 Hz, 63 Hz, 1000 Hz and 2000 Hz there is a relation between noise levels and the age of the vehicle, since p <0.05.

Table 7: Age of the vehicle / Occupation – Noise levels in octave band frequencies

		Frequencies								
		31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Age of the vehicle	**r**	-0.45	-0.35	0.05	0.28	0.33	0.44	0.47	0.29	0.23
	p - value	0.01*	0.04*	0.79	0.10	0.05	0.01*	0.01*	0.09	0.19
	N	35	35	35	35	35	35	35	35	35
Occupation	**r**	0.12	-0.15	0.04	0.16	0.12	0.27	0.28	0.33	0.29
	p - value	0.49	0.39	0.81	0.34	0.48	0.12	0.10	0.06	0.09
	N	35	35	35	35	35	35	35	35	35

Teste Correlação Linear de Pearson | * p < 0.05

By observing Table 7 it was not possible to relate the occupation of the vehicle with the noise values obtained by frequency, since all cases showed that p> 0.05, so there is statistically significant relation.
Didoné (2004) states that "the internal noise of cars consists of the portion of the structure that generates low frequencies and of air that contains high frequencies". On this basis, it can be stated that in the frequencies of 31.5 to 125Hz and of 4000 to 8000Hz concerning noise produced by the vehicle itself, are recorded the lower values.

4. CONCLUSIONS

The noise represents one of the biggest occupational hazards to which a large number of professionals from different areas are exposed. However, the driver's profession encompasses a number of factors and situations that hinder the maintenance of comfortable sound levels. Considering the location in which they work, a mobile place, with characteristics that change every second, and that the noise levels to which they are exposed are not only from the vehicle but from all the surroundings, thereby making difficult its control.
The study allowed the characterization of the acoustic environment inherent to the work of drivers of public passenger transport, and also allowed to identify some factors that influence the noise levels obtained.
One major issue that is common to several studies in the area of noise is related to compliance with legal regulations imposed on the activity in question. The evaluation of the results allows to suggest that the mean values obtained remained within the legal parameters. However, two situations occurred in which those limits imposed by national legislation have been exceeded. Although compliance with the legal limits, the values exceed the threshold of comfort defined by the WHO.

Most of the studies developed in the area of noise in buses relate noise levels with the age of the bus. Similarly to other studies, it can be argued that this one showed a tendency for noise levels to be higher in older vehicles; however, these data do not show statistical significance.
The influence of the type of windows of the vehicle on the noise levels measured showed a tendency to higher noise levels in vehicles with no windows impossible to open, which can be explained by the acoustic phenomenon of reverberation.
The factor influencing the levels of noise in public passenger transport vehicles that stood out the most in this study was the passengers. A clear correspondence between the number of passengers and the noise levels measured was obtained, and the bigger the number of passengers was the higher the noise levels were. This result was supported by the detection of higher noise levels in octave band frequencies related to speech.
In most situations, the results obtained did not permit statistically based, firm conclusions, although it is possible to denote some trends that point to certain conclusions. The enlargement of the sample could be a valid option to obtain results that are relevant from a statistical point of view thus substantiating conclusions of major importance.
This study made during a period of holidays limited the obtained results since the number of passengers was lower than what is usual over a year. It would be of great interest to carry out noise measurements on public passenger transport vehicles during the school period, thus enabling the research on a new situation and the investigation of the influence of the type of people transported to the noise values.
Various situations occur during the trips that directly affect the noise levels recorded, whether it is the entry of passengers, passing through a work zone or through a traffic lane with a degraded surface. Thus, it would have all the interest to conduct an analysis of the noise over time, allowing comparing any noise peaks with situations that occur in the corresponding time interval.
Factors such as the speed and the type of tires on the vehicle might influence the noise levels to which the driver is exposed. A study to evaluate the influence of these parameters could eventually provide highly relevant results.
The technological advances that have been done in the transport area are remarkable. All companies producing cars aim their excellence through continuous improvement of their vehicles, making them safer, more comfortable, and quieter. The comparison of noise levels produced according to the brands, although not significant due to the size and unequal distribution of the sample, allowed a glimpse of some tendencies of progress on the acoustics of the vehicles.
Taking into account that any fault committed by these professionals may have very serious repercussions not only for their physical integrity as for the others, the maintenance of healthy and safe working conditions for public passenger transport drivers should be a constant concern.

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Analysis and risk assessment of work-related MSDs in nurses and nurse assistants

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ABSTRACT
This work aims to present a risk analysis for musculoskeletal disorders (MSDs) for the activities of nurses and nurse assistants of a health unit in physical medicine and rehabilitation. A self-reporting questionnaire adapted from previous research, was administered to 9 nurses and 27 nurse assistants. Others instruments, such as MAPO index e REBA were applied. The results show that the prevalence of complaints and symptoms of MSDs is high in both the professional classes (91.6%). The high levels of complaints are anatomically distributed: upper (58.3%) and lower back (66.7%), shoulders (44.4%) and wrist(s)/hand (47.2%). The MAPO index, whose value score obtained was 4.76, indicates that the risk is moderate, meaning that one should consider an intervention in the medium and long term. The results of REBA score, derived from the analysis of different activities, are mostly classified in the high level of risk. Taking into account the risk analysis performed, several safety measures for the prevention of occupational risks were proposed such as construction/engineering measures, organizational measures and personal protective equipment. The results of this study identified and analyzed the existence of medium to high risk levels in the work context, requiring an intervention program in the short/medium term to prevent the occurrence of work related MSDs. Such program should respect the hierarchy measures proposed by international and national guidelines to mitigating risk.

Keywords: Nurse; Nurse assistants; Work-related MSDs; Risk analysis.

1. INTRODUCTION

Work-related musculoskeletal disorders (MSDs) are a group of inflammatory and degenerative diseases of the locomotion system, which result from professional risk factors such as repetition, force or awkward posture (Nunes, 2006; Queirós, 2008).

MSDs are a serious health problem among nurses and their assistants, resulting from tasks related with the mobilization of patients, such as lifting, transferring and positioning patients (Menzel, 2004; OSHA, 2009).

These disorders in nursing and nurse assistants are quite expensive and include indirect costs associated, for instance, with temporary hires for replacement personnel, overtime to absorb the duties of an injured worker, legal fees; time loss costs for claim processing; decreased output following traumatic event; training temporary and/or replacement personnel (Nelson & Baptiste, 2006).

It is commonly reported that nurses are exposed to a high risk of musculoskeletal disorders in the lower back due to patient handling. Recent evidence, however, suggests that nurses are exposed to the risk of musculoskeletal disorders not only in the lower back area but also in other regions of the body. The three highest prevalence rates of musculoskeletal disorders were found for the neck, shoulders and back, followed by the upper back, hands/wrists and knees/lower legs, then elbows/forearms, hips/thighs and ankles/feet (Daraiseh et al., 2003).

The main risk factors that workers in health face include: force - the amount of physical effort required to perform a task (such as heavy lifting) or to maintain control of equipment or tools; repetition - performing the same motion or series of motions continually or frequently; and awkward postures – assuming positions that place stress on the body, such as reaching above shoulder height, kneeling, squatting, leaning over a bed, or twisting the torso while lifting (OSHA, 2009).

The extreme positions taken during the care (Daraiseh et al., 2003), some aspects of work organization (e.g., shift work and the high number of patients), and other factors difficult to control, in particular patients morphological characteristics and inadequate architectural configuration of services and work circuits, among others, are also elements that can contribute to the development of MSDs (Alexandre et al. 2000; Castro, 2004; OSHA, 2009).

Manual lifting and other tasks involving the repositioning of patients are associated with an increased risk of pain and injury to caregivers, particularly to the back (Ando, 2000).

Despite the knowledge of these facts, efforts to reduce injuries associated with patient handling are often based on tradition and personal experience rather than scientific evidence (Nelson & Baptiste, 2006).

This work aims to present a risk analysis for MSDs in nurses and assistants of a health unit in physical medicine and rehabilitation, considering the activities which potentially present more predisposing risk for MSDs.

2. MATERIALS AND METHOD

The work was based on the use of a simple descriptive study, risk analysis tools, and descriptive statistics and qualitative results.

The sample consisted of 36 individuals, 9 nurses and 27 nurse assistants.

The work took place in two distinct phases, which are described next.
The first phase consisted in the application of a questionnaire that allowed the collection of general and biographical data of the sample population, information on incidents of work, identification of complaints and symptoms of MSDs (through the adapted Nordic Questionnaire), perceived risk of developing of MSDs and working conditions. It was also used the MAPO index (Movement and Assistance of Hospital Patients) (Battevi et al., 2006), which identified the level of risk of MSDs to the lumbar region, for activities associated with handling and transfer of patients. This risk is calculated based on factors such as the number of dependent patients and operators, space and presence of obstacles in bathrooms, space between beds, space between beds and walls, existence, adequacy and characteristics of equipment, as well as training and education for professionals in the use of such equipment.
In a second phase it was applied the observational method REBA (Rapid Entire Body Assessment) (McAtamney and Hignett, 2000), which is a qualitative method for whole body risk analysis that includes estimation of postures, force exerted and type of handle when moving loads. The analysis focused in the activities that potentially could be predictive of increased risk for MSDs, namely the transfer and moving of patients.

3. RESULTS AND DISCUSSION

The data collected (presented in Table 1) demonstrates that the perceived risk of MSDs of nurses and nurse assistants is high because the majority (94.4%) has either heard about MSDs and their risk factors. The source of knowledge was on job training (72.2%); discussing among peers (30.6%); books, journals or papers (25.0%); academic education (22.2%) and other sources (11.1%) which includes medical visits.

Table 1 – Source of knowledge about MSDs

Source of knowledge about MSDs	% of sample
Academic education	22.2
On job training	72.2
Discussing among peers	30.6
Seminars and lectures	5.6
Books, journals or papers	25.0
Others	11.1

The results show that the prevalence of complaints and symptoms of MSDs is high in both professional classes. A total of 972 days of work were lost, in the year 2010, as a result of work accidents. The occurrence of work accidents has higher incidence in nurse assistants. The accidents by falls (37.5%), together with the MSD (37.5%) top the causes for absenteeism.
Regarding the self-perception of risk factors for development of MSDs and the association of these with the work and activities, the nurses and nurse assistants refer the following factors: shortage of work spaces; lack of material and auxiliary equipment to assist in activities that require physical effort; work surfaces too high or too low; beds, chairs and other equipment difficult to move; mobilization and manual positioning of patients; transportation and manual handling of patients, equipment and other objects; reach and sustain weight (or objects and people) away from the body; storage of heavy objects in places too high or too low; little rotation of workers among the most physically demanding tasks; lack of work breaks when needed; and often, beds, wheelchairs, chairs have wheels in poor maintenance condition.
In the past 12 months, the presence of musculoskeletal complaints, self-reported pain and/or paresthesias and musculoskeletal symptoms was expressed by 91.6% of the sample population.
As shown in Table 2 a total of 13.9% of the individuals was prevented from performing functions, in the last 12 months, due to MSDs. The anatomical distribution of higher levels of complaints is as follows: lower (66.7%) and upper back (58.3%), wrist/hand (47.2%) and shoulder (44.4%).
The level of pain in the last 7 days, which was measured on a scale of 0 to 10, is presented in Table 2 for all anatomical regions. The lower back has the highest average value (3.2), followed by the upper back (2.8) and wrists/hands (2.4).

Table 2 – Observed prevalence rates for musculoskeletal problems (n = 36)

Area of body affected	Occurrence in last 12 months % of sample	Unable to work in last 12 months % of sample	Pain occurrence in last 7 days
Neck	33.3%	-	1.6
Shoulder	44.4%	2.8%	2.1
Upper back	58.3%	-	2.8
Elbow	22.2%	2.8%	0.7
Wrist/hand	47.2%	5.6%	2.4
Lower back	66.7%	-	3.2
Hip/thigh	36.1%	2.8%	1.6
Knee	27.8%	-	1.3
Ankle/feet	33.3%	-	1.6

The MAPO index used for assessing the risk of patient manual handling in hospital wards was calculated according to the following mathematical expression:

$$MAPO = (NC/Op \times LF + PC/Op \times AF) \times WF \times EF \times TF$$

Where the factors are: Disabled patient (NC - "totally non-cooperative patients" and PC - "partially cooperative patients")/Operator (Op) ratios; Lifting factor (LF); Minor aid factor (AF); Wheelchair factor (WF); Environment factor (EF) and Training factor (TF).
The score value obtained for the MAPO index was 4.76, indicating that the risk is moderate (Table 3). This means that an intervention should be considered in the medium and long term.

Table 3 – Calculating the MAPO index

NC/Op	PC/Op	LF	AF	WF	EF	TF	MAPO Score
0,76	1,19	4	1	0,75	1,5	1	4,76

On the other hand, the use of the REBA method, whose range varies between 1 and 15, allowed a rapid evaluation of potential activities performed by nurses and assistants that present risk for MSDs.
In this study, the activities evaluated were: transfer from bed to shower chair; transfer from shower chair to wheelchair; transfer from chair to wheelchair; transfer from wheelchair to bed; transfer from chair to bed; transfer from litter to wheelchair and positioning of patients in bed (Figure 1).

Figure 1 –Different activities evaluated: 1) Transfer from bed to shower chair executed by two assistants; 2) Transfer from wheelchair to bed executed by nurse 3) Positioning of patients in bed executed by nurse and assistant

The mentioned activities are executed by both professionals at any time. However, repositioning of patients in bed is an activity more frequent in the night shift. Tasks like vertical transfers of patients, positioning in bed and chairs, and toileting are executed more frequently in the morning and afternoon shifts.
The results of the REBA method are presented in Figure 2. The results present the average of the individual results obtained from the analysis of different activities, ranging between 4 and 11, corresponding to medium (4-7) to very high (11-15) risk levels. Since a majority of the average results reach the high risk level (8-10), most of the activities require a prompt intervention for mitigation of risk.
The high REBA results result from a combination of factors such as bad posture, patient's weight, sudden movements, poor latch and significant changes in posture or unstable postures.

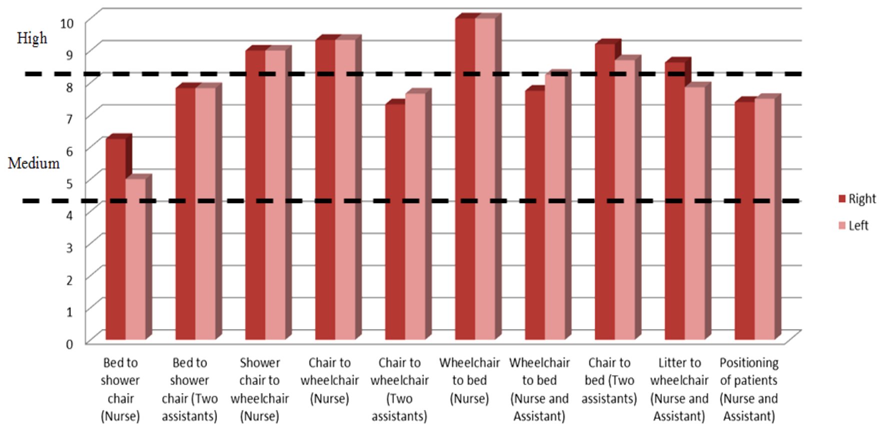

Figure 2 – REBA results regarding the analysis of different activities

Descriptive statistical analysis concluded that there is not a statistically significant association between the variable complaints and musculoskeletal symptoms and age ($\alpha = 0.77$) and duration of work ($\alpha = 0.47$). The analysis showed that there is a statistically significant association between the variable complaints and musculoskeletal symptoms and weekly working hours ($\alpha = 0.02$). The value of Pearson's correlation ($\rho = 0.52$) signs a moderate positive correlation, between load and complaints and musculoskeletal symptoms. This means that the higher the load, the greater the number of employees with complaints and musculoskeletal symptoms.

The complete hazard elimination on health units would be a utopian preventive action, because it is impossible to avoid direct exposure of workers to risk of manual handling task. The mechanization of the moving people task in health care is very difficult to implement. On the other hand, factors like humanization, respect and comfort are the cornerstone of health care. In fact, there are studies that refer patients discomfort because of the use of mechanical equipment in mobilization (Nelson et al, 2004).

Taking into account the risk analysis performed several safety measures for the prevention of occupational risks were proposed. The measures were ranked according to the Portuguese Law n.º 102/2009, from September 10th, the Portuguese Standard NP 4397:2008 and British Standard BS 8800:2004. Table 3 presents the proposed safety measures.

Table 3 - Safety measures proposed

Construction/Engineering Measures	Organizational Measures	Personal Protective Equipment
Acquire of a lift patient transfer Replace hydraulic/manual articulated beds by electric articulated beds Equip all beds with trapeze support of patients Increase the width of the doors of toilets and bathrooms Install anti-slip floors on patients' hygiene areas Remove unnecessary fixed obstacles Acquire new wheelchairs, sliding sheets of low friction fabric, ergonomic belts, rotating calipers Replace damaged and poorly maintained equipment, such as: new wheelchair, casters of chairs and beds, and hydraulic beds	Introduce relaxation sessions and fitness program Promote an adequate staff rotation during the work week Adequate the distribution of patients according to the degree of dependence Promote activities outside work that encourage teamwork and team spirit Ensure proper maintenance of all equipment Train personnel on manual handling Train personnel on transfer and positioning of patients	Acquire anti-slip orthopedic shoes

4. CONCLUSIONS

There is extensive literature indicating that the nurses and nurse assistants are professional classes who, because of the uniqueness of the functions they are responsible for, have actual risk of developing MSDs.

This paper describes a study combining several methodologies, which was conducted on a sample of 36 individuals working in a physical medicine and rehabilitation clinic. The results of this study identified and analyzed the existence of medium to high risk levels for MSDs in the work environment, calling for an intervention program in the short/medium term to prevent the occurrence of work-related musculoskeletal disorders. Such program should respect the hierarchy of measures proposed by international and national guidelines to mitigate MSDs risk.

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Integrated Management Systems: On the path to maturity and efficiency assessment

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ABSTRACT
The results from an online survey focusing Portuguese integrated management system (IMS) ruled companies are presented in the present article. These are partial results from an ongoing project aiming the maturity rating and assessment of IMS and companies where implemented. Surveyed companies match partially the national Portuguese profile, namely, on geographic location and company dimension characteristics. Results suggest that motivations, benefits and obstacles related to integration are internal or mainly internal. A sequential over a *step by step* or "all in" integration sequence as been reported as the most common one among the surveyed companies. Integrated audits seem to be the model adopted by the majority of the companies. Systems managers found implementation sub-systems standards easy or, at least, reasonably easy, to integrate. A major dividing point between surveyed companies is related to the identification of organizational items not susceptible of being integrated. Approximately 55% of the surveyed companies identified those items while 45% did not. Systems managers' majority did not felt that an ultimate excellence level of integration had been reached by their companies but rather a high integration level corresponding to common organizational structure plus policies and goals, management tools and documental integration. All respondents felt that the overall company performance would be lower (79%) or at least equal (21%) if running through separate management sub-systems. Almost totally agreed that IMS is an add value to the company. Related to responsibility it seem that companies option rely on traditional pyramidal model with an IMS coordinator and a QMS, an EMS and/or an OHSMS sub-systems responsible providing feedback. Finally, process, operations and management monitoring was assessed by the survey. Almost all companies agreed that monitoring was performed by key process indicators (KPI's), operations process indicators (OPI's) or management process indicators (MPI's). Similar results were found when asked about integrated indicators.

Keywords: IMS; Survey; Maturity.

1. INTRODUCTION

Integrated management systems (IMS) subject had been addressed by several authors since the early nineties of the last century, mainly due to the ISO 14001 release and the potential synergies that could be developed with ISO 9001 standard (published in middle eighties).

Recently, Asif *et al.* (2010) proposed a novel systematization scheme regarding IMS focused literature. On a national level, several papers have been published focusing IMS, namely those authored by Santos *et al.* (2011), Sampaio *et al.* (2010, 2011) and Domingues *et al.* (2010a,b, 2011a-e). Sampaio and Saraiva (2011) published the latest Portuguese data related to IMS (Figure 1 and 2). Those results show that the majority of the organizations with an IMS are located at the North, Centre and Lisbon regions. Regarding the IMS typology it seems possible to conclude that ISO 9001+ISO 14001 and ISO 9001+ISO 14001+OHSAS 18001/NP 4397 are the most reported options.

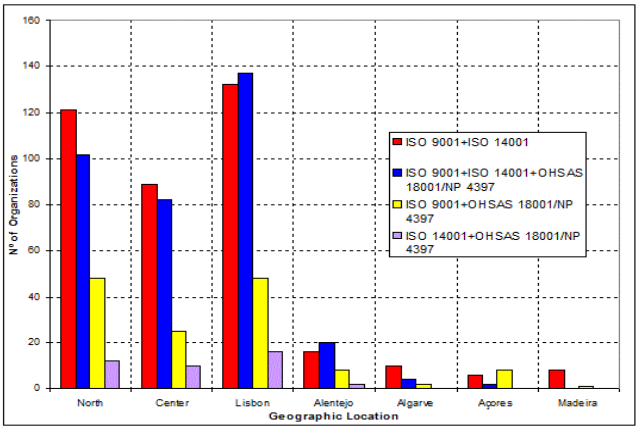

Figure 1- IMS data per NUT II Region and Typology

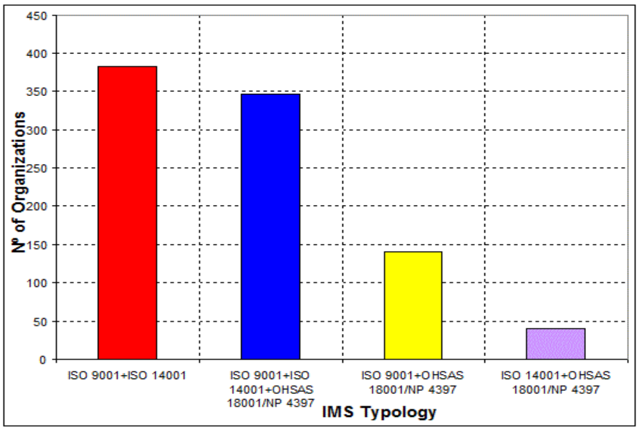

Figure 2- IMS typology data

Maturity assessment regarding products or systems had been described in several papers and it is currently a widely accepted methodology to comparatively ascribe an evolutionary level to the focus item. Thus, maturity models enable to

pinpoint the way to go (and which requirements should be complied) in order to achieve an ultimate and last excellence level. Khoshgoftar and Osman (2009) summarized the main characteristics of the most reported maturity models. Domingues *et al.* (2011e) reported a framework proposal regarding IMS maturity assessment based on published papers (Table 1) and Idrogo *et al.* (2011) a model focused on SMEs.
Maturity model development, due to its comparative and empirical nature, should rely mostly on data collected from the focus item. It is intended that the current paper report preliminary raw results from an ongoing project focusing the maturity and efficiency levels assessment of IMS.

Table 1- Framework proposal and key-process areas (KPA's) (adapted from Domingues et al., 2011e)

Level 1	Level 2	Level 3	Level 4	Level 5
Uncertainty	**Awakening**	**Enlightenment**	**Knowledge**	**Certainty**
External motivations, non-integrated policies, solely documental integration, residual authority, lack of training to top management	Integrating factor, sequential audits, massive QMS, integrated objectives	Tools, methodologies and objectives alignment; Simultaneous audits; Integrated vision by Top Management; *Step by Step* implementation process.	Management procedures integration, internal motivations, overlapping audits, IMS responsible, *All-in* implementation process, CPI, OPI and KPI indicators, organizational interactions.	Integrated indicators, organizational interactions assessment, integrated audits, integration based on a guideline or framework.

2. MATERIALS AND METHODS

An online survey with 30 questions, based on a questionnaire, was held focusing Portuguese organizations with more than one certified management sub-system according to the following standards: ISO 9001, ISO 14001 and OHSAS 18001/NP 4397. The survey was conceptually supported on a Likert type scale, categorical and multiple option answers. A pre-test performed on three companies was used to validate the questionnaire (Table 2). The results reported in the present paper were supported on 52 validate answers given by management systems responsible during the period between 01-07-2011 and 01-11-2011.

Table 2- Questionnaire Scheme

Section	Main topics
Company Characterization	Q1-Q4: Activity sector, nº of employees, geographic location and IMS typology.
Likert Scale perceptions assessment regarding common sub-systems requirements	Q5-Q20: Policy, top management commitment, integration concept, bureaucracy, goals and methodologies alignment, vision, management procedures, sub-systems interactions, integration process guideline, documental integration, OHS and Environmental responsible authority, add-value IMS, integrated objectives, IMS authority, indicators and integrated indicators.
Perception assessment between non-integrated to integrated performance	Q21-Q23, Q25: Add-value, performance comparison, integration levels.
Specific company characterization regarding IMS	Q24: audits typology, Q26: Integration sequence
	Q27: Non-integrable items identification
Motivations, benefits and Obstacles	Q28-Q30: Motivations, benefits and obstacles

3. RESULTS AND DISCUSSION

3.1. Surveyed Organizations Characterization

Figures 3 to 6 summarize the parameters chosen to characterize the surveyed organizations. Geographic location of sampled organizations (Figure 3) matches Portuguese certified organizations reality (Figure 1). Regarding to IMS typology (Figure 5) the correspondence is not so clear considering data reported on Figure 2. Figure 4 report the results regarding to organizations dimension (nº of employees). Santos *et al.* (2011) reported that Portuguese industry consists mainly of SMEs, making up 75% of the total labour force. Thus, at the moment, the surveyed organizations do not match the Portuguese reality being organizations dimension, related to nº of employees, higher than 100 workers (Figure 4).

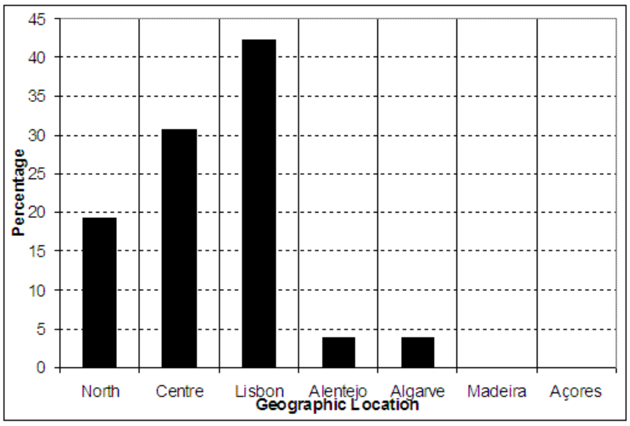

Figure 3- Location per NUT II Region

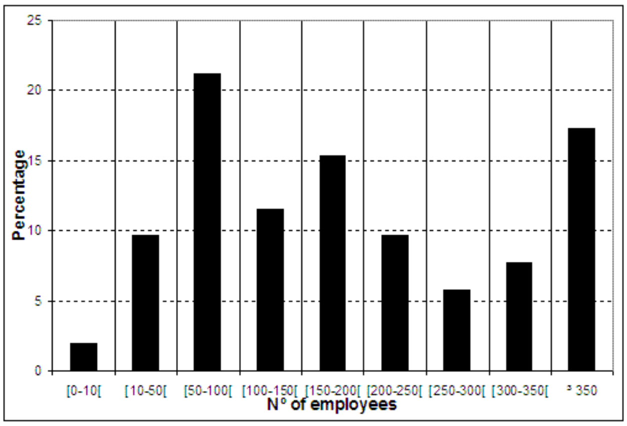

Figure 4- Organizations dimension (nº of employees)

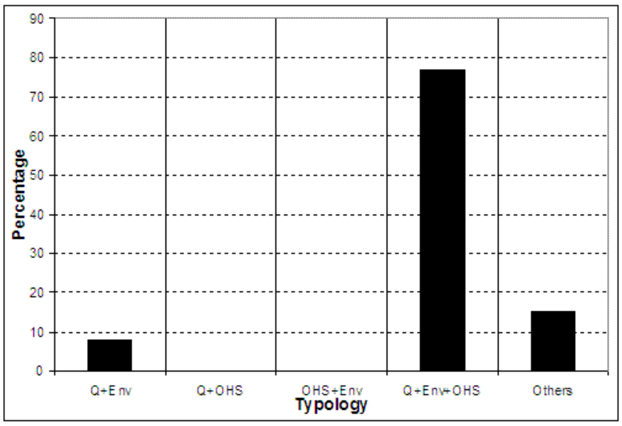

Figure 5- IMS Typology

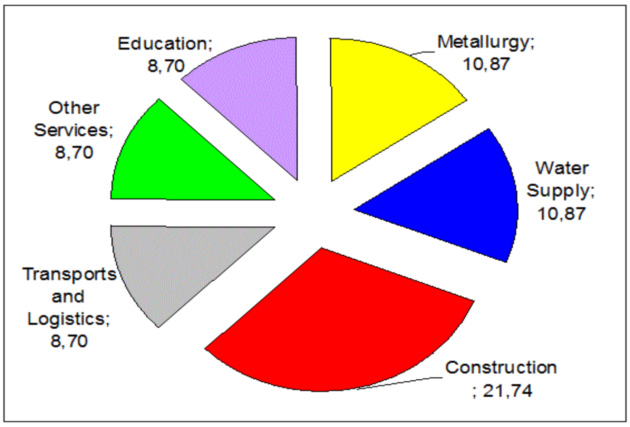

Figure 6- Main activity sectors surveyed

3.2. Motivations, Benefits and Obstacles

Internal or mainly internal motivations, benefits and obstacles were reported by organizations related to the integration process (Table 3). Several authors classified internal motivations as the *true* ones enhancing and promoting the most beneficial organizational outputs. Improvement of the organizational performance has been identified on companies mainly driven by internal motivations. Companies driven by external or mainly external motivations experienced higher external acceptance improvement and external requirements compliance but a positive correlation with internal improvement performance on their processes had not being reported.

Table 3- Motivations, Benefits and Obstacles regarding IMS implementation process

Type	Motivations	Benefits	Obstacles
Internal	23%	17%	44%
External	2%	4%	6%
Both, but mainly internal	52%	64%	42%
Both, but mainly external	23%	15%	8%

3.3. Integration Sequence and Audits Typology

An *All-In* or *Step by Step* (sequential) integration sequences were identified earlier in literature review. Results presented at Figure 7 suggest that a *Step by Step* integration sequence has been the option chosen by almost 65% of the sampled companies. This fact could be related to the company *life cycle*, that is the availability of management sub-systems standards at the moment when the decision to proceed with integration process was assumed. A *Step by Step* integration sequence and its organizational outputs have been addressed elsewhere (Domingues *et al.*, 2011d). Hence, decision degrees of freedom were lesser to companies which decided management systems certification when a single standard had been released.

When performing an audit under an IMS context several strategies could be followed, namely, sequential, overlapped, simultaneous or integrated. The nature of these strategies could be found in more detail at Domingues *et al.*, (2011c). Overlapped audits have not been reported by any of the sample companies as we may see in Figure 8. Reported audits typologies were integrated (75%), simultaneous (21%) and sequential (4%).

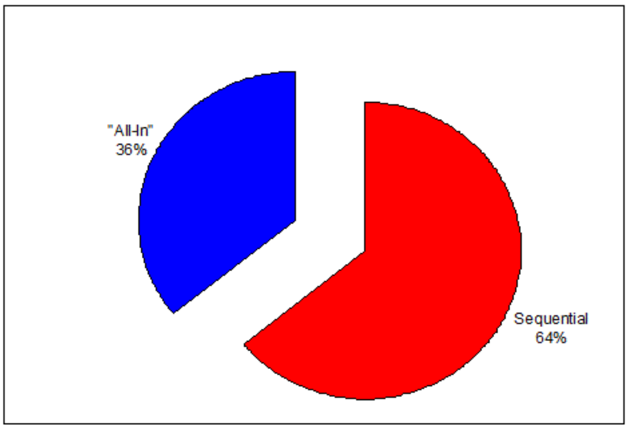

Figure 7- Integration sequence

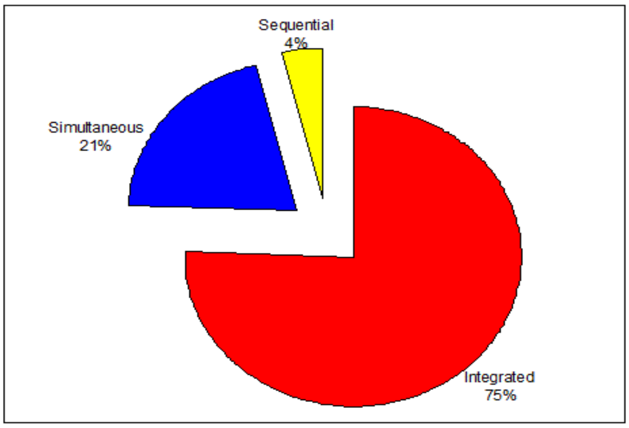

Figure 8- Audit typology

The analysis of Figure 9 shows that systems managers consider that standards integration, namely ISO 9001, ISO 14001 and OHSAS 18001 is easy or, at least, reasonably easy. In fact, noticeable efforts emphasising standards compatibility had been developed by ISO in last revisions. Regarding the identification of organizational items not susceptible of integration (Figure 10) a major division is detected. Nearly 55% of the companies identified items not susceptible of being integrated while almost 45% of the companies did not.

Figure 9– Sub-systems standards integration

Figure 10– Identification items not susceptible of integration

Figures 11, 12 and 13 relates with the perceived integration level achieved by companies. Only 4% of the surveyed companies considered a documental based integrated management system (Figure 12). This in accordance with results of Figure 11, that is, 4% of the respondents considered their management systems as low integration level. The common organizational structure (plus (1), (2) and (3)) option was chosen by 86% of the companies. Curiously, this model is not perceived by the companies as being the ultimate excellence integration model since just 6% of them thinks their management systems achieved the total/maximum integration level (Figure 11). Figure 13 suggests a reasonable relationship between IMS organization classification and integration level perceived, that is, results expressed in Figures 11 and 12.

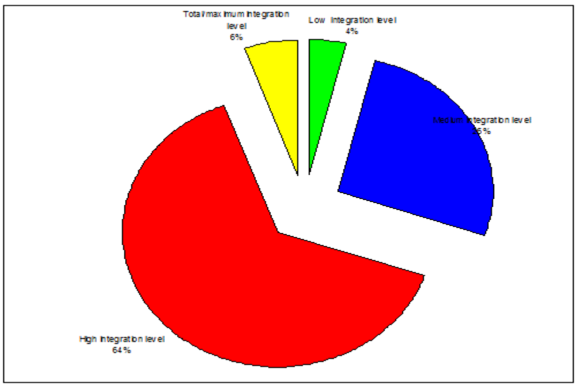

Figure 11- Integration level perceived

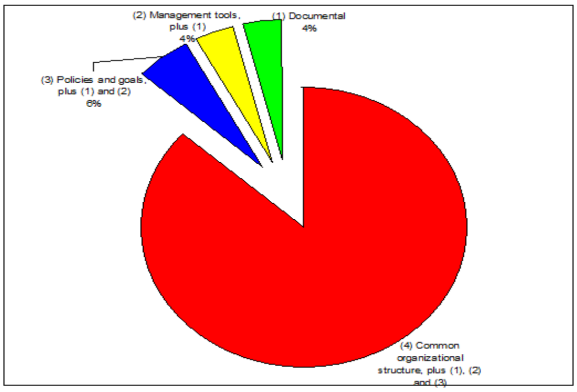

Figure 12- Integrated organizational structure

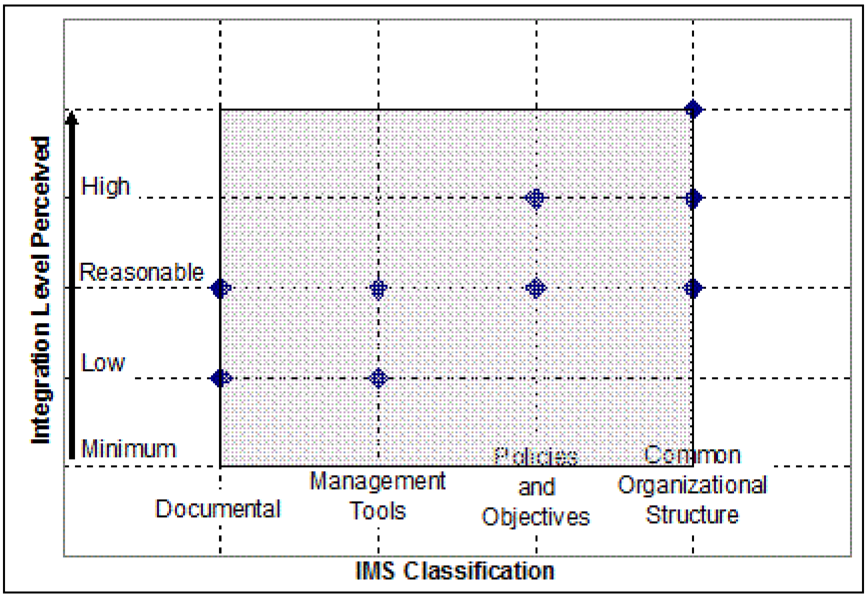

Figure 13- Correlation between IMS classification and classification level perceived

Performance comparison *pre* and *post* integration and IMS add value was surveyed and the analysis may be seen in Figures 14 and 15. Companies feel that its overall performance would be lower if a management system sustained on separated sub-systems ruled their organizational structure (Figure 14). Thus, almost every companies perceived the implemented IMS as an add value (Figure 15).

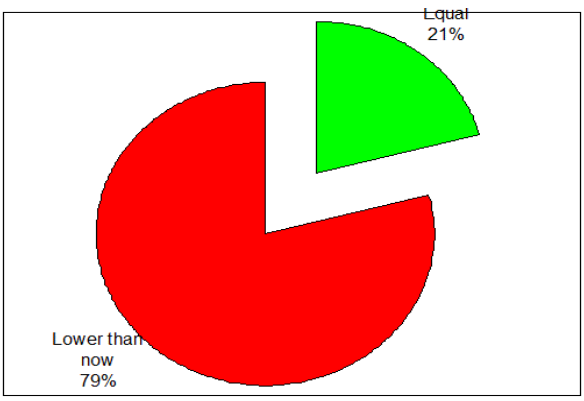

Figure 14– Management System Performance

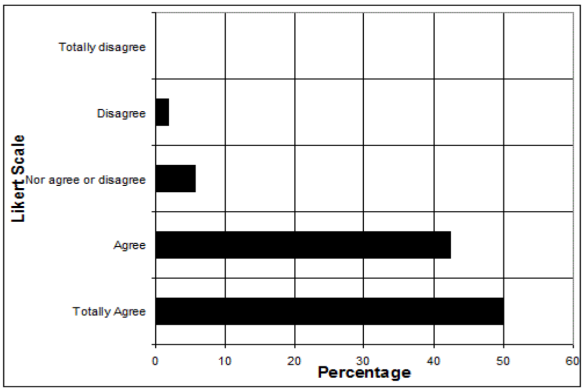

Figure 15– IMS perceived as add value

Authority and responsibility related to the IMS and the QMS, EMS and OHMS as been addressed in the survey (Figures 16 and 17). According to the analysis of Figure we may conclude that neither EMS and/or OHSMS responsible have a decorative functions on the companies surveyed. Also the analysis of Figure 17 suggests that an IMS responsible is clearly present coordinating all inputs from sub-systems, providing and rationalizing suitable outputs according the different sub-systems available.

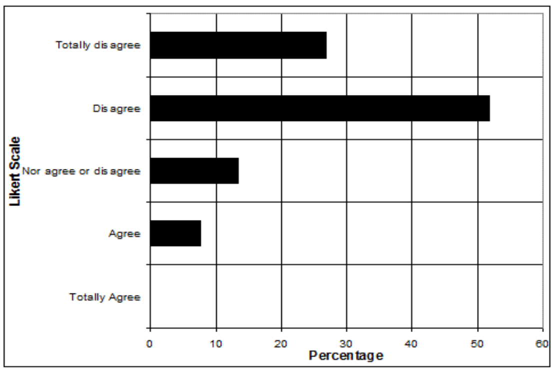

Figure 16– EMS and/or OHSMS responsible authority is residual

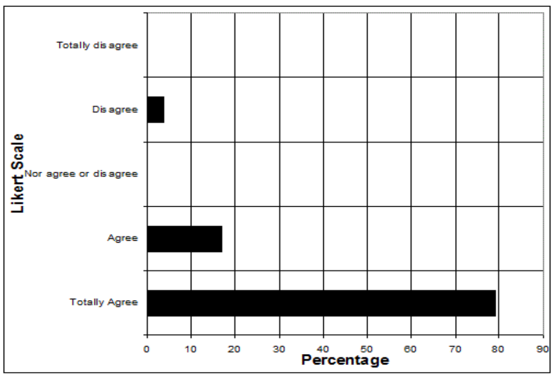

Figure 17– IMS responsible

Related to the definition of indicators (Figures 18 and 19), process, operation and management monitoring almost all companies agreed that monitoring was performed by key process indicators (KPI's), operations process indicators (OPI's) or management process indicators (MPI's). Similar results were found when asked about monitoring with integrated indicators, that is, indicators embedding quality, environmental and occupational and health and safety quantifiable issues.

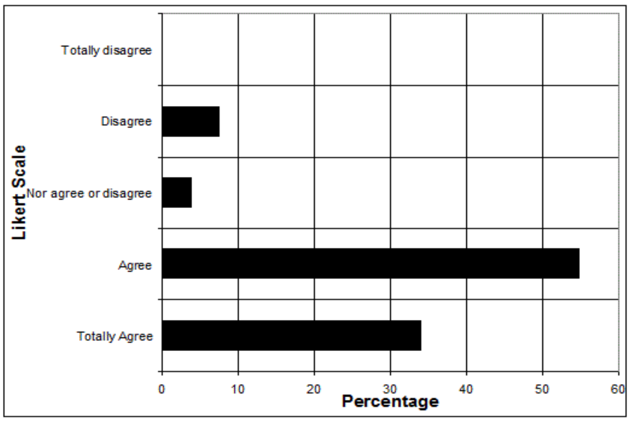

Figure 18– Integrated Indicators

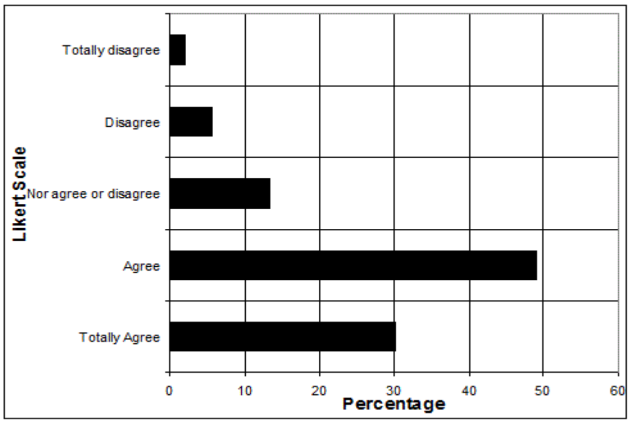

Figure 19– KPI's, OPI's and MPI's

Figure 20 relates two items assessed by the survey: the training provided to top managers and their integrated vision. Results suggest that companies where training related to integration have been provided to top managers improved and broaden their integrated vision.

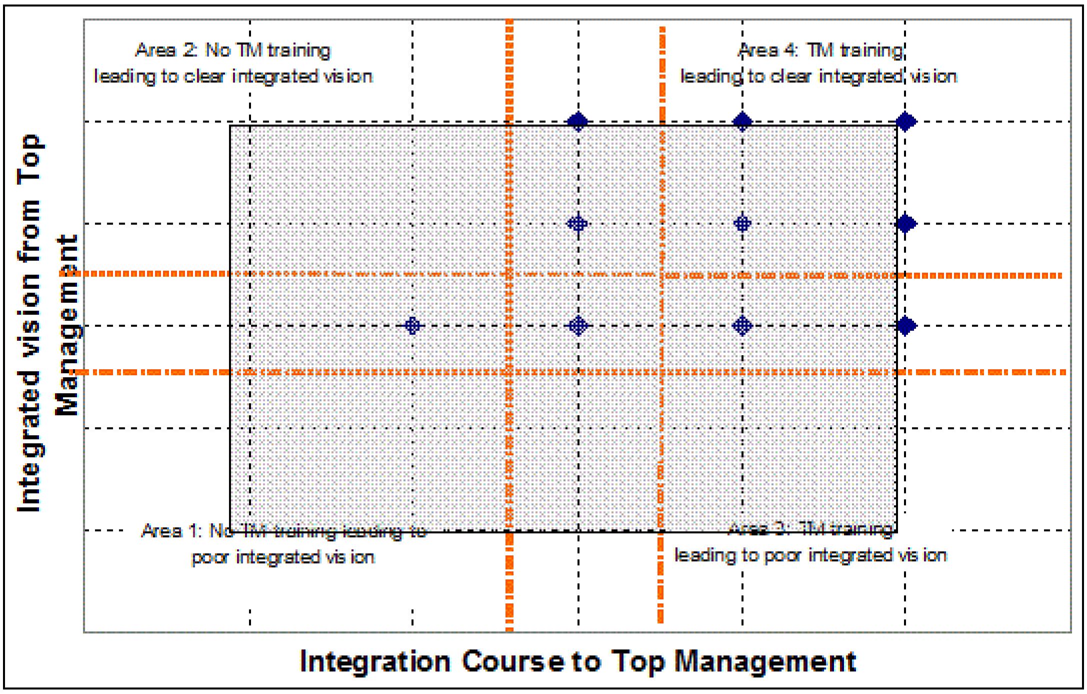

Figure 20- Training to top managers versus integrated vision

4. CONCLUSIONS

Methodologically supported on an online survey, the current study used a sample of companies that matches Portuguese geographical distribution organizations and IMS typology distribution. Company dimension (nº of employees) and activity sectors are partially reproduced by the surveyed companies comparing with the last available data.

According to the obtained results, internal or mainly internal motivations, benefits and obstacles before, during and after integration process were reported by the majority of companies. A *Step by Step* integration sequence and integrated audits seem to be the current strategies followed by IMS ruled companies. Regarding first framework proposal (Table 1), some adjustment on relative level location of some KPA's should be considered.

A major groundbreaking dividing point between surveyed companies is related to the identification of organizational items not susceptible of being integrated. In fact, identification *per se* of such items suggests a high maturity level. Another possible question in order to sharpen the maturity notion could be focused on if those items were correctly identified or not.

Sub-systems implementations standards are found to be easy or reasonably easy to integrate among each other. This fact is certainly related with the efforts developed by ISO on emphasize compatibility between standards.

The majority of the responsibles for the management systems feel that company performance would be lower if running though separate management sub-systems. Not surprisingly, IMS is seeing as an add value.

A traditional pyramidal structure seems to be the responsibility chain adopted by the surveyed companies. In fact, an IMS responsible is clear present at the surveyed companies and, at the same time; the authority of QMS, EMS and/or OHSMS is not residual suggesting that sub-systems responsible provide inputs to the IMS coordinator.

IMS monitoring is performed through key process indicators (KPI´s), operations process indicators (OPI´s) and management process indicators (MPI´s). Integrated indicators including inputs from quality, environment and/or occupational and health and safety issues altogether seem to be often used by surveyed companies taking into account the available results.

Organizational structural level and integration level perceived have been compared and a noticeable correlation seems to emerge. Despite of this fact, systems managers do not feel that an ultimate and excellence integration level had been reached by their companies. Integrated vision from top management was surveyed and results suggest that training prior IMS implementation improve that item.

5. AKNOWLEDGEMENTS

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Assessing the participatory dimension of a hands-on training intervention on Industrial and Environmental Safety in a Chemicals Plant in Portugal

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ABSTRACT
Participation is increasingly portrayed as a key aspect to intervene in Health and Safety at Work. Still, participation is an ambiguous and controversial concept due to the multiple representations that one can have about it. This paper aims to analyse the perceived participation of employees who have been involved in a participatory action-training intervention (the Matriosca Project), particularly through their response to a questionnaire drawn up for this purpose. An exploratory factor analysis allowed the extraction of three factors: "perceived impact", "perception of involvement" and "conflicts associated with participation". Through a Student's t-test it was concluded that the means of the participants' responses to items belonging to the factors "perceived impact" and "perception of involvement" were significantly above the scale midpoint. As for the mean of the participants' responses to the items belonging to the factor "conflicts associated with participation", it was significantly below the scale midpoint. Taking into account what each factor represents in terms of perceived participation, it is possible to infer that the subjects evaluate their participation in Matriosca Project in a positive way. The potential for using this instrument in future interventions and the importance of its contextualization among other elements of assessment (such as those that result from the analysis of work activities in question) are also discussed.

Keywords: Participatory Ergonomics; Training; Assessment; Perceived Participation; Questionnaire.

1. INTRODUCTION

1.1. Participation: an ambiguous concept

Participation is a fuzzy concept among social sciences and lacks epistemological and ontological consensus on its definition, measurement and application (Bar-Haim, 2002). It is a polysemic concept and it can be used to categorize several kinds of interventions (Garrigou, Daniellou, Caballeda & Ruaud, 1995).

The Japanese authors Noro and Imada (1991) have created the term "Participatory Ergonomics" to classify all the interventions that seek to employ the employees' participation within the field of Ergonomics. The most consensual definition of Participatory Ergonomics is Wilson and Haines's (1997, pp. 492-493), who define it as "the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes in order to achieve desirable goals". This is a broad definition as is the scope of interventions that fit Participatory Ergonomics, which are often connected to the cultural, social and scientific traditions of the countries from where the authors come. The framework developed by Haines, Wilson, Vink and Koningsveld (2002), the *Participatory Ergonomics Framework*, that defines a set of dimensions through which the several participatory interventions vary (like "Involvement", "Permanence" or "Focus"), enables to observe the great diversity of approaches included under the Participatory Ergonomics umbrella, as it considers a great variety of answers to each dimension.

Regarding the impact of Participatory Ergonomics interventions, systematic reviews (eg. Cole et al., 2005; Rivilis et al., 2008; e St. Vincent et al., 2010) point to a globally positive impact, taking some indicators under consideration such as the reduction of musculoskeletal injuries, days lost due to injuries, the improvement in the quality of the changes made, and the reduction of compensations paid to injured employees.

According to some authors, workers' participation presents great advantages such as the development of better solutions due to the experience developed during the work (Imada, 1991); a greater acceptance by the workers of the best solutions (Wilson, 1991); the possibility of the participation process representing a learning experience for everyone involved (Wilson et al., 2005) and the possibility of these processes leading to improvements not only in work processes but also in the workers' well being (Maciel, 1998).

However, since it is a concept that allows different interpretations, there are those who identify some downsides in the participation process, which means that sometimes a participatory project can be a "risky business" (Garrigou, 2002). In fact, many interventions fail and frustrate the workers involved, who feel cheated either because the results are not achieved, or because the working conditions don't really improve (Garrigou, 2002). Participation can also be used, as defended by Wells (1987), as a way of manipulating workers, leading them to believe that they are being involved when, in fact, they are being deviated from the decisions that have a real impact on their work and from the problems that really affect them, contributing to a break in cooperation among workers and to the weakening of the structures that have the legitimacy to represent them.

All this emphasizes the fact that participation is not something that can be analysed without taking into account the context in which it occurs (Granzow & Theberge, 2009).

1.2. Matriosca Project: a participatory intervention in Health and Safety at Work

Matriosca Project is a participatory intervention that was developed in a Portuguese chemical company (Vasconcelos, Silva, Pinto & Duarte, 2012). The methodology implemented corresponds to a development of an action-research model created by the Centre of Psychology of University of Porto in a multinational tire production company (Vasconcelos, 2008). The project aimed to involve workers in the amelioration of the working conditions by alternating moments of individual guided analysis of the activities of industrial operators in the workplace with moments of collective discussion in a classroom, where the results of the individual analysis in the workplace were shared and discussed. The methodology was based on a cyclical movement in which the training (moments in the classroom and on the job) and the transformation of working conditions influence each other in a constant intercommunicating process (Vasconcelos, Silva, Pinto, &, Duarte, 2011). On the one hand the training was contributing to the transformation of working conditions through the participation of the stakeholders. On the other, the transformation of working conditions (mediated by an organizational structure created by the Project called Monitoring Committee, which comprised company's managers and people representing the several training groups) brought the training process closer to reality, sustaining and enriching it.

Regarding the results, it should be noted, very briefly, that the project contributed to the identification of 200 problems related to industrial and environmental safety, 84 of which have already been solved concomitantly with the training process (a more detailed analysis of the overall results achieved with this intervention can be found in Vasconcelos, Silva, Pinto & Duarte (2012)), which in itself shows its impact on the transformation of working conditions.

1.3. Objective of the study

Focusing on Matriosca Project, this study's objective is to analyse the representations of the several stakeholders involved in the process about their participation. It aims to understand how the different actors involved in the process perceived their participation in the Matriosca Project, considering issues like the changes that it originated, the involvement that it promoted or the difficulties that it caused. Hence, it will complement the analysis of the changes in working conditions, which has already been addressed elsewhere (Vasconcelos, Silva, Pinto, & Duarte, 2012) with the employees' perceptions about the process. In short, it is a way of opening the project's evaluation to those who supposedly fed it.

It is expected that, given the impact occurred in the transformation of working conditions and the generally favorable feedback collected through a questionnaire that was delivered at the end of each session, workers have a positive perception regarding their participation in the Matriosca Project.

In order to analyse the employees' perceived participation in Matriosca Project it was developed a questionnaire to measure some dimensions linked to the participation - the Perceived Participation Assessment Questionnaire (PPAQ).

Through literature review and content analysis of four interviews with people who participated in the project, a set of items were developed reflecting different meanings of the concept of participation, focusing on issues considered to be positive, like involvement of different stakeholders and the impact of the intervention in working conditions and also issues that the literature reports as being negative, such as the conflicts caused by this type of intervention or how sometimes the participation is misused.

2. MATERIALS AND METHOD

2.1. Participants

77 employees participated in this study. However, four questionnaires were returned blank. The remaining 73 displayed an average age of 45.3 (SD = 10.27). Considering the gender, 66 were men (90.4%) and only eight were women (9.6%). 31 belonged to production and 32 belonged to support structures (the rest did not fill in this field in the questionnaire).

2.2. Construction of the Perceived Participation Assessment Questionnaire (PPAQ)

The PPAQ was outlined resorting to interviews with four company's stakeholders: the Director of Human Resources, who was responsible for monitoring the intervention in what regards the organisation and the negotiation of the request and three representatives of the support structures of the company that participated in the Matriosca Project training groups.

In general, the subjects highlighted issues such as the adjustment of the methodology to the context and the importance of listening to employees. They made references to the open environment in which the sessions took place, which allowed discussing issues without fear of reprisals. One of the subjects refered that going to the workplace allows a deeper analysis of work situations. Some subjects pointed out, however, some difficulties related to the Monitoring Committee, including the lack of involvement of some managers, the lack of follow-up given to some problems and the limited budget for the implementation of some of the actions outlined.

These conclusions, as well as a review of the literature in the field of Participatory Ergonomics and Work Psychology led to the construction of the 32 items in the questionnaire, which aims to assess the perceived participation of the people

involved in the Matriosca Project, bearing in mind the perceived results, their participation and problems associated with this kind of interventions.
The items correspond to statements about the Matriosca Project and the participation in general to which participants had to manifest their agreement / disagreement by assigning a number from 1 to 5, where 1 corresponded to "Completely disagree", 2 corresponded to "Disagree", 3 corresponded to "I do not agree, nor disagree", 4 corresponded to "Agree" and 5 corresponded to "Completely agree".
In addition to the 32 items, the questionnaire included a section for identification where subjects could indicate their age, gender, function, workplace and educational qualifications, a section in which the subjects could freely indicate positive and negative aspects of the Matriosca Project and a section where they could indicate their degree of participation at each stage of the Matriosca Project.

2.3. Procedure

The PPAQ was introduced to the subjects at the end of their last training session, between the months of September and November 2011. The trainers briefly presented the questionnaire, asking the workers to read the instructions, which clarified the purpose of the work and guaranteed its confidentiality. The trainers were always available to answer any questions that could have arisen. In the end, to ensure a complete confidentiality, the questionnaires were deposited in a box that would be opened only after the completion of all groups.

2.4. Statistical Analysis

For the statistical analysis of the data we used an Exploratory Factor Analysis on the matrix of correlations, with the factors extracted by the Principal components method, followed by a Varimax rotation.
Following the factors' extraction, we tried to understand how the subjects positioned themselves in relation to the dimensions in question. For that purpose, we used one sample Student's t-tests to compare the means of the answers to the items that compose each factor with the midpoint of the scale (3), which represents a neutral position in relation to the items.

3. RESULTS AND DISCUSSION

This section is divided into two parts. In the first one, we will describe the process of statistical analysis of the PPAQ by an exploratory factor analysis. The second one deals with the analysis of the answers of the employees who participated in the Matriosca Project taking into account the factors extracted in the first phase, which allows making a portrait of their perceived participation.

3.1. Validity and consistency of the PPAQ

3.1.1. Validity - Principal Component Factor Analysis

Items 1, 2, 4, 5, 11, 16, 18, 23 and 25 were excluded for having a value of less than 0.5 on the diagonal of the correlation matrix and items 3, 6, 8, 9, 10, 11, 22, 21, 24, 29 and 31 were excluded for saturating in more than one factor.
For the remaining items, and according to the rule of eigenvalue greater than 1 (Kaiser criterion), the relational structure of the items is explained by three factors. Table 1 summarizes the factorial weights of each item in each of its factors, the eigenvalues for each factor, the communality for each item and the percentage of variance explained by each factor. Globally, the saturation coefficients for most of these items are over 0.6 (the bold text shows the items with factorial weights greater than 0.4 in absolute value). The values of communality are above 0.45, which can be considered reasonable (only the item 14 has a communality value below 0.5). The first factor combines 4 items, the second factor combines 5 itens and the third factor combines 4 items. The saturation values are all above 0.4.

Table 1 – Principal component factor analysis after Varimax rotation (the items were originally in Portuguese, this translation serves only the purpose of this work).

	Factorial Weights			
Items	F1	F2	F3	Communalities
13. Interventions such as Matriosca Project allow the implementation of solutions of higher quality to problems raised.	**.78**	.00	.07	.61
27. Interventions such as Matriosca Project contribute to the implementation of safer solutions.	**.78**	.26	-.02	.67
28. Matriosca Project contributed to the identification of relevant problems for people.	**.72**	.29	-.10	.61
14. Matriosca Project contributed to the improvement of working conditions.	**.63**	.20	.17	.47
7. Matriosca Project made it possible to develop a greater awareness about safety issues.	**.60**	.36	-.29	.57
19. Matriosca Project really involved operators in the decision-making process.	.26	**.77**	.04	.67
17. Matriosca Project really involved support structures in the discussion of everyday issues.	.37	**.75**	.17	.72
20. Matriosca Project really involved support structures in the decision-making process.	.22	**.74**	.11	.61
12. Participation in the Matriosca Project represented a moment of learning to the people involved.	.05	**.73**	.08	.54
15. Interventions such as Matriosca Project are built deceive the workers.	-.05	-.11	**.78**	.63
30. Mixing managers and operators to discuss problems might lead to trouble.	.08	.15	**.76**	.61
26. Some details in the Matriosca Project caused unease among people.	.18	.14	**.73**	.59
32. Even within the Matriosca Project, there is information that should not be shared between operators and directors.	-.20	.17	**.71**	.58

Eigenvalue	4.23	2.45	1.21
Variance explained	33%	19%	9.3%

3.1.2. Internal consistency - Chronbach alpha

According to a commonly accepted rule of thumb for describing internal consistency (George & Mallery, 2003), Factor 2 demonstrated a good internal consistency (α=.8). Factor 1 (α= .771), Factor 3 (α= .719) and all the items as a whole (α= .762) demonstrated an acceptable internal consistency.

3.1.3. Discussion

The PPAQ allowed the extraction of three factors. However, it was necessary to exclude a large number of items (19) so that the exploratory factor analysis could produce these results. These items can be used in a future application of the PPAQ to a larger sample, with more items for each dimension. In fact, the sample size (*n*= 73) has conditioned this study in terms of the number of items used in the questionnaire and in what regards the results of the factor analysis.

The three factors extracted, called "perceived impact", "perception of involvement" and "conflicts associated with participation", represent, however, interesting results.

The first factor, "perceived impact", is related to how subjects perceive the impact of the project at various levels, since it groups items related to various types of impact, such as the improvement of working conditions, the implementation of safe solutions to problems, problem identification and awareness about safety issues. The higher the responses to the items comprising this factor, the more impact the subjects perceive.

The second factor, "perception of involvement", has to do with the participants' perception about the involvement of different stakeholders in several dimensions of the project. It means that the higher the responses to the items comprising this factor, the more subjects consider that there was a real involvement of the stakeholders in the process.

The third factor, "conflicts associated with participation", groups a set of items that are related to aspects of participation that can cause conflict. This has to do with the perception of some of the most controversial aspects of participation such as the conflict between different hierarchical structures (Wilson et al., 2005) and the manipulation associated with participation (Wells, 1987). The higher the responses to the items comprising this factor, the more subjects perceive the existence of this kind of conflicts.

The fact that one of the factors pertains to a negative aspect of the concept of participation and two factors (1 and 2) are associated with positive aspects (such as the impact of participation in the improvement of working conditions and the involvement of stakehoders) shows that the PPAQ has the potential to shed some light on the concept of participation in all its ambiguity.

3.2. Perceived Participation in Matriosca Project

3.2.1. Comparing the answers of the subjects with the scale midpoint

The means of the subjects' answers to items belonging to the factors "perceived impact", "perception of involvement" and "conflicts associated with participation" were 3.726 (SEM = .06), 3.842 (SEM = .053) and 2.29 (SEM = .1), respectively. According to a one sample Student's t-test the means of the subjects' answers to items belonging to the factors "perceived impact" (t (72) = 12,069, p = .000), "perception of involvement" (t (72) = 15,726, p = .000) and "conflict associated with participation" (t (72) = -6703, p = .000) are significantly different from the scale midpoint (3), i.e. the subjects expressed an opinion significantly higher than the scale midpoint on the items belonging to the factors "perceived impact" and "perception of involvement" and below the scale midpoint on the items belonging to the factor "conflicts associated with participation ". Figure 1 shows these results graphically.

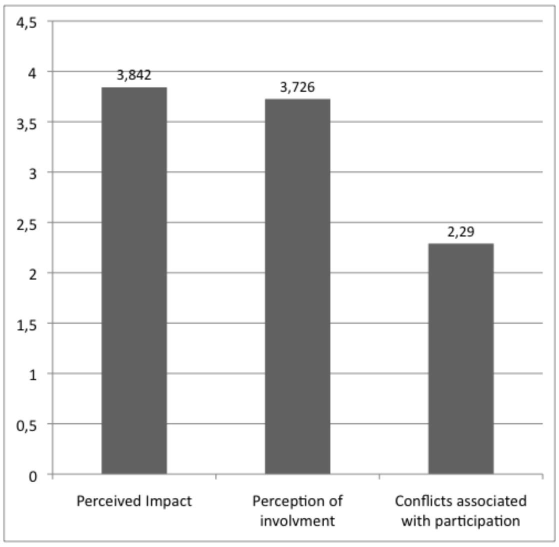

Figure 1 – Means of the items belonging to each factor.

3.2.2. Discussion

Having the results of the exploratory factor analysis shown that the factors measure the constructs that they intended to measure, it can be concluded that subjects were generally favorable to the participatory dimension of Matriosca Project.

Since the means of their responses to the items belonging to the factors "perception of involvement" and "perceived impact" are above the scale midpoint, it can be stated that the subjects feel they have really been involved in this intervention and that this involvement has brought visible results. On another perspective, the fact that the mean of their answers to the items belonging to the factor "conflicts associated with participation", which is part of perceived participation, is below the scale midpoint shows that they played down the negative aspects of participation, positioning negatively in relation to them.

These results support the hypothesis of this study and show that, in this particular intervention, the people who participated in the study experienced participation in a positive way.

4. CONCLUSIONS

The article aimed at measuring the perception of an array of actors who partook in a Health and Safety at Work participatory intervention; to serve the aforementioned purpose the PPAQ was built. The analysis of the resulting data clearly indicates that the workers recognize a positive impact upon their working conditions. They also reckon that they have been fully involved in the process and that the conflicts usually linked to participatory interventions did not occur.

These outcomes should not be considered on its own in the assessment of this aspect of the intervention. Hence, the next step of the study must include the application of the PPAQ within the managerial context, namely to the managers that participated in the Project's Monitoring Committee, as well as obtaining qualitative data (such as elements that frame the work activities in study or the subjects' answers to the questionnaire's open questions). The resulting data should be then presented to and discussed with the local stakeholders, in an effort to prompt further deliberation upon this issue.

Applying PPAQ to measure the overall perspective about the participation on an intervention in Participatory Ergonomics has the advantage of very frugally enabling the contribution of a great number of people. It is as significant as the results it generates and the meaning the participants assign to it, especially within the context of this particular intervention.

The workers' participation was a crucial aspect in the Matriosca Project, which thus made it so important to get to know the perspective of those whose involvement was encouraged. In a sense, this article achieves that goal. Still, this is solely one of the components of this process, which should be supported by a sustainable, deep and multidimensional approach, focused on the meaning that the work activities concede to (or withdraw from) this perceived participation in particular.

As for the PPAQ, we were able to draw a few interesting conclusions from this very first implementation. One of them concerns the issues that emerged from the exploratory factorial analysis. On the one hand, the factors "perceived impact" and "perceived involvement" give a perspective on the subjects' opinion about the positive aspects of the participation, such as the results that it generated as well as the amount of people it entailed at each stage. On the other hand, the factor "conflicts associated to participation" complied with the analysis of the other side of this concept, as it measures the subjects' perceptions on the most controversial aspects of participation, such as the conflicts between the several hierarchical structures, the use of the "participation" concept to favor pernicious approaches to less empowered groups of stakeholders, or the illusion usually associated to this sort of approaches.

The realization of the existence of these two sides in the participation (that guided the questionnaire's outline, considering that it was enhanced not only by the theoretical analysis of this concept but also by the interviews that were conducted) paved the way for the drafting of an instrument that assesses the perceived participation in some of its most important dimensions. This enables a wider and elucidative perspective on the way different agents experience this kind of interventions and on other key elements for the success of future interventions. Should it be subjected to a few changes, it could be a valuable tool in forthcoming interventions.

5. ACKNOWLEDGMENTS

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Chemical exposure in a pathological anatomy department

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ABSTRACT
The use of chemical agents is an integral part of the work process within Pathological Anatomy Services. Taking into account their potential adverse effects on the health of workers, a study was held which attempted to: (1) examine the exposure to chemical agents; (2) check if the perception of exposure to risks differs among doctors, technicians, assistants, orderlies and administrative workers; and (3) to know if in the opinion of the respondents the non-compliance with the rules of safety by coworkers compromises individual safety.
Work process analysis took place on two random days, indicated by the Pathological Anatomy Department, involving an unstructured interview, and a written and photographic record. A questionnaire was then developed and given to the workers. The measurement of total VOCs was carried out at fixed locations. Samples were collected as closely as possible at the level of the airways and in the immediate neighborhood of workers. The measurements took place during the entire time the task was performed.
The level of exposure to the VOCs exceeds the 0.600 mg/m^3 mentioned as an indicator of indoor air quality. The results from the questionnaire suggests the need to implement an effective training and information program that enables, according the different professional categories and specific risks, to provide the workers with the necessary tools to develop their work, minimizing hazard and exposure. The adoption of safe behavior as well as a common responsibility to achieve good safety conditions should be reinforced.

Keywords: Chemical agents; Pathological Anatomy; Formaldehyde; VOC.

1. INTRODUCTION

Chemical agents are the most extensive group of professional risks factors and maintain a demanding concern in their various aspects that relate to their potential effects on human health (Prista&Uva, 2006).
The evaluation of occupational exposure to chemical agents and the respective decision-making about the means for their control and prevention are essential for the creation and maintenance of healthy work environments. In addition, an early detection of an exposure to risk may significantly diminish the occurrence of adverse effects on the health of workers exposed to chemical agents.
The definition of hazardous chemical agent covers the chemical agents classified as dangerous substances or preparations according to the criteria of classification, packaging and labeling of dangerous substances and preparations and also the substances which, although not meeting the above criteria, may constitute a risk to the health and safety of workers due to their physical, chemical and toxicological properties.
With this in view, the employer must have a risk assessment and consider the adequate preventive measures. The prevention of occupational risks also depends on the workers adopting an appropriate behavior in accordance with the safety requirements imposed by chemical agents exposure. Information and training for workers on the safety measures to be taken in activities in which chemical agents are used, is, therefore, of considerable importance (MTS, 2001).
Knowing that in a Pathological Anatomy Department the use of chemical agents is an integral part of the work process and taking into account their potential adverse effects on the health of workers, a study was held, which attempted to: (1) examine the exposure to chemical agents in a service of pathological anatomy ; (2) check if the perception of exposure to risks differs among doctors, technicians, assistants, auxiliary medical action and administrative workers; and (3) to know if in the opinion of the respondents the non-compliance with the rules of safety by coworkers compromises individual safety.

2. THEORETICAL FRAMEWORK

2.1. Characterization of a Department of Pathological Anatomy

"The Pathological Anatomy, in its assistance side, has as a central objective a diagnosis based on morphological examination of organs, tissues and cells. It interrelates with almost all other medical specialties and surgical procedures in the establishment of the diagnosis and in the identification of the factors in the prognosis of the disease, and, also, in its prevention. The activity of pathological diagnosis integrates essentially the following areas: Macroscopy and Histopathology (biopsies and surgical specimens), Cytopathology (exfoliative and aspiration, implemented by needle biopsy), Extemporaneous Examinations, Morphometric, Immune-morphological and Molecular Analyzes, auxiliary to the diagnosis and Clinic Autopsy (Costa, et al., 2003).

2.2 Exposure to chemicals in a Department of Pathological Anatomy

Exposure to ***formaldehyde*** is one of the risk factors founded in the Pathology laboratories. It is soluble in water, colorless and has a pungent and characteristic odor, in its gaseous form, flammable and able to form explosive mixtures with the

air (Goyer N., 2007). Formaldehyde is used as a fixative or preservative, thus being a good way to store biopsies and anatomical parts (Viegas&Prista, 2009).
Many epidemiological studies have been conducted in order to verify the existence of a link between certain types of cancer (pharyngeal, for example) and the exposure to formaldehyde in chronic exposures.
According to several studies produced by the International Agency for Research on Cancer (IARC), there is evidence that formaldehyde is carcinogenic to humans (Group 1) (IARC, 2006). The NP 1796:2007 provides for formaldehyde a TLV-STEL of 0.300 ppm.
Xylol[1]is a colorless liquid, practically insoluble in water and miscible with ethanol, ether and other organic solvents. It is used in histopathological processes and cytological and it is considered the main diaphanous able agent (makes the tissues translucent) and remover of paraffin used in Laboratories of Pathological Anatomy. It has a characteristic odor and it is harmful and flammable (Neto & Silva).
Xylol is a volatile organic compound that can be absorbed in the body through the percutaneous, digestive and respiratory route. The main effect caused by the inhalation of xylol is the depression of the central nervous system, and the rise of symptoms such as: headaches, dizziness, nausea, and vomiting (Carriço, et al., 2006).
There is a reference to the emergence of infertility, fetal abnormalities, and renal diseases in children whose mothers were exposed. Pregnant women exposed to concentrations above the limit of tolerance present gynecological hemorrhage and threat of abortion (Michel, 2000).
The NP 1796:2007 provides for xylene a TLV-TWA of 100 ppm and a TLV-STEL of 150 ppm.
In addition to the use of formaldehyde and xylol, other chemical substances are still used by the Pathological Anatomy Department, namely: alcohol in various concentrations, methanol, nitric acid 10.0%, decalcifier, aseptic alcohol and ammoniac water.

2.3. VOCs as an indicator of Indoor Air Quality

Volatile Organic Compounds (VOCs) are a large group of chemical agents based on carbon that evaporate easily at room temperature.
The measurement and identification of individual VOCs is expensive and takes time because the VOCs present in very low concentrations are difficult to identify or measure. The concept of total VOCs was developed to deal with this situation. Measurements of overall VOC record the total VOC present without distinguishing the different compounds.
If a VOC mixture of indoor air is considered, the result is usually expressed as total VOCs. This means that a single value represents the mixture of VOCs.
Breathing air contaminated with VOCs, even at low concentrations for long periods of time may increase the risk of health problems in some people. Several studies suggest that exposure to volatile organic compounds can aggravate symptoms in people who have asthma or are particularly sensitive to chemicals.
Each chemical has its own toxicity and potential to cause different harm. The most common symptoms of exposure to volatile organic compounds (Portuguese Environment Agency Environment & Reference Laboratory, March 2009) include:
In the short-term and high levels of VOCs: irritation of eyes, nose and throat, headaches, nausea / vomiting, dizziness, increase of asthma symptoms,
In the long-term and high levels of VOCs: increased risk of cancer, liver and kidney injury and damage in the central nervous system.
Exposure in a range from 0.300 to 3.00 mg/m^3, there may be odors, irritation and discomfort as a response to the presence of VOCs, together with factors of thermal discomfort and stress. For values above 3.00 mg/m^3, complaints can be expected, and above 25.0 mg/m^3, respiratory irritation and temporary discomfort to a mixture of common VOCs were identified (Portuguese Environment Agency & Environment Reference Laboratory, March 2009).

Table 1 - Reference values versus type of exposure to VOCs

Chemicals Agents	Reference Values	Type of exposure	Normative reference
VOCs	< 0.200 mg/m^3	**The comfort range** - no match between health effects and exposure level - **VERY ACCEPTABLE**.	**Norma 62-1989 – ASHRAE public review draft August 1996** (Thermal Environmental Conditions for Human Occupancy)
	0.200 mg/m^3 – 3.00 mg/m^3	**the multifactorial exposure range**- Slight irritation, but often associated with other factors - **ACCEPTABLE FOR A SHORT PERIOD OF TIME**.	
	3.00 mg/m^3 – 25.0 mg/m^3	**The discomfort range**- sensory irritation, headaches, lack of comfort - **IT WILL REQUIRE A CORRECTIVE ACTION.**	
	> 25.0 mg/m^3	**The toxic range** - Possible neurotoxic effects - **UNACCEPTABLE FOR OCCUPATION.**	

[1]Xylene, Dimethylbenzene

The main objective of the VOC indicator is to obtain a simple measure of combined exposure to multiple VOCs in indoor air. The VOC indicator can be used in materials testing, as an indicator of ventilation, and the identification of sources or polluting activities.
Decree-Law No. 79/2006 of April, 4 referred as the maximum concentration value for COVs of 0.600 mg/m^3.

3. MATERIALS AND METHOD

3.1. Work process analysis

The work process analysis took place on two random days, indicated by the Pathological Anatomy Department. This analysis consisted in direct observation (with a total of 15 hours), involving an unstructured interview, and a written and photographic record.

3.2. Identification of chemical agents used

The procedure implemented for the assessment of occupational exposure to chemical agents was based on the NP EN 689:2008 with the following sequencing**:**

1. Identification of potential exposure (list of substances);
2. Determining the factors in the workplace

The identification of the chemical used was ensured through analysis of work process.

3.3. Assessment of the perceptions of workers against risks

The above-mentioned study hypotheses were investigated using a questionnaire. This was developed based on information gathered while observing performances, which took into consideration aspects related to work (process analysis) and workers (testimony).
The questionnaire was organized in two groups: characterization of the workers and questions directed to the hypothesis under study; it was composed of questions that provide three types of response: open; nominal qualitative and ordinal qualitative.
The analysis of data was ensured, initially, using descriptive statistics. In the second phase it was intended to infer about values of population parameters and validate the theoretical study, namely: (1) Kruskal-Wallis H test for independent samples: applied to measure whether the equal distribution of responses is identical for all professional categories in relation to perception of risk; specific training; adoption of implemented safety rules and use of personal protective equipment, (2) test the measure of association, Cramer V (replaced by the Phi coefficient as appropriate) to determine the following correlations: Professional categories vs. perceptions of risks; professional categories vs. specific training; professional categories vs. adoption of implemented safety rules; risk perception vs. specific training; Specific training vs. use of personal protective equipment; risks perception vs. use of personal protective equipment and increase of risk exposure due to non-compliance by colleagues vs. calling the attention of colleagues.

3.4. Total VOCs Measurement

VOCs measurement technique

The measurement of total VOCs was carried out in the Macroscopy room at fixed locations, these characterizing workers exposure at the workplace. Samples were collected as closely as possible at the level of the airways and in the immediate neighborhood of workers. For a better estimate of individual exposure samples were collected for three days. Samples were taken in situations where the probability of exposure is higher or in accordance with the normative model used (NP EN 689:2008) – sampling of the **most unfavorable case**.
The gathering took place on separate days, which yielded representative parameters during macroscopic activity for two professional categories: doctors and technicians. The measurements took place during the entire time the task was performed and using the equipment RaeSystemsMiniRAE 2000, an instrument for direct reading through photoionization detector (PID).

3.5. Evaluation of the ventilation system installed and flow measurement

General and local ventilation

The ventilation system of the Macroscopy room in the Pathology Department consists of a natural air fan that introduces fresh air and a horizontal coil fan, which cools introduced air. This room is also served by an extraction fan (LV). The extraction is carried out through four grids (in a parts store, in a soiled materials room and two in the Macroscopy room). The insufflation and air extraction are always preceded by filtering (particle filters).
The room Macroscopic Pathology Service also has two extraction hoods, extraction interconnected with each other, T system, registered in the same interconnection.
Area, the location and volume of air flow rate (inflation/extraction), to calculate the airflows, have been defined. The dimensions of the vents (inflation and extraction) of the laboratory have been taken into account, and to calculate the air velocity a digital hygro anemometer, TSI Model 9535 VELOCICALC, calibrated, has been used.

Measuring spots in the grids

The rate of air input and output was obtained by measuring actions in the grids (6 points per grid). The average value of these spots was used for calculation purposes.

4. RESULTS AND DISCUSSION

4.1. Sample

The sample used for this study included all team members of the Pathological Anatomy Department (N = 20), distributed as follows considering the professional groups: 10.0% (n = 2) Physicians, 55.0% (n = 11) Technical pathologists, 10.0% (n = 2) Auxiliary medical action, and 25.0% (n = 5) Administrative workers.

4.2. Workers perception of the risks

Workers in the area of administration evidenced a significant lack of knowledge of safety rules implemented in the Pathological Anatomy Service. The answers given in terms of adopting and following the implemented safety rules are not similar for all professional groups inquired.

The Statistical analysis carried also evidences the lack of specific formation for workers concerning professional risks to which they are exposed in 55.0% of the sample. This evidence seems to contribute to explain the poor relation between the specific formation and the use of PPE (Personal Protective Equipment) (Phi coefficient = 0.436, p-value = 0.154). This evidence is reinforced by the fact that there is no relation between the risk perception and the use of PPE Phi coefficient = -0.091, p-value = 1.00).

45.0% (n = 20) of the sample state having already considered that their exposition to the risk is higher due to the disrespect of the safety rules by their coworkers. However, 35.0% (n = 20) do not draw the attention of their coworkers to this disrespect. 70.0% (n = 20) recognize the need to improve the work conditions and 50.0% (n=14) the need to implement a more effective and less loud extraction system.

4.3. Measuring of the flow of the ventilation system

Since the conditions are more favourable to the workers, the values considered for the macroscopy room were the same referred to the autopsy room (new air flow: 100 m^3/h· people and 10 air changes per hour). For storage of anatomic parts and "dirty rooms", the reference taken was the one used for undifferentiated compartments 10 air changes per hour) (UONIE/ACSS, 2008):

Results of the measuring actions made:

- Values obtained of air insufflation into the macroscopy room: **350** m^3/h.
- Values obtained for extraction**:**
    - Macroscopy room: **3.25** air changes/with connected hoods: **8.36** air changes per hour.
    - Soiled materials room: **4.28** air changes per hour
    - Parts Store: **2.36** air changes per hour

The values of new fresh air (inflation) are ensured for three employees. The reference established is being therefore respected. In case of any changes, flow insufflation rates should be reviewed.

The number of air changes per hour (extraction) is not observed in any of the rooms. Although the functioning of the hood in the macroscopic room improving the air renewal, the required level of 10 air changes per hour is not reached.

4.4. VOC measurement

From measurements taken at the Macroscopy room in the Pathology Service of the Hospital under study, we noticed that all values exceeded the value specified in the Decree-Law No. 79/2006 of April 4, which states that the maximum concentration of reference as an indicator of indoor air Quality for VOCs is 0.600 mg/m^3. According to the figures contained in Rule 62-1989 - ASHRAE, five measurements were obtained which may be included in the discomfort area (3.00 mg/m^3 a 25.0 mg/m^3). It is necessary to develop a corrective action and carry out three measurements in the factorial exposure (0.200 mg/m^3 to 3.00 mg/m^3). This is therefore acceptable for a short period of time.

Table 2 - List of values obtained with the measures to be taken

Nº	Mean values mg/m^3	Type of exposure	Reference Values	Measures to be taken
01	4.60	The discomfort range	3.00 mg/m^3 to25.0 mg/m^3	It requires a corrective action
02	4.30			
03	1.20	The multifactorial exposure range	0.200 mg/m^3 to 3.00 mg/m^3	Acceptable for a short period of time
04	0.900			
05	1.80			
06	2.50	The discomfort range	3.00 mg/m^3 to 25.0 mg/m^3	It requires a corrective action
07	4.50			
08	7.30			

Once the exposure was appreciated (phase 3), it was noticed that the values obtained require a corrective action. Only measurement value 4 is acceptable since it is a short exposure. Regarding the measurement value 5, this is no longer acceptable since the exposure concerns a measurement with the duration of 6 hours.
After changing the ventilation system, a reduction in the measured values of VOC's is expected. However, in accordance with the strategy to compare the values of workers' exposure to chemical agents, periodic measuring actions must be made to regularly check if there was a change in exposure conditions (Phase 2 of the strategy).
It is important to note that the values obtained for total VOC result from the sum of the chemical agents used in the Pathological Anatomy Department.
These measurements will serve to establish the type of actual exposure. If the values exceeded beings and after exhausting all engineering measures that enable an effective legal protection, should be adopted masks of personal protection for the type of exposure

5. CONCLUSION

Exposure to chemical agents in a Pathological Anatomy Department has been evidenced with the development of this project. In what concerns the analysis of the questionnaires about the perception that workers have on the risks to which they may be exposed during their professional activity, the obtained conclusions were as follows:

- Workers who evidenced a more significant lack of knowledge of safety rules implemented in the Pathological Anatomy Department belong to the administration area. The answers given are not similar in all the professional areas in what concerns the adoption and accomplishment of safety rules implemented;
- The statistical analysis carried out shows that 55.0% of the people questioned do not have a specific formation about the hazards to which that may be exposed during their work. This reinforces the poor relation between this variable and the use of personal protective equipment and risk perception;
- Another interesting point is related to the fact that 45.0% (n = 20) of the sample answered affirmatively to the question of having already felt that their exposure to risk is higher due to disrespect of safety rules by coworkers. However 35.0% (n = 20) (which represents 20.0% (n = 5) of the administrative workers, 50.0% (n = 2) of doctors, 45.5% (n = 11) of the technicians) do not draw coworkers' attention to this fact;
- • To the question what they would do if they could change their job in order to improve work conditions, 70.0% (n = 20) in the sample gave an opinion answering as follows: 40.0% (n = 5) administrative workers, 50.0% (n = 2) doctors, 81.8% (n = 11) technicians, 100% (n = 2) auxiliary medical action;

These results evidence the need to implement an effective training and information program that enables, according the different professional categories and specific risks, to provide the workers with the necessary tools to develop their work, minimizing hazard and exposure.
The adoption of safe behavior as well as a common responsibility to achieve good safety conditions should be reinforced.
It was interesting to note that 70.0% of the Pathology Department workers expressed an opinion regarding their job. This participation of the workers is also important to the successful implementation of safety rules. The creation and development of this kind of attitude enables an open and informal communication, gives the perception that safety and health are important aspects for the Administration and that more attention is given to the opinions and suggestions issued by the workers.
From the point of view of effectiveness concerning the ventilation system only flow of fresh air insufflation is ensured In terms of air renewal per hour, the value is not reached in any of the three areas analyzed. Since there are already planned changes to the ventilation system, new evaluation and measuring actions should be carried out after these changes have occurred, attesting the effectiveness of the ventilation system and compliance with the existing references.
The level of exposure to the VOCs exceeds the 0.600 mg/m^3 mentioned as an indicator of indoor air quality. The values obtained from for total VOC result from the sum of the chemical agents used in the Pathological Anatomy Department. Since the values established are surpassed, the professional exposure to chemical agents must be evaluated in order to determine the individual concentration of chemical agents (like formaldehyde) in the work areas. The values found must be compared to the reference values, which constitute acceptable exposure levels. These actions would permit to determine the type of exposure and to lead, if all engineering measures have been taken to enable an effective collective protection but still were not enough, to the adoption of individual protection masks appropriate to the type of exposure.

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Food and Beverage Establishments: an Indoor Air Quality Study of Kitchens

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ABSTRACT
The assessment of indoor air quality in kitchens is very important to safeguard the health of occupants and food quality. The main objective of this study was to evaluate the indoor air quality in food and beverage establishments and to analyse the symptoms perceived by its occupants. The quantification of environmental parameters was based on the structural and operational characterization of the building, the measurement of physical parameters and the sampling of chemical and biological parameters. The samplings were performed in Spring/Summer seasons in five kitchens. In general, results showed that the cooking activities and inadequate ventilation conditions may have determined the quality of indoor air spaces. Physical parameters are outside the comfort zones established by applicable legislation. The concentration of chemical agents, such as particulate matter is above the maximum. However, it was verified that the operation of the grill during cooking was the factor that might have induced the increase in concentration of this agent. Only one establishment exceeded the maximum reference value of carbon dioxide concentration. In all establishments high concentrations of mesophilic microorganisms at 37ºC were found. This may be related to inadequate ventilation, occupants and cleaning processes/procedures. The highest concentration of moulds may be related to relative humidity and also related to inadequate air flow rate. In the symptomatic questionnaire it was found that only 2 of 14 participants related the symptoms with the indoor environment. The symptom reported by most of the occupants was fatigue. The restructuring of the kitchens layout and the improvement of working procedures, can improve the microbiological quality of air and reduce microbiological contamination of food.

Keywords: indoor air quality, food and beverage establishments, kitchens.

1. INTRODUCTION

The Hotel and Restaurant sector is constantly expanding and represents an important source of employment in the services sector, employing about 7.8 million people in the European Union (EU). Working conditions in this sector have several risks associated, including: physically demanding activities, exposure to high levels of noise, exposure to high or low temperatures, falls, cuts and burns, exposure to hazardous substances, psychosocial risks related to ergonomic conditions, function requirements, working hours and autonomy, among others (EU-OSHA, 2008).
A set of requirements should be considered in manufacturing areas of food and beverage establishments (FBEs) in order to minimize food contamination and to ensure adequate conditions of hygiene and safety at work (Afonso & Silva, 2009). In the context of health and safety at work the applicable Portuguese legislation (e.g. law n.º 987/93, of October 6th and law n.º 243/86, of August 20th) aims to eliminate/minimize exposure to occupational hazards by improving the structural and operational conditions of these spaces. The regulation n.º 852/2004, of April 29th, establishes general rules for operators of food businesses with regard to food hygiene. This regulation also refers that these companies should adopt food safety programs and procedures based on Hazard Analysis and Critical Control Points (HACCP).
The quality of food in restaurants is closely related to their structural and environmental conditions, and there are factors such as indoor air quality (IAQ) that may undermine food safety (Dioguardi & Franzetti, 2010). The existence of a healthful environment, free from any kind of contamination is essential to ensure food safety (Dioguardi & Franzetti, 2010). Whereas environmental factors can impact the comfort and health of the professionals and the quality of products manufactured, it is necessary to evaluate the IAQ in manufacturing areas. The Portuguese law n.º 79/2006, of April 4th (Regulation of Energy Systems of Climatization in Buildings) calls for legal compliance criteria to consider in IAQ audits and determines the concentrations of reference for the environmental parameters that characterize the IAQ. The limit values for the thermal parameters, air temperature (ºC) and relative humidity (%), which influence the concentration of chemical and microbiological agents present in indoor air, are defined in law n.º80/2006, of April 4th. In 2009, a Technical Note (NT-SCE-02) was published, establishing the methodology for IAQ audits.
Considering the above mentioned and taking into account the limited research developed in Portugal in this area, the present study aimed at evaluating the IAQ in kitchens before and during cooking, as well as analyzing the symptoms perceived by workers in these spaces.

2. MATERIALS AND METHOD

This study was conducted in five FBEs located in Porto during the Spring and Summer of 2011. These establishments have a great affluence of consumers and produce several meals per day.

The methodology applied in this study was based on:

- Analysis and observation of structural and operational characteristics of the kitchens by the application of a checklist;
- Assessment of environmental parameters, including carbon dioxide (CO_2), carbon monoxide (CO), airborne particles (PM_{10}), microbiological agents (total of mesophilic microorganisms and moulds), air temperature, relative humidity and air velocity**;**
- Analysis of symptoms perceived by the workers through the application of an interview survey.

2.1. Kitchen's structural and operational characterization

For kitchen's structural and operational characterization two checklists were applied, one regarding building general characteristics and other regarding the characteristics of kitchen materials (coatings, furniture and equipment) and cleaning processes.

2.2. Analysis of Indoor Air Quality

For the evaluation of environmental parameters, sampling points were initially selected according to areas and layout of the kitchens, doors and windows location, ventilation and the location of exhaust and cooling systems. Potential indoor and outdoor sources of contamination were also considered.

The samples were collected inside the kitchens of each establishment, near the food preparation area, before and during cooking. The environmental parameters measured inside the kitchens were also assessed on the outside, near the closest air entrance. Measurement of environmental parameters was based on the recommendations outlined in Technical Note – NT-SCE-02 and in the "Technical Guide for Air Quality in Indoor Spaces" from the Portuguese Environment Agency. Sampling and analysis of viable microorganisms were based on 0800 method - Bioaerosol Sampling (Indoor Air) from the National Institute for Occupational Safety and Health (NIOSH).

In all the selected locations the following parameters were evaluated in real time: carbon dioxide (CO_2) concentration, carbon monoxide (CO) concentration, air temperature and relative humidity and airborne particles (PM_{10}). The air temperature and relative humidity were measured using the equipment IAQ-Calc (TSI, Model 8762-M-EU). The airborne particles (PM10) were measured using the equipment Dust TrakTM Aerosol Monitor (TSI, Model 8520). The air velocity was determined using the thermo-anemometer Velocicalc (TSI, Model 8345). For the microbiological evaluation of the air (total count of mesophilic microorganisms at 37ºC and moulds at 25ºC) the air sampling equipment MAS 100 (Merck) was used.

The reference concentrations present in annex VII of the law n.º 79/2006, of April 4th were considered for interpreting the IAQ results, while those present in the article 14, chapter V of the law n.º 80/2006, of April 4th were considered for interpreting air temperature and relative humidity (Table 1). International recommendations were also considered from the Indoor Air Quality Association (IAQA) and the Standard 62.1 from the American National Standards Institute (ANSI)/American Society of Heating Refrigerating and Air-conditioning Engineers (ASHRAE).

Table 1 – Maximum concentration values for several environmental parameters

<table>
<tr><th colspan="6">Law nº 79/2006, of April 4th</th></tr>
<tr><td>CO
10.7 ppm</td><td>CO_2
984 ppm</td><td>PM_{10}
0.15 mg/m^3</td><td>Total mesophilic microorganisms (37ºC)
500 CFU/m^3</td><td>Moulds
500 CFU/m^3</td><td>Air Velocity
<0.2 m/s</td></tr>
<tr><th colspan="6">Law nº 80/2006, of April 4th</th></tr>
<tr><td colspan="3">Air Temperature
20ºC- Summer
25ºC – Winter</td><td colspan="3">Relative Humidity
50%</td></tr>
<tr><th colspan="6">Law nº 243/86, of August 20th</th></tr>
<tr><td colspan="3">Air Temperature
18ºC-22ºC
25ºC (in certain weather conditions)</td><td colspan="3">Relative Humidity
50% - 70%</td></tr>
</table>

2.3. Laboratory Analysis

For the sampling of microbiological agents different culture media were used, including Tripticase Soy Agar (TSA) for quantification of total mesophilic microorganisms and Malt Extract Agar (MEA) for quantification of moulds. The incubation temperature of the samples was 37ºC for total mesophilic microorganisms, during two days, and 25ºC for moulds, during five days. After incubation, the colonies were counted and calculated the Colony Forming Units (CFU/m^3).

2.4. Questionnaire Application

The survey developed for the analysis of symptoms perceived by the occupants focused mainly on the identification of symptoms and their temporal and spatial patterns. This questionnaire was applied to all workers in the kitchens, assessed by interview.

2.5. Statistical Analysis

The procedure for data analysis involved simple descriptive statistical methods, with frequency analysis, arithmetic mean and standard deviation using Microsoft Excel.

3. RESULTS AND DISCUSSION

The structural and functional characteristics were similar in all the evaluated kitchens. All of them had exhaust systems operating in the area of stoves and grills, and natural and/or artificial ventilation systems. The number of occupants in spaces ranged from 1 to 8 during the evaluations. In general, the state of hygiene of the locals was acceptable, however, one of the establishments had dirt accumulated on the floor, walls and equipment, particularly at the level of the exhaust system.

The results obtained for thermal parameters showed that only the values of air temperature increased during the preparation of meals, which would be expected, since at those times all the equipments were in operation (such as ovens and stoves). The values of air temperature ranged between 21 and 28.2ºC before cooking and between 21.1 and 30.4ºC during cooking. The values of relative humidity ranged between 45.6 and 70.5% before cooking and between 46.7 and 65.9% during cooking. Taking into account the values for air temperature in workplaces (between 18 and 22ºC) established in law n.º 243/86, of August 20th, it was found that most of the assessed places showed air temperature values higher than those established in this legislation. High temperature values can have not only a negative impact on comfort and welfare of workers, but also in productivity, since high the air temperature increase irritability and decrease motivation (Zhao *et al*., 2009). The relative humidity values obtained were close to the values recommended (between 50 and 70%) by the same law. However, levels of relative humidity greater than or equal to 60% are already considered by some authors as favourable to the proliferation of moulds in indoor spaces (Wolkoff & Kjaergaard, 2007). The threshold value of air temperature established for the heating season in law n.º 80/2006, of April 4th, was exceeded in all the evaluated kitchens.

The results obtained for air temperature and relative humidity in each evaluated FBE, as well as the reference values are represented in Figure 1.

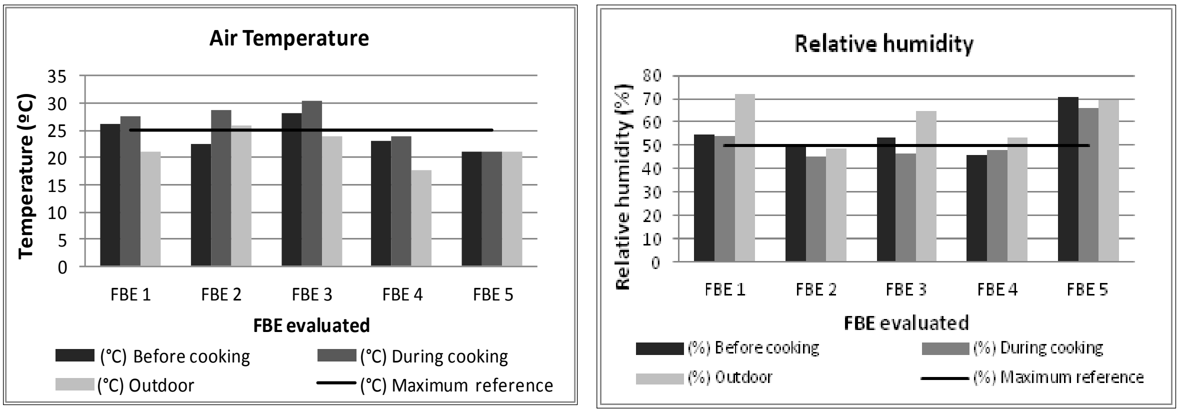

Figure 1 - Values of air temperature and relative humidity in each food and beverage establishment.

The values of air velocity ranged from 0.04 to 0.31 m/s, with two kitchens presenting a mean for this parameter above the limit (0.2m/s) set by the Portuguese law. This may be related to the existence of air currents in spaces, influencing occupant comfort. The results obtained for air velocity in each FBE, as well as the reference values are represented in Figure 2.

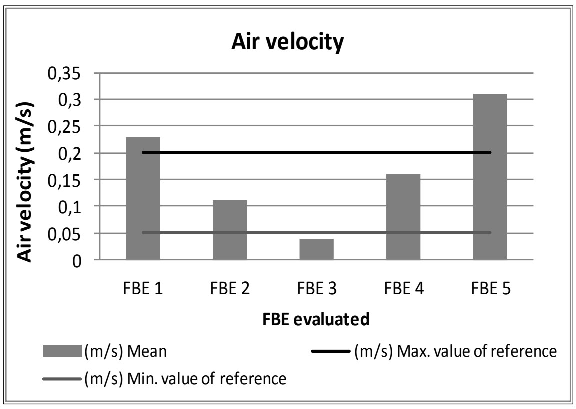

Figure 2 – Values of air velocity in each food and beverage establishment.

The average concentrations of CO_2 ranged between 718 and 1197 ppm before cooking and between 707 and 1098 ppm during cooking. The results showed that only one establishment exceeded the reference concentration (984 ppm) established in law n.º 79/2006, of April 4th. This agent is a good indicator of the efficiency of ventilation systems and the human occupation in indoor spaces (Santamouris *et al.*, 2008). Therefore, it appears that, in general, the space's ventilation is adequate. Also the average concentrations obtained for CO did not exceed the legal limit (10.7 ppm) imposed by Portuguese law. The average concentrations of this agent ranged between 3.0 and 6.5 ppm before cooking and between 2.9 and 8.7 ppm during cooking. The results obtained for both parameters, CO_2 and CO, in each establishment, are represented in Figure 3, as well as the reference concentrations.

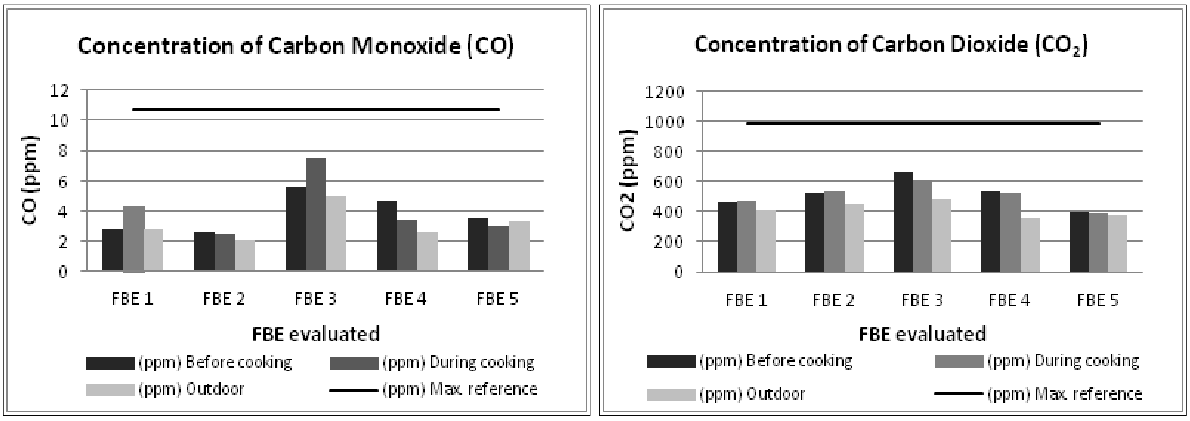

Figure 3 – CO_2 and CO concentrations obtained in each food and beverage establishment.

Regarding average concentrations of PM_{10} values were obtained that were above the maximum (0.15 mg/m^3) established in law n.º 79/2006, of April 4th, in two kitchens during the preparation of meals. Average concentrations ranged between 0.015 and 0.099 mg/m^3 before cooking and between 0.002 and 0.504 mg/m^3 during cooking, as observed in Figure 4. In both kitchens, the factor that might have induced the increase of PM_{10} concentration, during cooking, was the operation of the grill. However, other factors might have contributed to this increase, including the increased number of occupants and the greater movement of people. According to Lai & Ho (2008), the activity of cooking is a major source of particulate emissions, since the release of fumes may occur. Afonso & Silva (2009) obtained similar results in areas of manufacturing involving the use of flour.

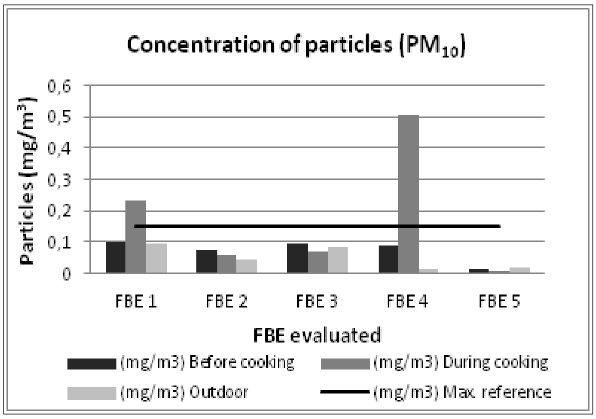

Figure 4 – PM_{10} concentration in each food and beverage establishment.

The average concentrations of total mesophilic microorganisms at 37ºC ranged between 520 and 1576 CFU/m^3 before cooking and between 447 and 2212 CFU/m^3 during cooking, as observed in Figure 5. In general the average concentrations of these agents increased during the period of meals preparation, which may be related to the increasing number of occupants in spaces, as observed by Rajasekar & Balasubramanian (2011) in a study about food areas. In addition, during this period several ingredients with different microbiological characteristics are handled, which can also be a source of air contamination. The average concentrations of moulds at 25ºC ranged between 364 and 927 CFU/m^3 before cooking and between 392 and 2212 CFU/m^3 during cooking, as observed in Figure 5. In both phases, the maximum reference concentration for this agent (500 CFU/m^3) has been exceeded. The indoor concentration of moulds was higher than the outdoor concentration, similar to what Kim *et al.* (2009) concluded. The high concentration of moulds may represents a hazard to food safety (Burfoot *et al.*, 2007).

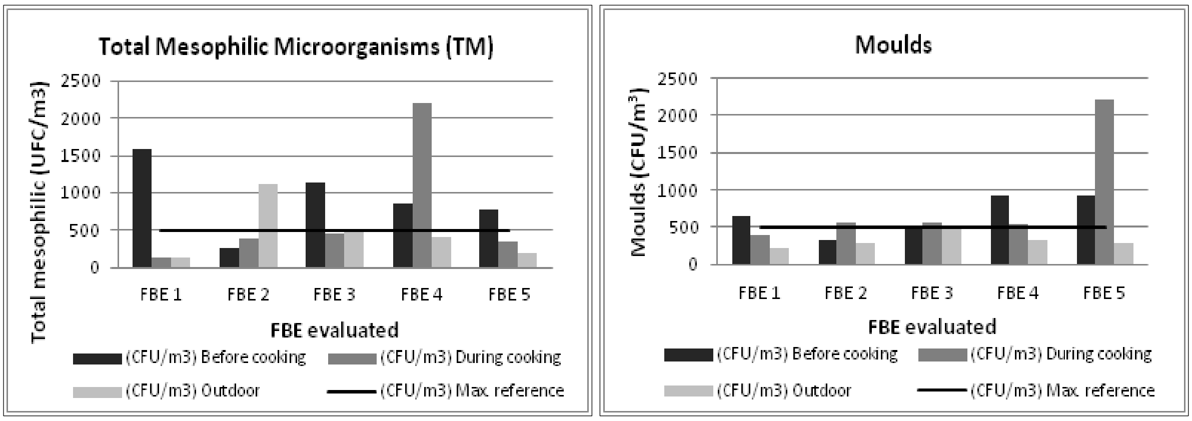

Figure 5 – Total mesophilic microorganisms concentration and moulds concentration in each food and beverage establishment.

The questionnaire was applied to fourteen workers with very similar functions, some cooks and others scullery helpers. The average age was forty six years, with the oldest person having fifty-nine years and the younger twenty-two years. The sample consisted of fourteen workers, eleven women and three men. The application of the survey showed that the main environmental factor identified as a cause of discomfort was the too high temperature, which is consistent with the results obtained. With regard to perceived symptoms, fatigue was the symptom reported by most workers, similar to what Rios *et al.* (2009) observed in their study. However, only two workers related fatigue with the workplace, saying that the symptoms disappeared after leaving the site.

4. CONCLUSIONS

In FBEs adequate conditions of hygiene and safety must be guaranteed, referring in general the IAQ as a critical point, and in particular, the biological agents as potential contaminants of food. This dual concern (occupational health and food quality and safety) is due mainly to the large influx of consumers to such establishments and the large number of workers involved. The restructuring of the kitchens layout could reduce the exposure of professionals to direct sources of heat (such as ovens and stoves). The execution of remodelling work in kitchens that have humidity in walls and ceiling, as well as the improvement of working procedures, including hygiene and disinfection, can improve the microbiological quality of air and reduce microbiological contamination of food. It would be important to carry out research of some microorganisms, both in food and air, since so far there is no data about the contribution of air as a vehicle of transmission of microorganisms to food. It would also be interesting to make assessments of IAQ in different seasons, in order to verify if there are changes in behaviour of pollutants at different times. Regarding the results obtained by the survey to workers, it would be interesting to extend the sample and ensure that the answers are not made in the presence of the interviewer, since this can influence the results, even unintentionally.

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Temporary work: perspectives and risks

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ABSTRACT
This study addresses temporary work (TW) focusing, on the one hand, on how the companies use temporary work and, on the other hand, on the perspectives and professional paths of temporary workers. To begin with, we present a background on the problem and its implications, enlightenment over issues such as work precarity and employment flexibility and an analysis on the use of TW in Portugal, including the presentation of true examples from companies and workers. From the companies' point of view, the main concern seems to be the need to reduce labor costs, in the search for maximum flexibility. From the workers' concerns emerge questions related to the lack of job security, due to the fact that being temporary, those workers do not receive training and protective equipment.

Keywords: temporary work; precarity; employment flexibility; work risks.

1. INTRODUCTION

We assist to a steady increase in TW throughout the European Union, and Portugal, whose legal framework for TW is the Law 7/2009 of 12th February, is no exception; official data from 2011 indicate the existence of 25 million workers with temporary contracts in the European Union (Wozowczyk & Massarelli, 2011).

TW is characterized by a triangular contractual relationship between the worker, the temporary work agency (TWA, also for plural references) and the hirer (the end-user company that hires the temporary work). This type of work encompasses additional issues, namely in terms of health and safety at work, training and integration in the work community, all explained by the different contractual bond celebrated with temporary workers; those issues are recognized by the Directive 91/383/EEC, which establishes as compulsory to include TW in the on-going safety and health measures at work and by the Directive 2008/104/EC, which promotes equal treatment for temporary workers and other HC workers alike.

The employer's role is divided by two companies and, given this peculiarity, the temporary work contract shall not be confused with any other work contracts, as it is apart from the purity of the contracts subject to labor law. The responsibilities are split between the TWA and the hirer, thus enforcing the uniqueness of temporary work. One of the companies is the actual employer that hires and pays, but does not assign any tasks, and the other company which benefits from the work, uses the labor force and determines the activity to be performed, supervises, establishes the working conditions and is responsible for the occupational safety, health and hygiene and for the worker's protection. Notwithstanding, quite often do we see – and we could testify so – the hirer stating that it is not its responsibility to provide temporary workers personal protection equipment (PPE), claiming that they are not directly employed by the hirer. This attitude is a clear attempt to dilute responsibilities among the two companies, but it causes the temporary worker serious harm.

Some authors consider that, as a flexible working situation, the TW takes precarity to an extreme level (Santana & Centeno, 2001). Precarity is usually related to poorly paid and devalued work, work instability, unemployment threat, social rights restriction and the lack of hope for a professional evolution. The dissemination of precarious employment choices has to do with the companies' attempt to achieve a quantitative flexibility and to reduce labor costs by using unstable contracts as a resource (Kovács, 2004).

The tendency towards more flexible contractual relationships has a negative impact on the working conditions and the workers' health and safety (Swaard, 2002; Dhondt & Knave 2002; Buffet & Priha, 2009). There are studies showing that the temporary workers have less time to get familiar with the activity, have less information on labor risks and prevention strategies and have a lower capability to foresee the danger and anticipate a decision; consequently, they are even more exposed to risk factors and face a higher rate of accidents at work than the other workers (Swaard, 2002; Pedersen *et al*, 2007; Buffet & Priha, 2009).

The multiple processes that emphasize job and employment precarity revise the health-work relationship (which is already complex as it is); this means that such relationship tends to stress all the potentially negative effects work can have on health and health can have on work (Hélardot, 2006).

There is inevitable interference on the performance of a work community whenever the teams are changed and disrupted by the bidirectional flow of temporary workers; moreover, the temporary workers arrive without being prepared to protect themselves from risks, so they cannot add more means and defenses against possible accidents and injuries (Cru, 2006). The temporary worker's situation is even more risky and fragile as far as safety and health at work are concerned because of the "tendency to trust the temporary workers, less protected specially owing to the lack of collective agreements, the most dangerous tasks." (Rosa, 2003, p.53)

Such concerns on the TW topic, not only with additional impacts on the health and safety but also on the social and personal penalization for the workers, lead to the need to deepen the knowledge on the subject, so to propose alternatives and ways to deal with the constraints imposed by this type of work. Based on this context, an exploratory study was conducted aiming a close and true understanding on the problem, therefore, the study finds anchor on the workers' speech and on available data from the hirers, both obtained through a temporary work agency.

2. METHODOLOGY

The qualitative approach was adopted to meet the standards of a study recognized as exploratory; the choice for a method, technique and instruments consistent with that approach was made in advance. The investigation seeks for new findings, its objectives are to describe and to understand; accordingly, the interview was the main technique for the temporary workers and the case study was preferred for the hirers.

The selection of the three hirers and the three temporary workers was based on the pertinence of the characteristics for the study's purpose, considering the theoretical research, in order to guarantee the problem representation rather than statistic representation.

The data collection and the interviews took place on a TWA located in Maia; that TWA made it available for research purposes all the data on the companies and the workers involved in the investigation. Research participants (TWA, the hirers and the workers) are guaranteed identity confidentiality given the nature of the data collected; otherwise the research could not move forward.

To better analyze the use of TW, all the available data on the commercial contracts signed between the TWA and the hirers, the correspondent work contracts and the workers assigned to those contracts were collected. We analyzed both the documents and the computer system for contract management, which enabled the data recording on the questions consistent with the problem and most pertinent to describe the use of TW: reason to contract, contract length, reason to terminate the contract, reason to use temporary work, professional categories, workers hired by the company, contract extension, readmissions, workers' integration, workers' characteristics (age, education) and strategy to manage temporary work, namely in terms of procedures within TWA and the hirers to meet the obligations related to safety and health at work.

An interview script was created specifically to study the workers' perspective; it is centered in the professional paths and in the relation established with the temporary work. Each worker was interviewed twice, firstly using the specific script which focused on, as previously mentioned, (1) the workers' life path and (2) their expectations on temporary work and on their paths influenced by the temporary work; secondly, a feedback interview where some questions can also be detailed.

The analysis of the data collected during the interviews combined the option Scenario of *TROPES* software and the classic content analysis. The life paths were analyzed with bio-graph (Ramos, 2010).

3. RESULTS AND DISCUSSION

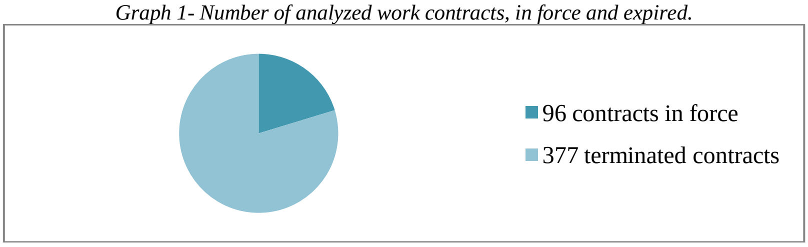
The results will be presented in two distinct parts: one dedicated to the data which describes the use of TW from the three hirers and another referring to the results of the interviews to the three temporary workers.

3.1 Analysis and discussion on the use of temporary work

The analysis covered 473 TW contracts, all related to the 3 hirers, during a period of 2 years and 4 months. All the contracts started between the 1st of January 2008 and the 31st of December 2009 were analyzed.

From the total of 473 contracts, only 96 were in force by the time the data were collected (from February to April 2010), as illustrated in the Graph 1.

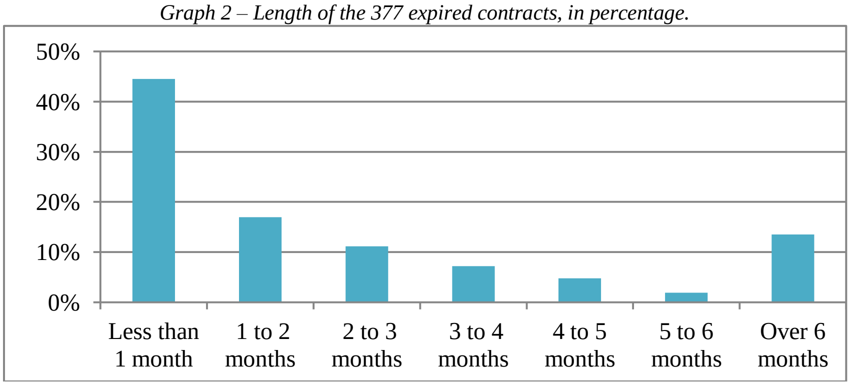
Graph 1- Number of analyzed work contracts, in force and expired.



The hirers evoke essentially two reasons to use TW: the extraordinary increase in the company's activity (Article 140 f) Law 7/2009) (this is the reason alleged in 42% of the contracts) and the execution of occasional task or determined service, definite and not long-lasting (Article 140 g) Law 7/2009) (indicated in the majority of the contracts: 56% of the total number of contracts).

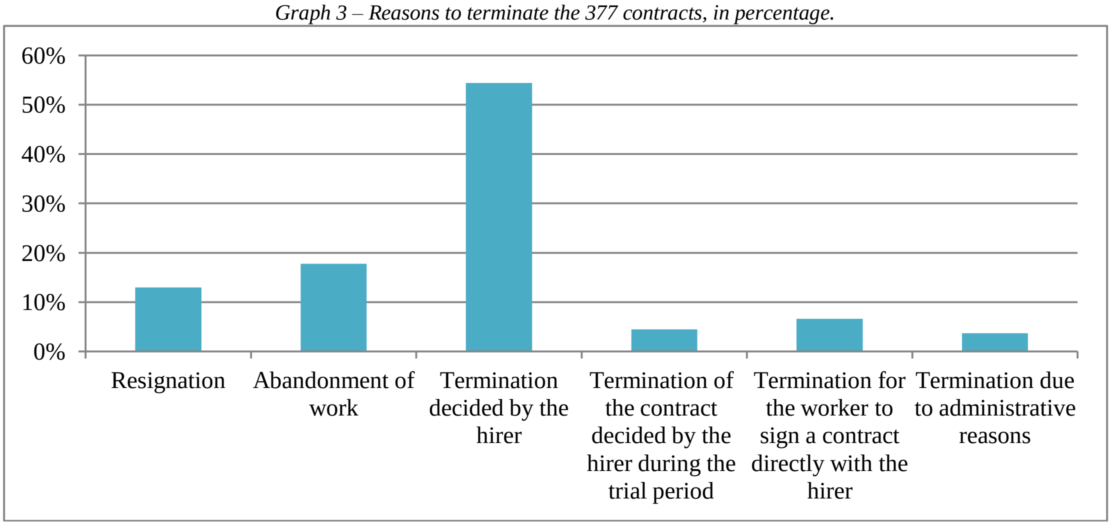
Taking the length of the contracts into consideration, most of them do not reach 3 months: contracts which last until 3 months represent 72,68% of all contracts. Among these, 44,56% do not even complete 1 month. It was confirmed that 13,79% of the contracts lasted 3 to 6 months. Only 13,53% of the contracts expired after 6 or more months. The short-term contracts are clearly prevalent, as shown in Graph 2.

Graph 2 – Length of the 377 expired contracts, in percentage.



Bearing in mind the reasons which lead to the termination of the contracts, Graph 3 shows that the two left bars are due to the worker's initiative, the following three bars express initiatives from the hirers and the last bar, "Termination due to administrative reasons", is triggered by the TWA. It is noticeable that the first step towards the termination of the contracts was taken by the hirers in 65,52% of the cases and it is prominent that the second cause for those terminations is the abandonment of the job by the employee without prior notice neither to the TWA nor to the hirers.

Graph 3 – Reasons to terminate the 377 contracts, in percentage.

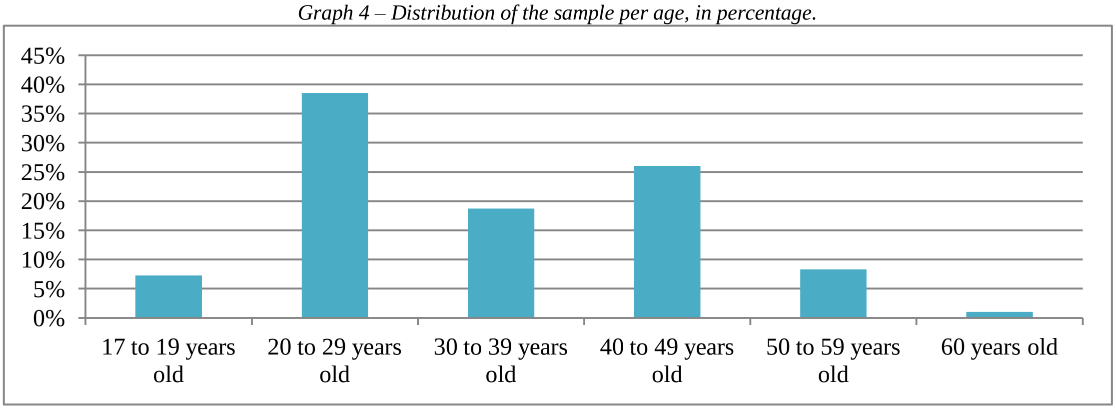


There are 306 workers connected to the sample of 473 analyzed contracts. As expected, the 96 contracts in force by the time of the data collection referred to 96 workers, so, 210 had already been dismissed. The workers still on duty were characterized in terms of education and age.

Regarding education, 70% of the workers attended school up to 9 years (inclusive) and, among these, 15,63% had only completed primary school. 8,33% of the workers on duty had attended university.

The distribution per age is shown in Graph 4, where the age group 20 to 29 years old presents a higher frequency, so to speak.

Graph 4 – Distribution of the sample per age, in percentage.



Now, concerning the management strategy for TW, the three hirers differ in a couple of aspects, but it is possible to highlight a group of common characteristics: 1) the hirers keep a core number of workers with an open-ended contract and the rest of the manpower ends up being hired to the TWA, thus keeping the jobs occupied by temporary workers for as long as possible; 2) the human resources strategy consists precisely in keeping in TW a significant, but constantly variable number of workers, depending on the needs assessed, at least, every week or every month; 3) the companies under analysis assume that there is a surplus of available labor force and, for that reason, they have to find the right person for the job; in addition, the replacements are considered easy and quick, it is not worth it to train one person for each place.

The hirers require the possibility to terminate the contracts easily (variable-term contracts or fixed-term contracts for 5, 15 or 30 days) and to request the trouble-free placement of a new worker in the exact same workstation; the worker must go through a quick adaptation process and will be dismissed in case of failure to do so, which happens quite often during the first month at work.

These companies use temporary work intensely and continuously, and scarcely is the use of this labor force coherent with the reasons that justify using temporary work as a resource: extraordinary increase and performance of a defined and not long-lasting task. In fact, the workstations were kept busy over two years by successive temporary workers.

None of the hirers analyzed provide training for their temporary workers, hence disrespecting the legislation in force which underlines the need for the hirer to guarantee enough training for an adequate fit to the job, namely in terms of safety and health at work (Article 4 Directive 91/383/EEC; Article 186, no. 6, Law 7/2009; Article 20 Law 102/2009), neither do they provide any type of PPE, although they are obliged by law (Article 15, no. 10, Law 102/2009), because the hirer is the one responsible for the safety, health and hygiene conditions under which the work is performed (Article 8, no. 1, Directive 91/383/EEC; Article 16, no. 2, Law 102/2009).

The TWA also avoids fulfilling its obligations regarding prevention of occupational health and safety: none of the workers still on duty attended an appointment with occupational medicine (admission examination, cf. Article 186, no. 4, Law 7/2009 and Article 108, no. 3 Law 102/2009) prior to the admission, nor did the hirer notify the TWA stating this failure. Usually, the TWA arranged the admission examinations by the time the individuals started working and surpassed the trial period in the work contract (the first 15 days), revealing a strategy not to carry the burden of paying for medical appointments to workers who do not make it through 10 working days; in this circumstances the invoice sent to the hirer for the hours of work would not compensate the value of the expenses. It was verified that a great number of workers had already attended their appointment with occupational medicine, but it did not happen before the first day at work, as required by law.

The TWA ought to inform the worker – even before he/she starts working – about the characteristics of the workstation, the labor risks, the protection and prevention measures regarding first aid and fire fighting and the instructions on how to act in case of close and serious danger; all the information shall be formerly sent by the hirer, as stated in the Article 186, no. 2, Law 7/2009, Article 19, Law 102/2009 and Article 3, no. 1 and Article 7, no. 1, Directive 91/383/EEC. In fact, two of the hirers under analysis reveal a disturbing practice: one of them simply mentions that “There are no risks” and the other sent a memorandum saying: “The TWA shall wait for the risks to be sent”. And this corresponded to the information transmitted to the workers – after they started working, we repeat, by the time they signed the work contract.

When it comes to the prevention and protection of the worker, the essential conditions are neglected, together with a contract management which fosters the precarity of the contracts, mostly short-term contracts. Truthfully, the way the hirers manage hiring and termination exposes their belief that “the employees positioned at the bottom of the social hierarchy, with less margin for maneuver, with lower professional qualifications, will have to be content with precarious jobs” (Martinez, 2010, p.11).

3.2 Analysis and discussion regarding the temporary workers’ perspectives and life paths

Three temporary workers were chosen in the TWA, based on the following criteria: they are temporary workers for, at least, two months and they are available to meet the interviewers in the TWA.

They are three male individuals, aged 24, 38 and 47, and with 6, 12 and 4 years of schooling, respectively. The first one, who is also the youngest, started working for the TWA 13 months ago in a hirer which provides services for the construction industry; the TW arose as an escape from several precarious situations, the last one being an experience as an illegal construction worker in Spain. This interviewee had monthly renewable contracts and could expand this situation for a total of 24 months. The second participant, 38 years old, was employed by the TWA in a hirer within the distribution sector for 15 months, with weekly non-renewable, but successive contracts. The TW emerged as an escape for an unemployment situation; after 2 years as managing partner in a café he was not entitled to unemployment benefit. The third participant joined TW three months before; he worked for the TWA in a hirer from the logistics sector, with weekly non-renewable, but successive contracts. For this participant the TW emerged as the solution after over three years of unemployment. He had a 20-year job as foreman in a company which declared insolvency.

As a result from the content analysis of the interviews responses, it is possible to underline three dimensions, precisely huge trends in the TW: (1) uncertainty and a feeling of insecurity towards the near future (employment, wage, subsistence, future plans), (2), the TW was an involuntary option and the perception tells them that it is difficult to change to something better in the current labor market, (3) ignorance about the reason why the hirer utilizes TW, although they realize it is contradictory with the activity and with the length of the contracts and totally independent of the worker's performance, (4) lack of identification with an occupation and with the present activity, (5) lack of PPE and training in safety.

The workers refer that they are treated differently when compared to the workers hired directly by the company and they mention their concern on the subject of the personal protection equipment; these workers have to, at their own expenses and at the limit of their possibilities, buy steel toe boots and protection gloves. The hirers do not provide and do not demand the temporary workers to present themselves fully equipped. The workers are aware of the need to protect themselves against the most obvious risks associated to their activity, so they choose to protect the feet (because of the risk of falling objects) and the hands (they manipulate and carry heavy objects and their work is exposed to weather conditions).

After analyzing the paths based on the bio-graph, it is clear that the beginning of the TW matches the exit from an unemployment phase or from an even more precarious employment and it occurred as the only possible option; this is one of the worst moments in life because it is unsafe, poorly paid and not qualifying. Facing the need to work, these men accepted a job below their qualifications, a lower wage when compared to what they afforded before being unemployed and assume risky functions without complaining in order to keep their source of income and avoid getting back to unemployment. These lives are marked by a constant mobility, mostly involuntary and always flat, the progression is not expected. As Martinez points out (2010, p.70), the notion of precarity is actually confirmed through the analysis of the professional paths marked by the real probability of returning to unemployment.

4. CONCLUSIONS

The study here presented focused on two possible angles to analyze temporary work: the hirers and the workers. The qualitative and exploratory analysis show that the data emerge from and rely on the approaches describing a reality where the hiring trends are based on the belief that an employee works better if the contractual tie does not guarantee stability (Lacomblez, 2008). We found out employment conditions inevitably affected the working conditions, life perspectives dominated by insecurity, lack of information, instability and the fear that it all gets worse with the possible, highly probable, return to unemployment.

According to the analysis described, the temporary workers do not stay on the job long enough to gain the necessary experience to recognize and avoid risk taking; similarly, there is not enough time to learn the job and develop an identification with the activity, to integrate the company's community, to conquer a position which allows them to fight for their rights. The workers have less room to develop their knowhow, therefore they face the activity's constraints with higher difficulty. Without time or way to share the collective know-how, namely in safety matters, each worker is on his/her own (Cru, 2006).

The workers' life is directly influenced by the "evil effects provoked by the new forms of work organization: suffering at work because of the exposure to job precarity, lack of sensitiveness for the workers' self-esteem, the contradiction and overlap of efficacy and performance demands beyond the workers' capabilities, the number of hours and the corresponding wage" (Hélardot, 2006).

Being a precarious form of employment, temporary work does not seem to facilitate professional development; this assumption is reinforced by the evidence that it does not help creating an occupation nor does it foster identification with a work community. The most vulnerable are those to whom TW was the only escape from unemployment, an escape which corresponds to a badly qualified activity, poorly paid and with no hope for continuity. The workers' reports highlight that the hirers do not provide personal protection equipment, do not train in safety, do not train at all, and make discretionary decisions regarding the termination of the work contracts.

The interpretation on how the companies use temporary work leads to the conclusion that it is abusive, at least in the cases under analysis. It does not respect the reason that justifies the use of temporary work as a resource, it does not encompass training nor does it provide the temporary workers with protection. Apparently it is forgotten that the temporary worker is included in the hirer procedures in terms of occupational safety and health (Article 185, no. 2, Law 7/200), he/she shall benefit from the same level of protection than the other co-workers (Article 186, no. 1, Law 7/2009; Article 2, no. 1, Directive 91/383/EEC) and that the existence of a different work relationship, a TW one, shall not justify different treatment (Article 2, no. 2, Directive 91/383/EEC).

The social legitimacy granted to TW contributed to eliminate all the possible room for negotiation between those which prescribe the work – the hirer – and those who perform the work – the workers, mainly because the work acts as a global delivery negotiated between the 2 companies: the hirer and the TWA (Thébaud-Mony, 2001)

In conclusion, the TW restricts the flexibility to manage labor risks, it generates personal unsafety towards the professional life and it complicates the construction of a life project, of a better future.

The temporary work imposes itself as a type of work which sets work and company apart, it plays with the transfer of (ir)responsibilities (outside the corresponding law), it extends suffering, tiredness and fragility from those who feed the flexibility machine: a mass of men and women who do not know what it is to be employed, to have a one-year contract, to spend a day in training, to foresee the development of an occupation, to exercise the right to demand an PPE without fearing to be dismissed...

All the professionals dedicated to the work subject shall pay twice as much attention to the use given to TW, particularly, but not solely, the psychologists who play a role in the definition of personnel management strategies and those who work for the TWA. TW may and should respect the labor law boundaries and the hirers' health and safety norms. The temporary worker goes through a process of integration and adaptation which also deserves particular attention and to do so it is important to provide all the information on the TW conditions and on the conditions, risks and protection measures inherent to the work activity, as pointed out in the law.
On behalf of the employers and the official institutions of employment it is necessary to raise awareness for the fact that "staying on a precarious situation does not allow an improvement in people's employability" (Kovács, 2004, p.62) and those partners shall not ignore that it is the stability in the contract relationship which "allows to ground a career, consolidate personal projects and open room for the negotiation of working conditions and working organization" (Martinez, 2010, p.233).

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Noise Exposure in School Ambient

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ABSTRACT

Noise is a factor that is achieving more and more importance, focusing on the repercussion for human health and the consequences that this entails. The human ear reacts differently to frequencies, thereby, is not only the intensity of the noise that makes it dangerous but also the exposure time itself. In this sense, it is important to make an assessment of exposure to noise in a school, not only on the slope of the students, who are the future and it is imperative to provide an appropriate learning environment, but also in a strand of teaching and non-teaching that give their contribution to provide the best for the students every day. In this study, which aimed at evaluating the noise levels in the school environment, we proceeded to a sample of nine schools in the area covered by a health group centre, Agrupamento de Centros de Saúde Oeste Norte "ACES". Noise measurements were made in classrooms, gyms and cafeterias of the schools in this research to calculate the levels of noise to which students, teachers and non-teachers are subject to a normal day of classes.

Keywords: Noise, schools, health, students, teachers, non-teachers.

1. INTRODUCTION

With the passage of time there is a growing interest in the environment, with an increasing focus on its relationship to health. Several studies about noise have been developed, with special attention to hearing changes caused by it and what its consequences are, in order to act in the prevention, detection and rehabilitation of these changes (Klodzinski, *et al.*, 2005). Noise pollution is thus revealed as an environmental factor more and more worthy of attention, requiring the creation of actions, measures and forms of control to minimize its harmful effects on health (Gonçalves, *et al*., n.d.). The investigation of the degree of interference of noise in the classroom on the ability to recognize speech can facilitate the development of programs that allow improving the acoustic environment of schools which may be, directly or indirectly, the cause of school failure and physical exhaustion of both the student and the teacher (Dreossi, *et al.*, 2004). Several studies report that it is common to find learning difficulties associated with the deteriorated noise environment or even teachers with voice disorders due to efforts made in the classroom to make themselves heard before the students (Klodzinski, *et al*., 2005; Jaroszewski, *et al*., 2007).

For the World Health Organization (WHO) the priority is to identify the needs of vulnerable groups and provide technical and political guidance to protect the health of these groups. Therefore, it demanded that children would be protected from exposure to harmful noise at home and at school. Also since 2002, it forced the European Member States to establish an action plan to control and reduce the adverse effects of noise exposure (WHO/Europe, 2011). The WHO / Europe also conducted studies to determine what symptoms are caused by noise exposure, through a project called RANGE Project, in which the main symptoms identified were sleep disturbance and cardiovascular and hearing problems (RANCH Project Background & Aims, n.d.). In these studies, children were identified as the group more susceptible to the harmful effects of noise and it was verified that the ones exposed to higher noise levels presented deficits of attention, memory, learning problems, reading and decrease in school performance (WHO/Europe, 2011). The WHO has issued a set of values establishing continuous exposure to levels of background noise above 50 decibels (dB) as a cause of hearing impairment, being possible to verify, however, considerable variation from individual to individual regarding the susceptibility to noise (WHO/Europe, 2011). As for the schools, the critical effects of noise interfere with speech, disrupt the acquisition of information and the communication of the message, cause nuisance to students and require an increased vocal effort from teachers in order to be heard, and therefore, understood (Dreossi, *et al.*, 2004 ; Ribeiro, *et al.*, 2010). To be able to hear and understand spoken messages in the classroom, the level of background noise should not exceed 35 dB (A) during class and from 60 dB (A) it causes discomfort and distraction, according to the orientation values of the WHO's "Guidelines for Community Noise" for children (Berglund, *et al.*, 1999; WHO, n.d.).

In a school environment the noise of the class, the sound coming from the street and the traffic, or even from school activities held in adjoining rooms or outside the building may affect the welfare of all, jeopardizing not only the concentration and learning, but also hearing acuity. The probability of damage to hearing and of all the resultant problems, increase proportionally with the exposure to noisy environments (Wålinder, *et al.*, 2007). The classrooms are not always built according to acoustic or low noise output criteria, and it is necessary to take into account that it also produces internal noise, such as the shuffling of chairs or even the side conversations. Both the internal noise in the classroom and the external noise end up competing with the teacher's voice, masking some words and making speech less

noticeable, which is detrimental to the teaching-learning process and also for the teacher himself, both having to make an extra effort by way of compensation (Lopes, n.d). It is essential that the oral message conveyed by the teacher is received and perceived and by the student in conditions of very good oral intelligibility without any additional effort by both teachers and students. Therefore, the issue is not only the students, as far as their health and learning are concerned, but also teachers with regard to their health. The school should be regarded as a whole (Alarcão, 2008). According to the Scientific American, ambient noise also affects people's health, increasing the overall levels of stress, aggravating conditions such as hypertension, coronary disease, peptic ulcers and migraines. In fact, continuous exposure does not lead to habituation, but aggravates the effects (Scientific American, n.d.).
There are numerous studies on the subject of noise, but in schools it is still an issue that needs to be further addressed. Therefore, it is necessary to alert society to this "silent" problem (Klodzinski, *et al.*, 2005). In addition to the students, the teachers and staff are also affected by noise (Jaroszewski, *et al.*, 2007; Ribeiro, *et al.*, 2010). The architecture and layout of the furniture of the rooms serve to exacerbate this problem, given that hard floors, cement walls, high ceilings, many windows, chalk boards, among others, cause and amplify noise. It is essential to be aware and develop new studies about the effect of the noise, thus avoiding future problems, by knowing better and more about this issue that objectively affects society and thereby to be able to act preventively to the good of future generations (Hans, n.d.). By knowing the harmful effects of excessive noise in schools for the health either of students or teaching and non-teaching staff, the main objective of this study was to perform a survey of noise levels which are achieved during theoretical and practical classes and during lunch time in canteens, to which they are exposed on a normal day of classes. In order to achieve the desired objective, the places chosen for sampling were the schools belonging to the area covered by the North West ACES.

2. MATERIAL AND METHODS

With a target population consisting of 17 possible schools for this research, belonging to the area covered by the North West ACES, which includes the counties of Peniche, Bombarral, Caldas da Rainha, Óbidos, Alcobaça and Nazaré, it was formed a sample of 9 schools having the second cycle of basic education and a total of more than 200 students. They were selected by a non-probability sampling technique and convenience sampling type. It was applied a level II study of the descriptive-correlational type. The type of cohort was prospective.
The study was based on the verification of noise levels in various environments (classroom, gymnasium and canteen), in its normal operating period, seeking to quantify the levels of noise to which students, teachers and staff are exposed. Each measurement performed had a total of 40 minutes. To carry out these measurements a Model 2260 Portable Analyzer Sound Level Meter and a Model 4231 Calibrator were used from Brüel & Kjær. To transfer data between the measurement equipment and the computer it was used the specific software Noise Explorer Type 7815.
It was taken in consideration the Decree-Law No. 182/2006 of 6 September concerning the minimum safety and health requirements regarding the exposure of workers to risks due to noise and that sets the exposure limit value (Lex, 8h = 87 dB (a) and LCpeak = 140 dB (C)) and the of upper action (Lex,8h =85 dB(A) and LCpeak=137 dB(C)) and lower action values (Lex,8h =80 dB(A) and LCpeak=145 dB(C)), determining a set of measures in case these values are met or exceeded. (Decree-Law No. 182/2006 of 6 September, 2006) For this study, it was also considered as a reference to the daily exposure limit values for students in dB (A) and the base value set by the WHO of 60 dB (A) LAeq. Anything above this value is already considered as a cause of discomfort (Berglund, et al., 1999). The calculation of Lex, 8h for teachers was for 6 hours of classes, non-teaching staff was for 2 hours serving lunches and students was for 7 hours in school environment. For teachin and non-teaching staff, it was considered as criterion the daily exposure limit value (daily ELV) for workers of 87dB (A) contained in the above Decree by the following formula:

$$Lex, 8h = LAeq, Te + 10 \lg\left(\frac{Te}{T0}\right)$$

In which Te represents the measurement time in minutes and T0 is the time of criterion of 8 h.

The statistical treatment of data was performed using the Statistical Package for Social Sciences (SPSS) Software, version 19.0 for Windows, and the Excel for Windows 2007. As statistical measures, it was applied: simple descriptive measures, measures of dispersion, central and frequencies tendency. When checking the hypotheses of the study it was used the ANOVA test to I factor and the t-Student test for independent samples. The interpretation of the statistical tests was based on a significance level p = 0,05 and a confidence interval of 95%.
All the data collected were used to perform a statistical study with no economic or commercial interest, being submitted only for curricular or academic purposes. The measurements of noise levels were performed with prior knowledge and consent of those responsible for schools and respective teachers, after being informed of the purposes and objectives of the research.

3. RESULTS AND DISCUSSION

In each school, measurements were made in all the classrooms, gymnasium and canteen, totalling 27 measurements distributed in 9 measurements per location.

Table 1: Determination of the existence of significant differences at the levels of L_{Aeq} and L_{Cpeak} in the different school spaces.

		n	**$\bar{x}$**	**± s**
L_{Aeq}	Gymnasium	9	74.86	3.17
	Classroom	9	71.98	5.86
	Canteen	9	79.96	3.34
	Total	27	75.60*	5.33
L_{Cpeak}	Gymnasium	9	111.41	2.17
	Classroom	9	109.38	7.66
	Canteen	9	115.64	5.07
	Total	27	112.14	5.87

Test: *ANOVA for one sample*
*$p \leq 0{,}005$

As seen in Table 1, there were statistically significant mean differences of the LAeq noise levels among different spaces: Gymnasium ($\bar{x}$=74.86±3.17); Classroom ($\bar{x}$=71.98±5.86) and Canteen ($\bar{x}$=79.96±3.34).

Table 2: Comparison of the L_{Cpeak} levels with the exposure limit values (ELV) and upper action (UAV) and lower action values (LAV)

	$\bar{x}$ dB (C)	**Mean Difference**	**± s**	**Reference Value**
L_{Cpeak} n = 27	112.14	-27.86	5.87	140 (ELV)
	112.14	-24.86	5.87	137 (UAV)
	112.14	-22.86	5.87	135 (LAV)

Test: *t-student for one sample*
* $\rho < 0{,}001$

In examining Table 2 as for the LCpeak noise parameter there were no significant mean differences in the three spaces studied. Later, we tried to evaluate if the noise levels LAeq and LCpeak would have been different when compared with the exposure limit values and upper and lower exposure action value imposed in the legislation for the parameter LCpeak: it was verified that, in accordance with the legal framework relative to the exposure value and the action values of the LCpeak, the estimated mean noise ($\bar{x}$=112.14±5.87) remained significantly below the legal limits established as a reference: ELV = 140, UAV = 137 and LAV = 135. We note the absence of mean differences of LAeq dB (A) among the schools' different physical spaces.

Table 3: Verification of theL$_{Aeq}$ [dB(A)] per school and per measurement location

	Location	**Mean L_{Aeq} dB (A)**			**$\bar{x}$**	**± s**
		Class room	**Class room**	**Class room**		
L_{Aeq} n = 27	Escola D. Pedro I	**77.40**	72.40	78.30	76.03	3.18
	EB 2,3 + S de São Martinho do Porto	**64.80**	72.20	82.40	**73.13**	8.84
	Complexo dos Arcos	69.10	77.50	**85.00**	**77.20**	7.96
	EB 1,2 Integrada de Santo Onofre	66.60	**69.70**	**83.80**	**73.37**	9.17
	EB 2,3 de Atouguia da Baleia	75.50	**79.30**	**76.60**	**77.13**	1.96
	Agrupamento Fernão do Pó	**79.60**	76.30	77.00	**77.63**	1.74
	EB 2,3 Amadeu Gaudêncio	71.90	74.50	82.10	76.17	5.30
	EB 1,2 de Peniche	**64.90**	**78.10**	77.70	**73.57**	7.51
	EB 1,2,3 de Santa Catarina	**78.00**	73.70	**76.70**	76.13	2.21
	Total				75.60	5.33

Test: *ANOVA for one sample*

By analyzing the data outlined in Table 3, it is verified that there is no significance among the variants (p>0.05). The schools that had the highest average noise LAeq dB(A) in the three measurement locations were Agrupamento Fernão do Pó, EB 2,3 from Atouguia da Baleia and Complexo dos Arcos, with noise levels very similar with 78.4 dB(A) and 76.8

dB(A) respectively. On the other hand, the school EB 2,3+S of São Martinho do Porto with 63.6 dB(A) and the EB 2,3 of Peniche with 63.7 dB(A) were the ones that reported lower levels, also with very similar values.
Using the calculation formula of the Lex,8H existent in Decree-Law No. 182/2006, the following tables were developed (Chart 1 and 2), containing the noise exposure levels to which a teacher with 6 daily teaching hours is exposed to in the classroom and in the gymnasium. Taken into account was the daily exposure limit value (ELV) and upper action (UAV) and lower action values (LAV), established by the current legislation.

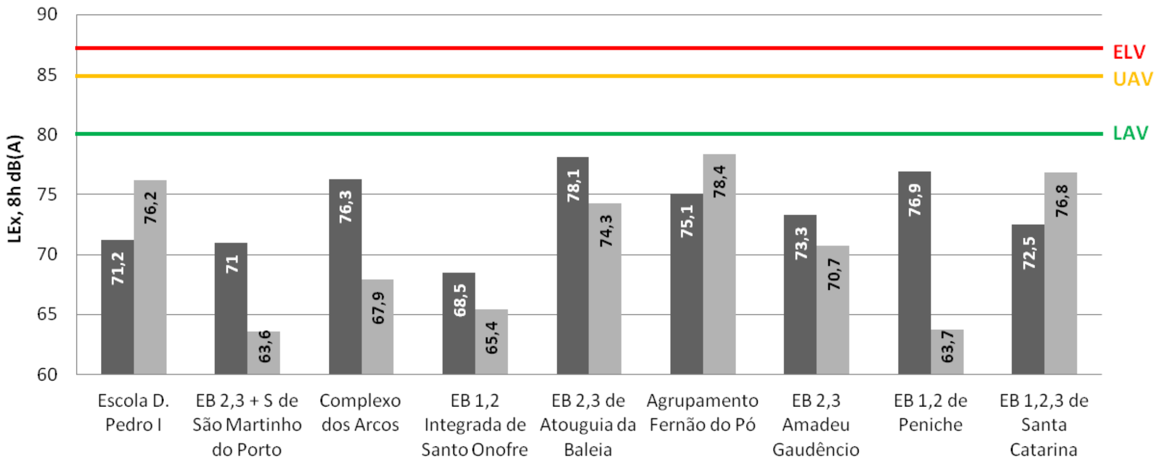

Figure 1: Levels of noise to which a teacher with 6 daily teaching hours is exposed to in the classroom and in the gymnasium – analysis of the $L_{ex,8H}$

Comparing the noise levels that the teachers are exposed to in each school with the ELV, UAV or LAV values contained in the legislation it appears that all of them are below the limit set.
After analyzing the results obtained with regard to Physical Education teachers, who teach mostly in a gymnasium, for a total of 6 daily teaching hours of exposure in a school: the school of EB 2,3 de Atouguia da Baleia with 78.1 dB(A) was the one that showed the highest levels of noise. On the other hand, the school EB 1,2 Integrada de Santo Onofre recorded the lowest levels with 68.5 dB(A). The differences in noise levels from school to school may have to do with a different number of people on the location and with the fact that the activities were also different. While in schools as EB 1,2 Integrada de Santo Onofre, EB 2,3+S of São Martinho and Escola D. Pedro I the physical activities were games of badminton, in the other schools there were games featuring the use of balls. The spaces that had lower noise levels had also a smaller area compared to the other, thus justifying the results, because there was not such a high reverberation (Rocha, 2010; Oliveira, *et al.*, 2010). As for the number of people in the location, EB 1,2 Integrada de Santo Onofre, EB 2,3 de Peniche and Agrupamento Fernão do Pó were the schools that showed a lower number while the measurement during the Physical Education class was done, thus justifying the noise levels found: fewer people lead to a lower level of noise generated. It is also important to note that linked to any type of sport or game there are always isolated or associated acts with a greater or lesser degree of intensification of environmental noise in the gymnasium, such as the acts of sports excitement on the part of students to celebrate a goal / point, the shouting and banter inherent to any physical education class. It is therefore difficult, based on the measurements made, to quantify the levels of noise to which a physical education teacher is exposed during a normal school day with 6h (Conceição, 2009).
Regarding the exposure to noise levels for a teacher who teaches in a classroom on a normal day of classes, schools that have shown higher levels of noise were in the Agrupamento Fernão do Pó with 78.4 dB(A), Escola D. Pedro I with 76.2 dB(A) and EB 1,2,3 de Santa Catarina with 76.8 dB(A), while the smaller values were in schools EB 2,3+S de São Martinho do Porto and EB 1,2 de Peniche with 63.6 dB(A) e 63.7 dB(A) respectively. In the three schools where there were major levels of noise during the measurements, were taking place classes with a more practical level: Visual and Technology Education (VTE) classes. During these classes, it was necessary to work with different materials such as wood and nails, cardboard and paper, tape, glue, paint, among others, and that required group work which increases the need for greater dialogue between the students leading to increased background noise. In the remaining schools, since it were taking place theoretical classes of Portuguese language, math and English, the noise levels were not as high, but they are still a factor to be considered. Lectures such as mathematics, Portuguese, English, VTE, among others, require high levels of concentration and according to the noise levels verified, especially in VTE, it was demonstrated the existence of the need for an additional effort on the part of teachers to raise their voices to be heard, as well as for students who also had to make a complementary effort in order to understand the information that they were being transmitted. If, on the one hand, learning is affected by higher noise levels, on the other, the ability to impart knowledge is affected as well, forcing an extra effort from both sides (Hans, n.d.).

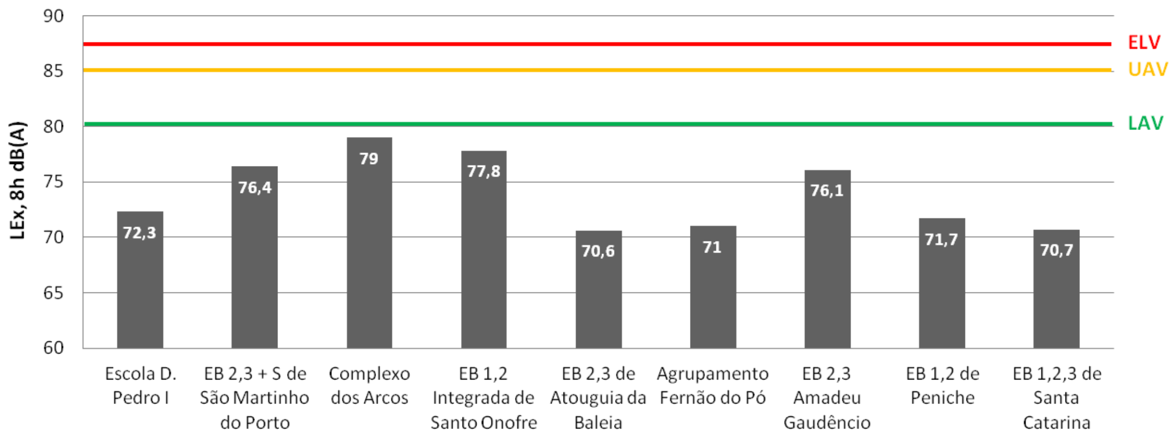

Figure 2: Levels of noise to which a non-teaching worker serving lunches during 2 hours is exposed to – analysis of the $L_{ex,8H}$

With regard to the non-teaching staff serving lunches in school canteens, the $L_{ex,\ 8h}$ was calculated with emphasis on the two hours during which they are serving lunches in school canteens, and the school of EB 2,3 de Atouguia da Baleia with 70.6 dB(A) was the one to show lower levels of noise exposure. The Complexo dos Arcos with 79 dB(A) was the school were the higher levels of noise were reached. However, all schools revealed noise levels below the limits established in the current legislation.

Despite the fact that the noise levels are below the exposure limit values and the upper and lower action values stipulated in the legislation, it was verified that in the schools of the Complexo dos Arcos and EB 1,2 Integrada de Santo Onofre the exposure values are not far from the ones cited in that legal reference, deserving attention to fill any gaps that may be contributing to these noise levels.

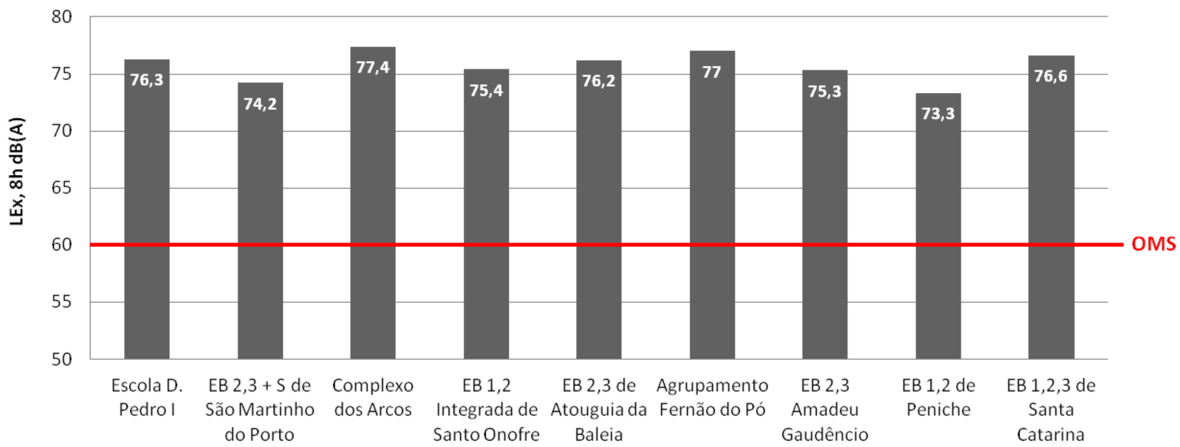

Figure 3: Levels of noise to which a student is exposed to during a normal class day – analysis of the $L_{ex,8H}$

For the students, in a normal day of classes, in which were included 4h30 of lectures in the classroom, 1h30 of a physical education practical class and 1h in the canteen for lunch, it was verified that different students from various schools are exposed to very similar noise levels, being the EB 2,3 de Peniche with 73.3 dB(A) the school that records the lowest values and the Complexo dos Arcos with 77.4 dB(A) the one that presents higher values of noise . According to the WHO recommendation for acoustic environments that do not cause discomfort (60 dB(A)), it was found that all schools were significantly above this value.

Throughout the day, in a school environment, the student ends up spending a large percentage of energy to deal with the noise, trying to focus on a stimulus during class, but the same noise leads to fatigue and wear and, because it is impossible to maintain attention, it leads to inattention. Side conversations and learning failures are ultimately reflected in school performance, which means that due to noise the student needs to make a greater effort to concentrate during class and the teacher has to make, also, a greater effort to be heard (Dreossi, *et al.*, 2004).

4. CONCLUSION

Regarding noise levels measured in schools, it is important to note that the calculations performed in a school are always influenced by the number of days per week in which teachers/students have classes, by the type of class, by the school structure itself, by the number of people on site, by the proximity to noisy places and even by the relationships formed between teacher/class within the classroom, leading to several variables that must be taken into account. During the monitoring of the measurements, it was possible to see that the quantification of noise in the school environment turns out to have much influence on the type of school, the school structure and even relationships formed between teacher/class within the classroom, not to mention the surroundings of the school. All schools were installed in quiet places, not very close to very busy road areas, or industry, facts that contributed to the fact that the noise levels found were not higher due to background noise from outside.

Noise is already a constant in our daily life. Therefore, and in particular in the case of the target audience of the school environment, the objective of this work has sought to meet the way noise is present at these locations, almost without people noticing it. From the results found, it was possible to verify that the assessed schools have high levels of noise, and that there are some structural gaps that influence the acoustic, hindering the performance of teachers, students and non-teaching staff. Given that individual sensitivity to noise is a subjective aspect, inherent to each individual and a determining factor to the various reactions to this physical agent, it becomes essential to study the noise in schools and its effects in the short and long term health and in the capabilities of learning (Oliveira, *et al.*, 2010). It is therefore essential to characterize the levels of noise, not as those likely to cause injury to the auditory system, but as those likely to cause disturbance to the good performance of tasks and focus our attention on this issue (Gonçalves, *et al.*, 2006).

Regarding noise levels measured in schools, it is important to note that the calculations performed in a school are always influenced by the number of days per week in which teachers/students have classes, by the type of class, by the school structure itself, by the number of people on site, by the proximity to noisy places and even by the relationships formed between teacher/class within the classroom, leading to several variables that must be taken into account (Ribeiro, 2008). It is preferable to compare and make estimates with the same number of daily teaching hours for each analyzed group, which makes this study too narrow in that sense, but not less important because of the need to move on to more complete and thorough new studies.

During this research, it was sought to collect data from the most similar possible situations, although this may have had some obstacles. Although the characteristics of the selected classes were very similar, the disciplines where the measurements took place were different, the number of class hours that each student/teacher was exposed to daily was also different, and the schools had different structural conditions. These realities make the process of comparability of results more difficult, and thus the suggestion for a future study performing measurements of noise levels in a school per week and not daily as in this case, addressing the points that have proved as the difficulties of the study (Conceição, 2009; Gonçalves, *et al.*, 2006).

It is also important to emphasize the need for more comprehensive and complex studies on this issue of noise in schools, not only because of the relevance that the issue itself provides as because of the need to safeguard the risks that may derive from the exposure to these levels. The complex and multidimensional nature of sensitivity to noise, as an attribute of personality, creates difficulties in measuring it, however it is, in unambiguous terms, through an ever deepening consciousness of the theme that knowledge is reached. Further studies could be a determining factor in awareness and implementation of new measures and practices, at the level of the construction of future schools that aim to provide people involved with the best conditions.

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Relationship between Age, Work Ability and Physical Demands: Study on Sanitation Sector of a Municipal Service

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ABSTRACT
This study was performed in a Municipal Service of Water and Sanitation and its aim was to analyze the relation between the age and the work ability of the workers of the Sanitation department (sewage and drain cleaners), as well as to quantify the physical demands imposed by their work activity. Firstly, this activity was characterized using the methodology of work ergonomic analysis. The everyday work of the sewage and drain cleaners was accompanied and registered on paper, video and photos. From this phase it could be identified that the most frequent activity performed was the cleaning and the clearing of collectors. This activity is very demanding from a physical point of view and exposes the worker to several hazards and associated risks. Secondly, the WAI questionnaire was applied having in view a subjective appreciation of the work ability by the workers themselves. The results showed that globally all the workers consider themselves to have a good work ability. The correlation between these results and age was not revealed as being statistically significant. Thirdly, an evaluation of the mechanical exposure was made using the REBA method. The analysis of some of the operations linked to the cleaning and clearing of collectors revealed high REBA scores, denouncing high risk levels and a pressing need to implement changes on the current work conditions. As a result, it was proposed to (1) change the way human resources are managed in order to reduce mechanical exposure; (2) continue the training project in terms of safety at work; and (3) whenever possible, introduce auxiliary mechanical means to avoid unnecessary efforts.

Keywords: Age; Work Ability Index; Physical Demands; REBA; Sanitation Sector.

1. INTRODUCTION

In recent decades, many national and European policies have had in mind the problems associated with an ageing active population. One of them is the sustainability of the social security system which implies that people stay longer in the labour market. The *Eurostat Labour Force Survey* (2011) indicates that the proportion of people between 55 and 64 years in the labour market has increased (approximately 36.9% in year 2000 to 45.6% in 2008). According to the latest results of the European Working Conditions Survey (EWCS, 2010) promoted by Eurofound (European Foundation for the improvement of living and working conditions) can be seen that the percentage of workers in the EU 27 who believe they will be able to perform their current job at the age of 60 increased slightly from 57% in 2000 to 59% in 2010 (Eurofound, 2011).

Globally accepted today is that the age-related developments are very sensitive to constraints experienced throughout the occupational pathway and that exposure to certain working conditions, in particular, can have an even more important effect than age alone (Volkoff, Molinié & Jolivet, 2000).

Thus, in the professional field, the dimension age is not only a temporal indicator but incorporates all the genesis of the individual, his professional experience and his know-how acquired (Paumès, 1995), his history and his experience, that does not result in a more or less good performance, but in a different way of conducting his activity (Ramos & Lacomblez, 2005).

Currently, there is a growing reference to the need for an increasingly global perspective on the subject of ageing, progressively geared towards an opening up to new concepts and relationships, considering the personal history of the individuals, the strong link between living conditions and working conditions and between professional and social trajectories (Drees, Dares & Poste, 2003).

The objective of this study was to correlate age with the operational assistants' work abilityof the Sanitation Sector of the Municipalized Services of Oeiras and Amadora and quantify the physical demands imposed on them by their working activity, with a view to developing proposals for improving working conditions.

2. MATERIALS AND METHOD

This study´s duration was seven and a half months, from October 2010 to May 2011.

The sample consisted of twenty-three assistants operating the sanitation sector SMAS of Oeiras and Amadora, all male, with an average age of 45 ± 8.6 years and an average length of 19 ± 10.6 years in the sanitation service. This study was conducted in three phases, each with different objectives and methodologies. The first phase of the study aimed to obtain a descriptive characterization of the work activity of sewage workers. For this purpose five visits were made, following the course of activity in the workplace. For data collection we used the observation to record on paper, video and photography. During the visit, dialogues were established with the operators to clarify / supplement the data from the observations.

The second phase of this study was the application of WAI the Portuguese Version of Work Ability Index (Silva, et al, 2006), in order to obtain a subjective perception of each worker in relation to their own ability to work. The questionnaire was applied to groups of five operators at a conference room. The WAI data were subjected to descriptive statistical analysis and a correlation (Spearman) with the independent variable age. In the third phase of the study, we used the instrument REBA (Hignett & McAtamney, 2000), exposure assessment associated with the mechanical activity of these workers, with the aim of quantifying how hard the work was. In making this assessment it was necessary to analyze the video recordings, various work situations, made in the first phase of this study. Each situation envisaged in this analysis results in a score where REBA can classify the level of heavy work that goes with it.
The results of the different phases were gradually being integrated into a perspective of understanding the relationship between age, the work ability and the physical demands of sanitation professionals, in order to develop proposals for improvement of working conditions.

3. RESULTS AND DISCUSSION

The work activity in the sanitation sector is carried out by sewage and drain cleaners. These professionals are responsible for: a) cleaning and unclogging collectors, manholes and branches connections; b) cleaning of cesspits; c) digging of ditches. Of these activities, the first one is the one which is more frequently done.
At the moment, the sanitation service is endowed with specific vehicles which allow that the cleaning and the unclogging of collectors are made mechanically in addition to manual activities to be carried out during interventions. Thus, the organization of work provides a functioning in teams of two sewage and drain cleaners and a sanitation vehicle driver.
In the course of their activity, the sewage and drain cleaners are exposed to several dangers, such as: road traffic (works on the roads), adverse weather conditions (heat, moisture, cold); toxic gases, (resulting from decomposition) etc.
These hazards can cause serious health consequences for the operators such as: being run over (due to collision with vehicles), colds and flu (due to the climate), poisoning (due to inhalation of gases) (Costa & Silva, 2010).
But, in addition to these dangers, the activity of sewage and drain cleaners is demanding in a mechanical point of view, since it involves the manual handling of loads and the adoption of inappropriate/painful postures, as the work is being carried out close to the ground, within ditches or boxes. For this reason these operators constitute a group which is likely to acquire musculoskeletal disorders, mainly at the level of the lumbar zone.
Table 1 presents a chronological summary of the main operations associated with the task of cleaning and unclogging collectors, its dangers and risks.

3.2 Individual Perception of Work Ability

In order to understand the relationship between age and the work ability of workers, was implemented the WAI questionnaire, which consists of the self-assessment of their ability to work. As we can see in table 2, the results showed that the majority of employees took good perception of their working ability.

Table 1 – Characterization of actions, hazards and risks associated with the job of cleaning and unclogging collectors (adapted from Costa, 2010)

Operations	Dangers	Risks
Operation 1 - Signal the road	Road traffic Reduced visibility locations	Running over.
Operation 2 - Remove the lid of the collector	Weight of the lid (400cm Ø, with 20 kg) Toxic gases Wastewater and solid particles	Awkward posture/MSDS Falling objects Slip/fall Inhalation of toxic gases; Projection of wastewater and solid particles
Operation 3 - Pull the cleaning hose attached to the vehicle	Weight of hose. Slippery surfaces	Awkward posture/MSDS Slip/fall
Operation 4 - Cleaning of the collector / Suction and aspiration of the collector	Weight / pressure of the hose; Projection of wastewater and solid particles Toxic gases Pathogens Wastewater and solid particles Unevenness of the box	Awkward posture/MSDS Inhalation of toxic gases; Entry of pathogens in your body Projection of solid particles and wastewater Fall from height
Operation 5 – Retraction of the hose	Weight of the hose Slippery surfaces	Awkward posture/MSDS Slip/fall
Operation 6 – Placing the lid of the collector	Weight of the lid (400cm Ø, with 20 kg) Toxic gases Wastewater and solid particles	Awkward posture/MSDS Falling objects Slip/fall Projection of solid particles and wastewater
Operation 7 - Remove the Signalling	Road circulation / road traffic Reduced visibility locations	Running over

Taking these results of the quotation of the work ability index as the dependent variable, we correlated them (Spearman's technique) with the independent variable of age. The results proved to be statistically non-significant (rho =.019; p =.822), indicating that there is no relation between the result of the work ability index and the workers' age.

Table 2 – Results of the work ability index and age (average and standard deviation) of Operational Assistants

Work Ability Index Categories	**Number of Operational assistants**	**Age**	
		Average	**Standard Deviation**
Moderate [28-36]	4	46	5,9
Good [37-43]	10	45	10,2
Excellent [44-49]	9	45	8,6
Total	23	45	8,6

3.3 Evaluation of the mechanical exposure

By using the assessment tool REBA, we assessed the risk of exposure, of biomechanical nature, in the by operators' most carried out activity: cleaning and unclogging collectors with the support of a car. The results are presented in table 3.

Table 3 – Results of the REBA score and their evaluation in three operations in the task of cleaning and unclogging of collectors. Age and seniority (in years) of the operators covered by the analysis.

Figures	**Age (Years)**	**Seniority (Years)**	**REBA *score***	**Evaluation**
Figure 1	41	8	10	High risk, investigate and implement changes
Figure 2	32	9	9	High risk, investigate and implement changes
Figure 3	54	37	9	High risk, investigate and implement changes

Figure 1 - Cleaning with support from a car

Figure 2 - Attaching the hose cleaning the collector.

Figure 3 - Lifting the lid of the collector.

The operator of Figure 1 performs the cleaning of a collector with the support of a car. He is 41 years old and has a seniority of 8 years in the role. In this situation was obtained a REBA classification of 10 points, which corresponds to a high level of risk, in which it is to investigate and implement changes in the short term.

In figure 2 the operator who performs the task of placing the cleaning hose in the collector, is 32 years old and has a seniority of 9 years. In this situation, the operator has obtained a REBA classification of 9 points, which corresponds to a high risk situation and there is also the necessity of investigation and implementation of changes.

Finally, in the figure 3, the operator is lifting an older collector lid which is heavier than the current ones (weighing approximately 30 Kg). This operator is 54 years old and has a seniority of 37 years. For this situation, like in the previous one, the operator obtained a REBA classification of 9 points, a lower classification than the first one, but which, nonetheless, corresponds to a situation of elevated risk, being equally necessary to investigate and to implement changes.
So, and in accordance with the results it was possible to check that there is no association between the operators' age and the work ability. However, the painful working conditions question the sustainability of the work activity, in the long term, for this group of workers.

4. CONCLUSIONS

This study used the ergonomic analysis of work methodology in the professional context of the sanitation sector SMAS of Oeiras and Amadora, with a view to propose measures to improve the working conditions of these operators.
According to the statistical results obtained, we can say that there is no direct relationship between age and the work ability of these workers.
The results obtained through observation and application of assessment tools of this situation, indicated that the operators' working conditions impose the adoption of inappropriate/painful postures because the activity is very demanding from a physical and mechanical standpoint, being necessary to implement immediate and/or short term changes, as well as implement mechanical auxiliary devices where the situation allows. On the impossibility of implementing these means, and knowing that there is no way to modify the postures in task completion, measures of human resources management shall be taken, regarding the organisation of work, such as the introduction of rotating work and versatile teams, with the goal of minimizing risk exposure of biomechanical nature associated with the occurrence of musculoskeletal disorders. By strengthening these organizational measures it is important to continue the training given to these operators, in relation to manual load handling.
According to the data collected through the European Working Conditions Survey (EWCS, 2010) promoted by Eurofound (European Foundation for the improvement of living and working conditions), we ask whether these workers are included in the European average of 59%, which see themselves working at the age of 60? Are these workers capable of performing the tasks assigned to them and meet their objectives without limitations or health problems? The results of the INSAT inquiry (Silva, Costa & Saraiva, 2011) made in this group of professionals indicated that 25% believe that they will not be able to perform their work at the age of 60. Although the percentage is lower than that achieved in EWCS, it is worrying considering the specificity of the sector in question. So it is expected that the subjective perception of the ability to work evolves towards its reduction.
So, knowing that this work is very demanding in physical terms we ask again: can the operators perform the same work in ten/fifteen years with the same intensity of mechanical load to which they are exposed currently without (further) compromising their health and safety? As Ilmarinen et al (1999) noted in their studies, high physical demands contribute to the exclusion of older workers (above 50 years old) from their workplaces.

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Work Ability and Patient Handling Occupational Risk Perception among Nurses

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ABSTRACT
This study focused on assessing the work ability of nurses and their relationship to job satisfaction, and the relationship between perception of the risks of manual handling of patients and musculoskeletal self-reported MSDs. The evaluation was conducted in eight wards for adults with 126 nurses. The tools used were: the Portuguese version of the WAI, the Nordic Questionnaire, questionnaires of satisfaction and of patient handling risk perception. The work ability of nurses corresponded to the category of "Good" work ability, with an average score of 40.14 (sd = 4.58). The results showed a higher percentage of good work ability on the ages of 21 to 35 years and unsatisfactory from 36 years on. Self-reported MSDs (12 months) were more prevalent in the back (66.9% lumbar, 45.2% cervical, 39.5% dorsal), shoulder (35.5%) and wrists (20.2%). Of professionals without low back complaints, the majority never used a dangerous method (65.9%) or conducted patient handling without lifting equipment (68.3%). From the group of nurses who were "almost always" satisfied with their work, 80% had a satisfactory ICT. The occupational health professionals can use the WAI to determine the important measures to maintain work ability along the working life. Individual health conditions and physical work load are main factors contributing to decrease the perception of the ability to senior nurses working in hospitals.

Keywords: Hospital Ergonomics; Work Ability; Nurses' Work Satisfaction; IET; Patient Handling.

1. INTRODUCTION

In the perspective of productive ageing, the prevalence of musculoskeletal injuries in nurses have scaled and frequently alter work ability in a hospital's context, contributing for the exclusion of these care providers (Cotrim, 2008).
Work ability is also significantly related with the physical environment, to job satisfaction, psychosocial support and physical exercise and healthy lifestyles (Estryn-Behar et al, 2005). In nurses, in order to improve and maintain work capabilities, certain measures are recommended such as: increasing the capacity of dealing with the mental work demands in young nurses and improving working conditions in order to reduce the physical workload in senior nurses (Chiu et al, 2007).
In fact, nurses are exposed to a multiplicity of occupational risk factors, many of them caused by the high levels of physical and mental tasks they carry out. Several studies refer the risk of musculoskeletal injuries (MSD's) related to the handling of dependent patients (Cotrim, 2008; Smith et al, 2006).
Therefore, a study in ergonomics was carried out, to try to understand in what measure work ability, risk perception when handling patients and work satisfaction variables of nurses were related to each other.
The general objective was to understand the relation between nurses' work ability and their satisfaction at work, and the relation between the perception of these care providers with the risks of handling patients and the self-described musculoskeletal injuries.

2. MATERIALS AND METHODS

The sample consisted of 126 nurses of 8 adult Medical Wings at the Hospital Garcia de Orta, EPE: Cardiology, Gynecology, Hemato-oncology, Medicine I, Medicine II, Medicine III, Orthopedics and Traumatology. Most of the nurses were women (81%), with a mean age of 33,7 years (sd=8,5; min=22; máx=53) and a mean seniority in the hospital of 8 and a half years (sd=6,0; min=0,5; máx=19,0).
According to the study's objective and the literature's revision, the following assessment instruments were used, that were joined in a single questionnaire.

2.1. Work Ability Index (WAI)

In this study the Portuguese version of the Work Ability Index (Silva et al, 2006) was used. The Work Ability Index describes the worker's assessment regarding his own work ability. This instrument should be used in the area of Occupational Health, simultaneously with the assessment of work places, and is intended to be used as an aid for maintaining work ability (Ilmarinen, 1999; Ilmarinen et al, 2005).
WAI is made up of 7 items, based on the actual work ability, the physical and mental work demands, health conditions, absenteeism, work ability prognosis and psychological resources. Scoring that varies between 7 and 49, is distributed from a poor to excellent work ability. Depending on the work capacity level, certain intervention measures are recommended (Ilmarinen, 1999).

2.2. Intervention Evaluation Tool (IET)

The Intervention Evaluation Tool (IET) was developed by Fray (Fray & Hignett, 2009) and is made up of 12 parts. In this study only 3 parts were used:

- **Nordic Questionnaire** (Standardized Nordic Questionnaire, Kuorinka et al, 1987), in an abridged version, is used for auto-referring the healthcare workers' musculoskeletal symptoms. Musculoskeletal symptoms are identified by the healthcare workers in different body parts, as well as the subsequent inability for carrying out work. The questions are related to the last 12 months, the last 7 days and the inability of carrying out normal work in the last 12 months.
- **Questionnaire of the Healthcare Workers Satisfaction and Well-Being**, is made up of 13 questions regarding satisfaction at work.
- **Questionnaire of the Healthcare Workers' Perception** regarding Patient Manual Handling, includes 9 questions in the scope of accidents occurring from handling patients, use of lift equipment's, interference in work conditions when changing the patient's position.

3. RESULTS AND DISCUSSION

3.1. Work Ability Index

The average Work Ability Index (WAI) was 40,14 (sd=4,58), indicating a "good" Work Ability for the nurses of the sample. This average was higher than the one found in other studies with nurses: 38,4 in Chiu et al (2007), 38,7 in Cotrim (2008). On the contrary, the percentage in the "poor" category (0,9%, n=1) (figure 1) was lower than in other studies: 3,2% in Costa (2005), 4,1% in Estryn-Behar et al (2005) and 5,0% in Cotrim (2008).

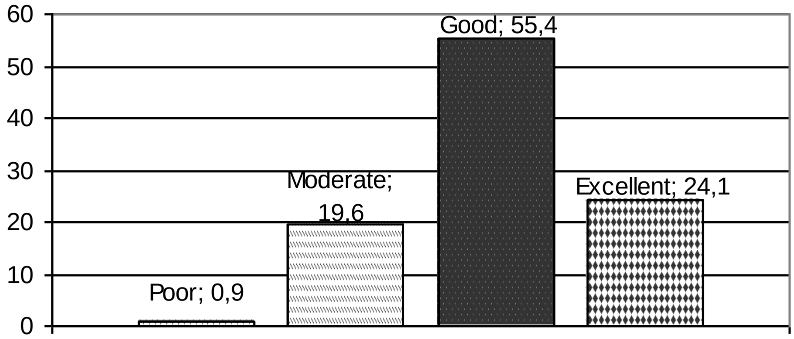

Figure 1 – WAI distribution by categories.

The obtained results, showed a greater percentage of nurses with a satisfactory WAI in the young ages (between 21 and 35 years), and an unsatisfactory WAI for care providers over 36 years of age (table 1). These results indicate that WAI diminishes with age, which is in agreements with Ilmarinem (2005), Estryn-Behar (2005) and Cotrim (2008). However, no statistical significant dependence relation was found between the two variables (X^2=3,018; gl=3; p=0,389).

Table 1 – WAI distribution by age.

ICT Dichotomized		**Age Group**			
		21-25	**26-35**	**36-45**	**46-55**
Unsatisfactory WAI	Freq.	3	7	7	4
	%	15,0	20,6	30,4	40,0
Satisfactory WAI	Freq.	17	27	16	6
	%	85,0	79,4	69,6	60,0

Regarding gender, the average WAI obtained was greater in men (41,13) than in women (39,93), although the differences were not statistically significant. Also, other results in nurses revealed an average WAI higher in men (40,71 in men; 38,27 in women) (Cotrim, 2008).

Concerning the diseases diagnosed by a doctor, 60,7% of the nurses' sample referred having illnesses diagnosed by a doctor. Of these illnesses, the three that stood out were respiratory ones (26,8%), injuries caused by work accidents (25%) and digestive illnesses (16,1%) (table 2). Other studies with nurses obtained similar results (Fisher et al, 2005; Andrade and Monteiro, 2007).

Table 2 - Distribution of diseases diagnosed by a doctor.

Diseases / Disorders Diagnosed by a Doctor		Freq.	%
Disorders after Accidents	Yes	28	25,0
	No	84	75,0
Circulatory diseases	Yes	13	11,6
	No	99	88,4
Respiratory diseases	Yes	30	26,8
	No	82	73,2
Mental disorders	Yes	4	3,6
	No	108	96,4
Neurological and Sensory Disorders	Yes	11	9,8
	No	101	90,2
Digestive diseases	Yes	18	16,1
	No	94	83,9
Urogenital diseases	Yes	5	4,5
	No	107	95,5
Dermatology diseases	Yes	13	11,6
	No	99	88,4
Tumor disorders	Yes	3	2,7
	No	109	97,3
Endocrine and Metabolic Diseases	Yes	5	4,5
	No	107	95,5
Blood diseases	Yes	2	1,8
	No	110	98,2
Musculo-skeletal disorders	Yes	10	8,9
	No	102	91,1
	Total	**112**	**100**

Of the care providers with diagnosed illnesses, 17% had to “frequently” or “sometimes” slow down their work pace or their way of working due to the illnesses. Also, Andrade and Monteiro (2007) stated that healthcare workers with musculoskeletal disorders needed to slow down their pace of work.

3.2. Prevalence of Musculoskeletal Disorders

From the characterization of the self reported MSD’s by nurses we noticed that the vertebral column (lumbar, cervical and dorsal) and the shoulders represented the body parts with the greatest prevalence of MSD’s in the last year and in the last 7 days. However, most of the nurses referred that these health problems did not lead to an incapacity or limitation for work in the last 12 months (table 3).

Table 3 - Distribution of self-described MSD per body parts.

Self-described MSD’s		12 months		7 days		Incapacity	
		Freq.	%	Freq.	%	Freq.	%
Cervical Region	**Yes**	56	45,2	26	21,0	1	0,8
	No	68	54,8	98	79,0	123	99,2
Dorsal Region	**Yes**	49	39,5	28	22,6	1	0,8
	No	75	60,5	96	77,4	123	99,2
Lumbar Region	**Yes**	83	66,9	46	37,1	2	1,6
	No	41	33,1	78	62,9	122	98,4

These results are very similar to the ones obtained by Fonseca and Serranheira (2006), in a study about the self described musculoskeletal symptoms by nurses in a Portuguese Hospital, where there is a high prevalence of symptoms in the last 12 months, in the same body parts: lumbar (65%), cervical (55%), dorsal (37%), shoulders (34%) and wrists/hands (30%). In a study with nurses in Japan, Smith et al (2006) obtained similar results, in the lumbar column (71,3%), cervical (54,7%) and dorsal (33,9%), although there was a much higher prevalence at the shoulder level (71,9%).
Therefore, musculoskeletal injuries in nurses can be associated to the nature of the tasks this professional group carries out, their adopted postures and performed physical effort. In his study Smith et al (2006) refers that MSD in the shoulder were associated to patient handling, in the dorsal column associated to bending/twisting the trunk, and in the lumbar column to handling movements, bending/twisting the trunk and great physical effort. On the other hand, the lay-out and size of work spaces also contribute to the complexity of patient handling tasks (Cotrim, 2008).

3.3. WAI and Prevalence of Musculoskeletal Disorders

In the relation between WAI and the self-described MSD, we obtained higher WAI values in the nurses without musculoskeletal complaints. These differences were statistically significant for the regions with a higher prevalence of MSD: cervical region (U=1112,0; p=0,009), dorsal (U=1149,5; p=0,029), lumbar (U=917,5; p=0,013) and shoulders (U=1059,0; p=0,009). Regarding the prevalence of the self-described MSD in the lumbar region, the nurses with complaints had an average WAI of 39,41 and the nurses without complaints had an average WAI of 41,89 (figure 2).
In her study Cotrim (2008) also concluded that in the group of nurses with a "poor" work capacity, 81,8% referred acute lumbar pain in the last 12 months and that WAI diminished when the presence of acute lumbar pains occurred.

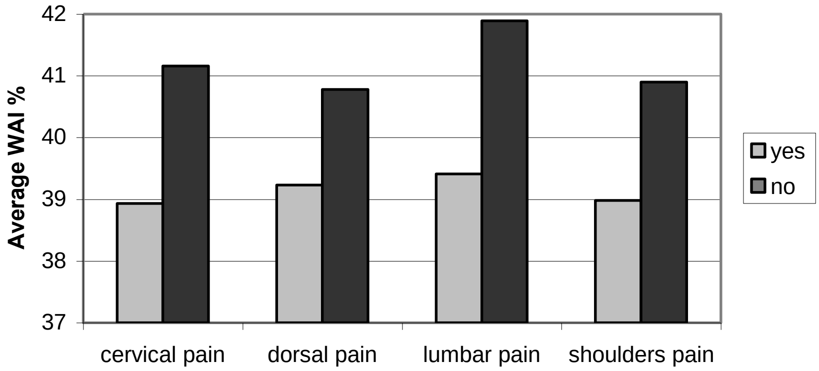

Figure 2 – WAI and self-described Musculoskeletal Disorders.

3.4. WAI and Work Satisfaction

The results allowed us to notice that WAI varied with the results of Work Satisfaction, as in the studies of Estryn-Behar et al (2005) and Chiu et al (2007).
Regarding the satisfaction about some aspects related to work (I like the task (table 4), time to accomplish a task, etc), from the "almost always" satisfied nurses, a high percentage of them obtained a satisfactory WAI. Similar results were obtained concerning the satisfaction with colleagues (sharing problems, support, solving conflicts, etc.) and superiors (relationship with superiors and support).

Table 4 – Distribution of the variable «enjoy the tasks» in relation to WAI.

WAI Dichotomized		Enjoy the Tasks: Rarely	Sometimes	Almost Always
Not satisfactory	Freq.	2	11	13
	%	66,7	19,0	26,5
Satisfactory	Freq.	1	47	36
	%	33,3	81,0	73,7

Estryn-Behar et al (2005) also referred that the support and help given by work colleagues and by the management can partially compensate the difficulties felt by the nurses. She noticed that from the nurses who referred getting "frequent" or "very frequent" support from colleagues, 16,3% presented excellent WAI, opposed to the 11% of the care providers who referred "rarely" or "never" getting that support. Regarding the management's support, of the care providers who referred receiving this support "frequently" or "very frequently", 18,4% showed an "excellent" WAI whereas 13% referred "never" or "almost never" receiving that support.

3.5. The Perception of Nurses when Handling Patients

Only 7,5% of the nurses referred having some kind of work accident, in the last 12 months, related to patient handling.
In this sphere of action, 43% of the nurses referred having used, at some point, dangerous methods for handling patients, or having carried out tasks for handling or transferring patients without the use of lifting equipment, when this was recommended. This aspect can be explained by the fact that these care providers frequently presented a collection of motives for not using this kind of equipment.
In Holman's et al. (2010) study, these motives were identified: not enough time in an emergency situation, non-available equipment and existing space not big enough for its use (dimension, configuration and space cluttering). In the same study, only 6,7% of the nurses when "needing to transfer a patient on their own", can locate and use the technical help equipment" (Holman et al, 2010).
Regarding the relation between not using good practices and the musculoskeletal symptoms in the lumbar region, we noticed that of the nurses with no lumbar complaints, a great deal of them did not use dangerous methods (65,9%) and

did not handle patients without help equipment when recommended (68,3%) (figure 3). However, despite this tendency, we did not notice a statistically significant dependency relation between the two variables (X^2=3,213; gl=1; p=0,073).

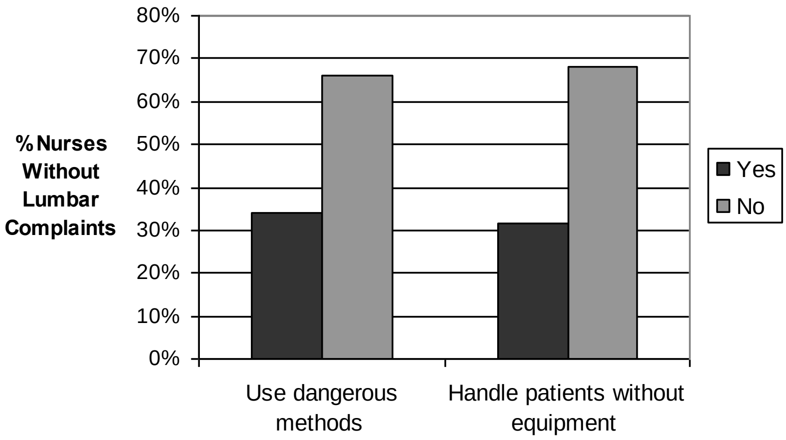

Figure 3 – Good practices and lumbar symptoms.

Within this context, Alamgir et al (2009) referred that the perception of the health care providers has been used to assess their acceptance of mechanical transfer equipments, as an efficient means for reducing MSD associated with patient handling.
From the obtained results, 9 nurses mentioned having had at least one work accident in the last year, during patient handling. On the other hand, the notifications were much less than the self described accidents. In the same year only 3 accidents were noted in the targeted medical wings.

4. CONCLUSIONS

The Work Ability Index varied according to age (WAI diminishes as age increases) and varied, also, with work satisfaction (higher values of WAI were noticed in nurses who were "almost always" satisfied with work, with their colleagues and management).
In this group a high prevalence of musculoskeletal injuries was noticed, potentially associated to the tasks of patient handling, and we know that the appearance of musculoskeletal injuries is conditioned by the risks of patient handling, with repercussions at the work ability level.
In a society where the ageing of the active population is noticeable and, consequently, nurses will have to work more years, it is noteworthy that these results that relate WAI with the MSD associated to work are very relevant. The significant differences in WAI between groups of care providers with and without MSD complaints, is an indicator that reinforces the need for implementing measures. We know from other studies, that the presence of MSD correlates negatively with WAI (Cotrim, 2008) and that the groups with a weak WAI and aged over 50 years old have a higher probability of being removed from their work posts (Ilmarinen et al, 2005).
Thus, this study emphasizes the need for implementing intervention measures at the Hospital, in order to diminish exposure to musculoskeletal injuries inherent to patient handling and of promoting and maintaining work ability for the future. The main Ergonomic intervention measures belong to three principal groups: healthcare workers training, work conditions and work organization. In the area of training, it is necessary to intensify information and training of the healthcare workers in order to apply good work practices, the use of available help equipments and the adoption of healthy life styles. Regarding the conditions for carrying out tasks, it is necessary to act in the design of work spaces, in maintenance of existing furniture and equipments, as well as acquiring furniture that is adequate and adjustable to the anthropometric characteristics of the users and the wards' needs. The measures integrated in the organizational aspects of work are related to: patient ratio / nurse, distribution of dependent patients per care provider, heavier tasks carried out by 2 healthcare workers, number of continuous work hours, adapting tasks or replacing healthcare workers in case of Partial Incapacity for Work (temporary or permanent).

5. ACKNOWLEDGMENTS

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Effect of an exercise program in work environment on musculoskeletal disorders. Report of an experience in administrative workers

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ABSTRACT
INTRODUCTION: There is no doubt that the new forms of work led to greater ease and comfort in the lives of workers, however physical inactivity associated with the work process mechanistic, conceived the onset of new types of diseases related to work activity or occupational diseases (OD). There is a set of OD generally designated by musculoskeletal disorder (MSDs) related work that are of great prominence, being described that are increasingly frequent and constitute a major problem in industrialized countries (Airaksinen et al. 2006; Bigos et al, 2009). MSDs are currently reported as the main causes of absenteeism and reduced productivity of workers which affects the production capacity and increases not only absenteeism but also presenteeism. European Foundation for the Improvement of Living and Working Conditions (Giaccone, 2007), notes that Portugal is the third country in the EU in which the workers most miss due to MDSs. It is in order to counteract this that it tends to appear prevention programs in workplace health. Such programs aim to reduce the risk of chronic degenerative diseases related to work, besides serving as a promoter element of lifestyle changes, particularly with regard to prevention of risk factors for cardiovascular diseases, stress management and improvement in functional capacity. There are numerous strategies you can use to carry out this type of initiative and exercise in the work environment best known for Labor Gymnastics (LG) is one of the most emerging. In Portugal, exercise interventions in the work environment, are still not significant, since few companies have this type of service, there are few reports in the media and there are virtually no scientific publications about it. It seems therefore essential to seek to ascertain the effects of this type of intervention in order to realize the respective cost / benefit to the company and the employee. Therefore, this research is covered by two objectives: (1) estimate the prevalence of MSDs on the neck and lumbar pain in office workers, (2) determine the effect of an exercise program in the workplace back pain and neck in adult workers of both sexes. MATERIAL AND METHODS: The sample consisted of 36 subjects, of whom 23 were female (41.2 ± 11.1 years) and 13 males (42.0 ± 10.4 years). All patients underwent an exercise program working with the frequency of two weekly sessions, 10 to 15 min during 3 months. MSDs were assessed based on the Nordic Questionnaire for musculoskeletal injuries, validated for the Portuguese population by Mesquita et al. (2010). Pain intensity was assessed by visual analogue scale VAS of 10 points (Wewers & Lowe, 1990). The data were based on descriptive statistics and prevalence. To compare time points t test was used for repeated measures. RESULTS: We found a high prevalence of MSDs, in the neck (50.0%) and in the lumbar (44.4%), being higher in females in both: neck (52.2 ♀, ♂ 46.2) lumbar (65.2 ♀, ♂ 38.5). The application of the program had an controversial effect in reducing pain in neck (p = 0.047), however, lower back, was a significant reduction (p=0.003). Analyzed by sex, we can see that the in female was observed only a significant reduction of pain in lumbar (p=0.015) and in males only in the neck (p=0.028). CONCLUSIONS: There is a high prevalence of MSDs in the neck and lumbar regions in the administrative workers for both sexes. Despite the short duration of the program (about 3 months), the reduced number of week sessions (two per week) and reduced the time of exercise per sessions (10 to 15 min.), a program of exercise in the work environment seems to have potential to reduce pain in office workers.

Keywords: Labor Gymnastics; Pain; Musculoskeletal disorder; work environment.

1. INTRODUCTION

Over the years, there were major changes in ways of working resulting from industrialization and technological advancement. Mendes and Leite (2004) reported that before the Industrial Revolution of 1774, human effort contributed 30% of energy used in factories and farming activities and that currently, the new forms of work in developed countries mean that the rate of effort physical accounts for only 1% of total energy expenditure. Therefore, the worker sharply reduces the physical effort during the workday and reduces physical fatigue but, in contrast, sedentary lifestyle and the consequent lack of muscular demand, are gaining tremendous proportions, so that they are described a set of health problems related to lack of movement that is called a "hypokinetic diseases" (Bouchard, 2003).

There is no doubt that the new forms of work led to greater ease and comfort in the lives of workers, however physical inactivity associated with the work process mechanistic, conceived the onset of new types of diseases related to work activity or occupational diseases (OD). OD is one that is a direct result of working conditions, contained in the List of Occupational Diseases (Decree No. 76/2007 of 17 July) and cause inability to practice the profession. In this context, there is a set of OD generally designated by MSD-Related Work (MSDs) that are of great prominence, being described that are increasingly frequent and constitute a major problem in industrialized countries (Airaksinen et al. 2006; Bigos et al, 2009). Another aspect to consider is that the highest incidence occurs between the ages of greater productivity, that is, thirty to forty years, being higher in females, due to the increase of women in the labor market, but mainly by hormonal issues, balancing work and lack of muscular capacity to perform certain tasks (Przysiezny, 2000).

MSDs are currently reported as the main causes of absenteeism and reduced productivity of workers which affects the production capacity and increases not only absenteeism but also presenteeism. Such lesions have a high impact on worker productivity. The European Agency for Safety and Health at Work (EASHW, 2008), states that the MSDs Related Work were the most common OD in Europe. In the 2005 study, where 31 countries were surveyed, 25% of workers reported back pain and 23% had complaints of muscle pain. According this survey, 62% of the workers reported that they were exposed to repetitive hand or arm movements and 46% reported working in painful or tiring positions for at least a quarter of their working time.

According to the European Agency for Safety and Health at Work (EASHW, 2008), 53% of EU workers have MSDs and these are responsible for 25 working days lost per worker, and 70% of people with chronic pain, lose concentration at work and 76% of workers with pain lack the energy to perform fully its task!

Portuguese Association of Ergonomics (APERGO, 2005) says that in Portugal there are no studies about prevalence of MSDs but that has been witnessing a gradual increase in the number of cases reported in the National Center for Protection Against Occupational Hazards.

It is in order to counteract this trend that it tends to appear prevention programs in workplace health. Such programs aim to reduce the risk of chronic degenerative diseases related to work, besides serving as a promoter element of lifestyle changes, particularly with regard to prevention of risk factors for cardio-vascular, stress management and improvement in functional capacity. There are numerous strategies you can use to carry out this type of initiative and exercise in the work environment best known for Labor Gymnastics (LG) is one of the most emerging. It consists of performing a sequence of exercises (at work), for short periods of time, and aims to normalize body functions and reduce the possibility of impairment of physical integrity (Trunk, 2002). This regular practice, by redressing imbalances and daily overloads, aims to improve the quality of life of workers and workplace performance. Large and small companies in many countries have discovered a beneficial relationship between productivity and quality of life, therefore, have increasingly invested in valuing human life in the workplace and extended care for their physical and mental health.

The costs of prevention programs, with the adoption of physical activity and access to proper ergonomics for workers is insignificant when compared with the benefits of health and quality of life achieved in the future with the possibility of greater productivity.

Thus, a program of physical exercise in the workplace seems to be an interesting strategy for the prevention of OD and thus increase productivity. This fact is verified by the World Health Report (WHO, 2002), by stating that for every euro invested in health promotion programs based on exercise, you get a reduction in absenteeism 4.9€, 3.4€ in health care and 3.30€ in medical costs.

In Portugal, exercise interventions in the work environment, such as Labor Gymnastics (LG), are still not significant, since few companies have this type of service, there are few reports in the media and there are virtually no scientific publications about it. It seems therefore essential to seek to ascertain the effects of this type of intervention in order to realize the respective cost / benefit to the company and the employee.

Therefore, this research is covered by two objectives: (1) estimate the prevalence of MSDs on the neck and lumbar pain in office workers, (2) determine the effect of an exercise program in the workplace back pain and neck in adult workers of both sexes.

2. MATERIAL AND METHODS

The sample consisted of 36 subjects, of whom 23 were female (41.2 ± 11.1 years) and 13 males (42.0 ± 10.4 years). Workers completed the form of "informed consent" before participating in the respective program. All patients underwent an exercise program working with the frequency of two weekly sessions, lasting 10 to 15 min. The program use the methodology of Lian Gong in 18 therapies created by Yuen Ming Zhuan, a Chinese orthopedist and consists of 54 exercises divided into 3 parts for easy learning and operation. The first part seeks to strengthen the muscles of the neck, shoulders, back and lumbar region and lower limbs (muscle strength), the second emphasizes the work of joint mobilization (stretching), and the last part calls especially breathing exercises (Lee, 1997, Livramento et al, 2010). All subjects were evaluated before and after the program. MSDs were assessed based on the Nordic Questionnaire for musculoskeletal injuries, validated for the Portuguese population by Mesquita et al. (2010). The reliability of the results were very good with the correlation coefficients varied between 0.7 and 1. Pain intensity was assessed by visual analogue scale VAS of 10 points (Wewers & Lowe, 1990). The data were based on descriptive statistics (mean and standard deviation) and percentage of occurrence or prevalence. To compare time points t test was used for repeated measures. We used SPSS version 19.0 software and the significance level was maintained at 5%.

3. RESULTS AND DISCUSSION

Exploratory analysis was performed to investigate the possible presence of outliers and normality of distribution. After removing two outliers, we obtain a normal distribution. Despite the lifting of the subjective feeling of pain have been conducted in different regions of the body, we just centered our analysis on those that had a higher prevalence, for instance, the neck and lumbar spine. The main results can be seen in the table 1:

Table 1. Prevalence of back pain and neck for the overall sample

Neck	Lumbar
50,0 %	44,4 %

As is possible to verify the prevalence of back pain is high and confirms the literature data (EASHW, 2008). In any case, in our sample, the values are higher than those described by the European Foundation for the Improvement of Living and Working Conditions (Giaccone, 2007) which has a prevalence of low back pain by 25%. However, the same institution suggests that low back pain is a condition that implies greater morbidity and disability, including considerable financial implications affecting 58 to 84% of working adults (Airaksinen et al. 2006; Alipour, Ghaffari, Shariati, Jensen & Vingard, 2008). The current research suggests that prevalence of low back and neck problems varies widely from study to study as can be seen in Table 2

Table 2. Studies about the most referred pain areas

Author	**Type of Task**	**The most referred areas (%)**
Myung, Y. (2001)	Female Bank tellers	38,3% lumbar, 38,0% neck
Doracilde, H. (2005)	Collar workers	22% lumbar
Rocha, J. (2007)	Furniture industry	54% lumbar
Silva, M. (1998)	Collar workers	55% spine (neck, thorax and lumbar)
Gouveia, R. (2011)	Collar workers	63% lumbar; 53% neck

In addition, in this sample, neck problems have higher expression than lumbar. This may be due to the type of task that most of these workers are subjected (seated at desks with flexion of the neck).
In Table 3 is possible to see the prevalence of back pain and neck by sex

Table 3. Prevalence of back pain and neck by sex

Female (n=23)		**Male (n=13)**	
Neck	Lumbar	Neck	Lumbar
52,2 %	65,2 %	46,2 %	38,5 %

When analyzed by gender, it is possible to observe a high prevalence in both sexes, being, in relative terms, higher in females in both regions of the spine. Contrary to the general tendency of this sample, but meeting the values of the international literature (EASHW, 2008), females exhibit a higher prevalence in the lumbar.
The level of subjective feeling of pain before and after program is in Table 4.

Table 4. Level of subjective feeling of pain (VAS 10-point scale) before and after program implementation for the entire sample

	NECK		LUMBAR	
	Before	After	Before	After
average	2,8±0.8	1,9±0.5	2,9±0.7	1,6±0.4
p	**0,047**		**0,003**	

By reading Table 4, it is clear that, on average, it was noticed a significant reduction of the subjective feeling of pain, both in the neck (p = 0.047) and in the lumbar spine (p = 0.003). The analysis of individual values allows us to realize that in the neck of the 36 subjects, 18 (50.0%) had pain at baseline. Of these, 6 (33.3%) worsened the level of pain sensation, 1 (5.6%) kept and 11 (61.1%) improved. In turn, in the lumbar of the 36 subjects, 19 (52.8%) had pain at baseline. Of these, two (11.1%) worsened the level of pain sensation, 1 (5.6%) kept and 16 (88.9%) improved. Identical results were reported in several studies (Arokoski et al. 2004; Kuukkanen & Malka, 2000; Moseley, 2002; O'Sullivan, Mitchell, Bulich, Waller, & Holte, 2006; Rainville, Hartigan, Martinez, et al. 2004, Waddell & Burton, 2001). These refer that specific exercise programs can reduce the intensity of back pain and relieve disability in those who suffer from pain sub acute and chronic low back. According to Friedrich, Gittler, Arendasy, & Friedrich (2005) benefits can be achieved only if the exercises are performed regularly and consistently. In Table 5 is possible to see the level of subjective feeling pain before and after program by gender.

Table 5. Level of subjective feeling pain (VAS 10-point scale) before and after the implementation of the program by gender.

	Female (n=23)				**Male (n=13)**			
	NECK		LUMBAR		NECK		LUMBAR	
	Before	After	Before	After	Before	After	Before	After
average	2,9±0.9	2,4±0.8	3,3±0.5	1,8±0.7	2,6±0.6	1,0±0.5	2,2±0.7	1,4±0.4
p	0,389		**0,015**		**0,028**		0,084	

Reading the table, it is clear that was noticed a statistically significant improvement in the level of the lumbar in females and males in the neck. Perhaps these results can be explained by the fact that they are the most affected regions in each sex. Analyzing the individual values, it can be seen that: for women, the neck of 23 women, 14 (60.9%) had pain at baseline. Of these, seven (50.0%) worsened the level of pain sensation, 1 (7.1%) and remained six (42.9%) improved. In turn, lower back 15 women (65.2%) had pain at baseline. Of these, 2 (13.3%) worsened the level of pain sensation, one (6.7%) remained and 12 (80.0%) improved. For males we can see that in the neck of the 6 subjects (46.2%) who had pain at baseline, all reduced sensation. In the lumbar we find the same trend, that is, the four subjects (30.8%) who had pain at baseline all decreased the subjective feeling of pain at the end. Several studies have shown benefit with the use of physical activity programs in business, such as reducing fatigue (Kolling, 1982), improves the dynamic posture of the worker (Rocha, 1999), increased flexibility and change in lifestyle (Martins, 2000), reduction of musculoskeletal complaints (Santos, 2003), reduced leave for low back pain (Reis, 20003), a decrease in outpatient visits (Santos, 2003; Souza, 2004). Militão (2001) concluded that exercise at work when driven directly by the physical education teacher, greatly reduces problems related to pain, discouragement, lack of willingness, insomnia, irritability, and promotes greater motivation for physical exercise. According to Lima (2007), LG stands out as a way to injury prevention in the workplace, improves flexibility and joint mobility, reduces muscle fatigue and benefits the position of the individual in front of the station and his work routine.

In addition to benefits related to health worker, LG brings great benefits to business organizations (income and production), which is why this physical activity is encouraged and implemented by various companies (Carvalho, 2004). Cañete (2001) conducted a survey of five Brazilian companies and found, through interviews with employees from different hierarchical levels, the LG significantly reduces absenteeism by occupational diseases and the absence from work due to the effects of relaxation, relaxation and elimination of pain that exercise provides.

It is important to consider that the LG is adopted as a preventive measure for supporting an approach that considers the "work" and "who works" (Devide, 1998).

The execution of LG programs should cherish freedom of speech and worker's own initiative, therefore, should not be imposed as an additional task to be performed on the journey to work (Soares & Assunção, 2002). According Cañete (2001), exercise in work can provide all these benefits, however, its success depends on the competence, level of awareness and ethics adopted by the leading professionals. Militão (2001), adds that physical activity may be a "double-edged sword" because according to the professional guidance it can be an instrument of high educational value health promoter or, if conducted by incompetent practitioners, can produce physical injuries and negative qualities. However, with regard to bad practices it can be seen as harmful in any kind of approach, that is, an incorrect prescription of a drug is harmful, a poorly designed physical therapy tends to increase the injury, a botched surgery can lead to permanent disability, etc.

4. CONCLUSIONS

There is a high prevalence of MSDs in the neck and lumbar regions in the administrative sector workers for both sexes. Despite the short duration of the program (about 3 months), the reduced week (two sessions per week) and reduced the time of exercise sessions (10 to 15 min.), a program of exercise in the work environment seems to have potential to reduce the subjective feeling of pain in office workers.

5. SUGESTIONS

Given the dearth of intervention work in the work environment we think is fundamental to its expansion and dissemination in the scientific community and may be based on strategies for single or multi-disciplinary approach. Given the trend towards increasing the framework of the DP, it is essential to characterize the prevalence of pain and discomfort and different types of activity and determine the effect of intervention strategies, with ergonomic intervention, physical therapy, exercise an so on.

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Sodium Content in Vegetable Soups Prepared Outside the Home: Identifying the Problem

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ABSTRACT
Cardiovascular diseases are a major cause of mortality and disability in developed countries, accounting for 39% of deaths. One of the most important factors associated with their onset is a high sodium intake, which increases the risk of high blood pressure. Excessive salt intake is associated with the consumption of processed foods and eating outside home, which nowadays can vary from one to all day meals. The consumption of vegetable soup is a healthy cultural practice, negatively associated with obesity, but their high sodium levels raised some concern recently.
The aim of this work was to quantify the sodium content in vegetable soups served at public institutions' canteens. Soups, with and without salt added, were collected from kindergartens, elementary schools and nursing homes, and their sodium content was determined by flame photometry.
In soups without added salt, sodium contents ranged from 0.13 to 216.63 mg/100g, in nursing homes, and 0.93 to 284.02 mg/100g, in kindergartens. Sodium content in soups with added salt ranged from 124.71 to 429.04 mg/100g, in nursing homes, from 36.58 to 409.53 mg /100g, in elementary schools, and from 63.23 to 438 mg/100g, in kindergartens. Considering a standard serving of 300g, sodium intake reported from soup alone can represent 31 to 54% of the adequate daily intake, becoming a major contributor to the high sodium intakes reported in developed countries. As most of the sodium comes from added salt during cooking processes, intervention strategies should be directed to raise awareness among food handlers and chefs about limiting salt content in different foods, as well as educational strategies directed for the consumer, in order to maintain acceptability of soups with reduced sodium content.

Keywords: Sodium; Soup; Nursing Homes; Elementary Schools; Kindergartens.

1. INTRODUCTION

Modern life leads consumers to eat out and away from home and this is a trend that does not appear to be declining. The number of meals eaten away from home may vary from one to all day meals, and this practice has been associated with an increased risk of higher energy intake and obesity [Orfanos, 2007]. One important food item consumed in Portugal, even when eating out, is “vegetable soup” which is strongly recommended given its high nutritional value and negative association with obesity [Moreira, 2006]. However, soup has been identified in some studies as a food with high levels of sodium [Conceição, 2011; Mano, 1983].
The average salt intake in most countries is about 9 to 12 g/d [Brown, 2009], and in Europe the average intake range from 5.4 to 18 g/d [Webster, 2011]. The average daily intake reported for sodium is between 3500 and 4700 mg/d, well beyond the Food and Nutrition Board [2004] and the 2010 U.S. Dietary Guidelines [USDA, 2010] recommendations, set at 1500 mg/d (“adequate intake”) for elderly and children.
Several studies have linked a high intake of salt with pathological conditions, such as high blood pressure, left ventricular hypertrophy, and increased risk of cardiovascular and renal diseases. There is also some evidence that excessive salt intake is associated with an increased risk of osteoporosis and stomach cancer [He, 2009].
In Portugal, over the past twenty years, cardiovascular diseases accounted for 39% of deaths and malignant tumours for 20% of deaths, being the incidence and mortality of gastric cancer the highest in the European Union [Ferlay, 2006]. By this set of evidence, excessive salt intake is one of the main concerns for health professionals [INE, 2002] and, from a public health perspective, reducing salt intake is one of the most upcoming strategies to put into practice. About 80% of salt intake can come from added salt in processed foods [Ferlay, 2006] and soup is no exception. However, given the high nutritional density of vegetable soup, it would be desirable to encourage its consumption at main meals, both at home and when eating out, without concerns of increasing sodium intake at the same time.
This study aims to quantify the sodium content in vegetable soups served in several different Portuguese institutions, namely kindergartens, elementary schools and nursing homes.

2. MATERIALS AND METHOD

2.1 Study Design

This study encompasses data on sodium content in vegetable soup collected in 3 different institutions at lunch. At first, two samples of soup were collected in two geriatric institutions of the city of Barcelos for seven consecutive days, both before and after the addition of salt. Secondly, samples of soup were collected in eight kindergartens of the city of Vila

Nova de Gaia for five consecutive days, also before and after adding salt. Lastly, samples were collected in ten elementary schools in the city of Porto and Bragança for three consecutive weeks, but only after the addition of salt. The total number of samples was 588, being 28 samples of nursing homes (14 before and 14 after salt addition), 110 of kindergartens (55 before and 55 after salt addition) and 450 of elementary schools.

2.2 Sample preparation

The sample preparation procedure was adapted to soups from one validated method proposed to quantify sodium content in bread [Vieira, 2011]. All soup samples were stored in plastic containers at 4 °C until analysis. After homogenization of each soup, 2g were sampled and 2ml of nitric acid were added. The mixture was shaken during 90 minutes to allow the food matrix's complete hydrolysis. Then, 20 ml of water were added and the mixture was again homogenized using an electric homogenizer (Ultra Turrax model). Volume was completed up to 40 ml and shaken for 30 min, followed by centrifugation (4,000 rpm, 15 min). Finally, 1.00 ml of aqueous supernatant was diluted up to 40 ml of deionized water before reading in the flame photometer.

2.3 Chemicals and samples

All reagents used were of analytical grade purity. Standard solution of sodium (1,000 mg/L) was supplied by JenWay, England. Calibration curves were constructed using 0.5, 1, 2.5, 5.0 and 7.5 µg/ml standards. The solutions were stored in a refrigerator. To avoid contamination of the samples, all PTFE materials were emerged in a freshly prepared solution composed of 15% (v/v) proanalysis HNO3 (Merck) during 24 h, then rinsed thoroughly with doubly deionized water, and dried in a stove.

2.4 Instrumentation

A flame photometer (Model PFP7, JenWay, England) with filters for lithium, sodium, and potassium was used. Butane gas and air were supplied as the source of flame. The flow rate of fuel was adjusted to get a maximum sensitivity. Other apparatus used were a Seradest LFM 20 Water Purification System, a Heidolph REAX 2000 vortex, a Kern ALS 120–4 balance (Ziegelei), an Ultra Turrax homogenizer T25 (Sotel), a Heraeus stove D-6450 model and a Centrifuge Labofuge 6000 ®, from Heraeus.

2.5 Method validation

For the evaluation of the instrumental precision, intensity emitted was determined in the same soup sample 20 times under the established instrumental conditions. Linearity was observed in the working ranges (in microgram per milliliter) from 0.5 to 7.5. Repeatability of the extraction procedure was evaluated by the coefficient variation using six aliquots of solutions that were submitted to extraction by direct dissolution of soup sodium in water. Recovery studies were carried out to determine the accuracy of the method. The samples were analyzed after the methods validation.

2.6 Statistical analysis

Statistical analyses were carried out with SPSS (version 17, Chicago, USA). Data are presented as the mean ± standard deviation, and percentiles 5, 25, 50, 75 and 95; mode, maximum and minimum are also presented.

3. RESULTS AND DISCUSSION

The method’s limit of detection was 0.2µg/ml and the limit of quantification was 0.2µg/ml. These values show that the method is precise and sensitive, enabling the quantification of low levels of sodium. The instrumental precision was 1.46%. Recovery studies were carried out to determine the accuracy of the method and it was found that recoveries ranged between 93.8% and 97.5%.

The higher mean values of sodium in soups with added salt were found in nursing homes (269.06mg/100g) and kindergartens (213.16mg/100g). These results (Table 1) may be due to a lack of awareness of the cooks to limit sodium intake, the absence of specific control for added salt in food preparation, or to rely on salt to satisfy consumer preferences (particularly in geriatric institutions). Moderate content in elementary schools may be due to a greater control by the institutions, but further analysis should be carried to test this assumption.

As expected, the sodium content of soups with added salt was significantly higher than before adding salt, strongly suggesting that the main contributor for sodium content is the addition in the cooking process. Actually, we found that the large majority of the soup sodium content (more than 90%) comes from the salt added during cooking.

The Portuguese traditional food habits include the consumption of soup, rich in vegetables, twice a day (lunch and dinner). In the cohort EPI Porto study, the frequency of daily consumption of vegetable soup was 58.8% in women, and 54.9% in men [Lopes, 2006]. As populations are becoming more sedentary and with higher access to energy-dense foods, there is a strong need to maintain or increase the intake of vegetable soup, which may protect against obesity and other chronic diseases [Flood, 2007; Maureen, 2011]. At the same time, it is very important to determine the level of sodium added to soups in order to maintain its positive nutritional characteristics.

Table 1 – Results of sodium content in soups (mg Na/100g of soup)

	Sodium in soup before adding salt			Sodium in soup after adding salt		
	Nursing Homes	Elementary Schools	Kindergartens	Nursing Homes	Elementary Schools	Kindergartens
Mo	0.13	-	4.93	124.71	372.14	63.23
Mean ± sd	25.33 ± 48.78	-	18.07 ± 37.18	269.06 ± 75.64	153 ± 105.59	213.16 ± 85.11
Min	0.13	-	0.93	124.71	36.58	63.23
Max	216.63	-	284.02	429.04	409.53	438.79
P5	0.42	-	0.94	151.45	52.06	77.98
P25	2.96	-	4.68	208.41	67.96	139.21
P50	5.24	-	8.90	277.66	98.06	225.42
P75	20.14	-	14.87	324.36	238.32	269.38
P95	142.73	-	62.56	423.98	366.26	362.63

Considering the possibility of having a standard serving of 300 g of soup served per meal, sodium intake per soup may be up to 459-850mg, representing 31 to 54% of the daily adequate sodium intake [He, 2009] for the elderly and children. We should also be aware that the salt consumed in the soup is only a part of the total sodium intake throughout the day, and that the recommended dietary intake values can be easily overcome.

There is a well-established link between high intake of salt and physiological and pathological changes such as increased blood pressure [Nagata, 2004], left ventricular hypertrophy [Du Cailar, 1992], increased cardiovascular disease (heart attacks, strokes and heart failure) and renal diseases [Verhave,2004; Arnlov, 2005]. There is also some evidence that salt intake is associated with an increased risk of osteoporosis [Cappuccio, 2000] and stomach cancer [Jooseens, 1996]. In a meta-analysis of randomized salt reduction trials, 17 trials estimated that a reduction of 6 g / d in salt intake could reduce strokes by 24% and cardiovascular disease by 18% [He, 2002].

Many workplaces, schools or social institutions provide daily meals for their employees, by self-production of meals or catering business, and thus have the potential to induce healthy food consumption choices [Wanjek, 2005]. The payback for investing in workplace health programs can be measured in several ways, including decreased direct health costs, increased performance measures and lower rate of absenteeism. A 400 mg of sodium reduction by adults with uncontrolled hypertension could represent an annual reduction of 1.3 million absent days, 6.3 million full-time equivalent days with presenteeism and 1.8 million days lost because disability [Dall, 2009].

It would be desirable that consumers exposed to the consumption of meals outside the home could make informed choices and take effective action about their own salt intake, and benefit from meals that reduce their health risks. Geaney and colleagues [2010] have shown that structured catering initiatives in public sector have potential to reduce dietary intakes of salt. These initiatives may be through increased consumer information and / or by providing healthy meals at the public institutions.

Studies show that 25% to 30% of medical costs per year are spent on employees, that exhibit health risk factors for chronic diseases, such as hypertension [Zuidhof, 1998], and the reduction of one risk factor decreases presenteeism by more than 9% and absenteeism by 2% [Glasgow, 1997]. To solve this problem, national food policy aiming at reducing salt intake should establish dietary guidelines and sodium intake goals in a defined timeline. A solution that ensures the maintenance of the basic elements of the healthy meal requirements: with an emphasis on reducing added sodium to foods, namely to vegetable soups, together with measures to raise the awareness among chefs and food handlers on this topic, is needed.

The strengths of this work lie in the equal methodology laboratory in all three institutions, the accuracy of sample collection, the large number of samples and differentiate the added salt from that intrinsic of soup ingredients. The small number of the institutions surveyed and the convenience sample used act as the main weaknesses of this study.

4. CONCLUSIONS

Average sodium levels in soups may be considered high, particularly in nursing homes and in kindergartens. Sodium content per soup has reached 31 to 54% of the daily adequate intake for the elderly and children. The values were very heterogeneous, probably because the sodium added to soups varied according to intrapersonal and interpersonal food preparation practices.

In terms of public health it would be important to standardize and monitor the sodium content of foods served outside the home, and provide nutrition education to food handlers about reducing salt consumption and global health. For companies in the European market, the development of health promoting workplace will be an essential requisite to corporate a healthy, qualified and motivated workforce.

5. ACKNOWLEDGMENTS

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Citizen Education and the theme of Occupational Safety and Health in Portugal and in Brazil: Formation or information to prevention?

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ABSTRACT
This article presents the discussion and reflexion of the theme Occupational Safety and Health (OSH) in the citizen formation behind education. In the basis of this investigation we used the Portuguese and Brazilian educational laws and other important texts. The analysis of the texts was realized with a methodology called Discursive Textual Analysis (DTA). The results obtained show the possibilities that educational laws open to the theme of OSH to be developed in the citizen formation with critical and reflexive conscience about the prevention of occupational risks.

Keywords: Education; Citizenship; Prevention; Risks.

1. INTRODUCTION

In this investigation emerge questions to the reflexion of the structure of the educational school processes and which will be the main directions to the theme of OSH.

The issue OSH should refer the main aspects for the education, formation and investigation studies for the future of the democratic countries.

The professionals and teachers of the OSH and the educational areas should pay attention and take care of the educational processes that show this theme as a mechanism that gives and results in the efficient of occupational risks prevention.

The efficiency of the scientific and technical control about the occupational unhealthy processes, dangerous and damage to human being depends on the citizens' fulfilment to the importance and prepare to their use.

The prevention of the occupational risks can and must be realized throw the scientific and technical control that occurs in Portugal, in Brazil and other countries too. But the prevention of the occupational risks can be faced with more efficiency if it is faced together with the educational processes that are concerned with the OSH system to citizenship.

It's very important to remember the meaning of citizen and citizenship. P. Freire (1993) says: "(…) citizen means an individual with his civil and political rights in a state" and citizenship "(…) is related to the use of the rights and the right of having citizen duties." The question above rights and duties of a citizen must be understood and exercised since the family education, then the school and at least other institutions that compose the social institutional mosaic.

2. MATERIALS AND METHOD

It was used the same method as it was in educational investigations that need a qualitative methodology to understand a multifaceted theme. So, it was used the DTA. Moraes, (2005) states: " (…) textual analysis are means of developing and to improve discursive processes, hopping to achieve learnings from reconstructive comprehensions of the speeches, leading to a communication of the learner and, by that way, the researcher becomes an historical subject, capable of being a part of the new speeches." Figure 1 shows a graphic representation of DTA methodology.

The investigation corpus are the results obtained in the bibliographic search and used in the references, specially the educational laws of Portuguese and Brazilian systems (ideas, reflexions, arguments, others).

These materials, according to Torres *et al* (2008), should be selected by investigators, who decide and restrict the necessary elements to the analysis.

The next step, the deconstruction or delimitation into unit of analysis, wants to specify important textual elements that enable a comprehension of the senses that emerge from the registers. In this study the textual elements of the references were drawn from the original text to form a group of textual pieces. (stage of deconstruction in Figure 1). The unit of analysis is supported by the principles of the investigation.

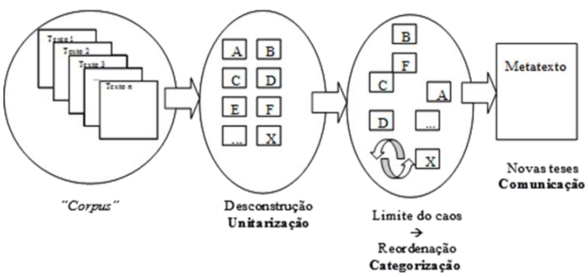

Figure 1 – Graphic representation of DTA methodology (Torres et al., 2008)

In this investigation it was observed, in predicted categories, the educational structure of the issue OSH in Portugal and in Brazil, comparing their educative basis laws and other bibliographic references. In textual analysis, categorization phases, says Torres *et al* (2008): "[…] Initially it is constituted a process of textual entropy, that is normal to establishing articulations between units of analysis to do a new regulation, in order to enhance the understanding about analytic investigation of the phenomena. This stage consists in a continuum between the units of analysis previously established, in order to join the textual elements that present similarity of meanings and significance, which cause categories. That procedure must be important to the end of categories and it is processed through the sensorial mechanisms of inference, induction and intuition of the researcher, which is also related to the process of analytic investigation.

The stage that ends the process is the communication which is, to this study, the presented article. As technique of data research it was used the documental bibliographic research. Important bibliography was consulted to support the communication. We have also interviewed a Portuguese teacher (public school) to have a better understanding about the treatment of this issue in the Portuguese education.

We have used DTA methodology to assist in verifying similarities and difference regarding the OSH issue analysing the laws of the education systems of Portugal and Brazil. The result was the reconstruction of the existing understanding and added comprehension of the authors of this communication about OSH in Portugal and in Brazil and about its contribution to the citizenship formation. The methodology used allows for content and discourse analysis and applies to the investigations which are characterized in the meaning assigned by the subjects (in this case the researchers) to the interpretive process of social life.

3. RESULTS AND DISCUSSION

In order to fulfil the main purpose of this study, the laws on education both in Portugal and Brazil were compared, making an approach to critical, productive and active citizenship, present in this legislation, as Table 1 states, mentioning some parts of the documents used in this investigation (Brazil, 1996; Portugal, 1986).

Through the excerpts presented on Table 1, we can see that, in the third line, there is a reference to the student's citizenship. While the Portuguese legislation states that the educational system must contribute to the development of citizenship, the Brazilian proposes an exercise of citizenship and stands for the student's qualification for work. The analyzed part stands for the main educational principles, what reinforces the necessity of an education focused on citizenship and that could include the formation to work, this meaning the initiation to an active and productive life as an important part of the citizenship exercise.

The fourth line of Table 1 also states the necessity of preparing for just work. This attribute should be understood as citizen development, which emphasizes in the learning processes enough notions for students to reflect critically upon the conditions of labour activity for their health and security, for their social interactions, respecting their nature, their human fragilities towards exposition to situations that offer risk to their physical, psychological and social integrity. This ability to reflect should enable them to have a perception of the dangers and risks of labour activities and even of the non labour activities, based on the idea that security and health are essential no matter the situation.

The sixth line of Table 1 shows, according to the Portuguese educational laws, that the hygiene habits and the health defence are thought of since the first children's steps at school, even knowing that, at this time, there will be no association to productive life. Nevertheless, these aspects appear in the educational processes; at least, the health care is referred in the legislation and transcends the individual, allowing a collective perspective.

In the last few lines of Table 1, it becomes clear the association between the educational laws and the development of productive citizenship/active life, this meaning that the preparation towards the world of work is taken into account, beyond the human development.

In this sense, there are also educators that see the act of work as an act of human fulfilment. One of those educators was P. Freire, who developed the theory of learning construction (2005): "Being critically aware that it is necessary to be the owner of his own work and that this constitutes a part of 'the humanity of the person' (…)". Work appears as part of each human and this perspective requires from citizens the sense of health, comfort and security, keeping away from what is imposed to workers and that appears as unhealthy, painful and dangerous.

The worker must be prepared to understand adverse situations to his own human condition and he should contribute to public politics and laws in democratic countries, by means of a citizen participation in social processes.

Table 1 – Comparison between the Educational Laws in Portugal and Brazil

Portuguese Educational Law	Brazilian Educational Law
Chapter I "Âims and principles", Art. 3º "Organizational principles"	Title II "About the principles and aims of National Education"
"The educational law organizes itself in order to: b) Contribute to the student's fulfilment, through the development of personality, character and citizenship, preparing himself for being aware of spiritual, aesthetic, moral and civic values, allowing a balanced physical development,"	Art. 2º *"The education, the family and State's duty, inspired in the principles of freedom and in the ideals of human solidarity, aims the full development of the student, preparing him for the exercise of citizenship and his qualification for the world of work."*

"e) Develop the ability to work and allow a specific and solid formation towards a work that occupies a fair place in active life…"	Art. 3º *"Teaching will be based on the following principles: XI – the linking between schooling, work and social practices."*
Chapter II "The organization of the educational law" SECTION I "Education in kindergarten" Art- 5º 1 — The aims of education in kindergarten are:	Title V – From levels and modalities in education and teaching Chapter II – About Basic Education Section I – Main principles
"g) Develop hygiene habits and defence of individual and collective health;"	Art. 22º *"The basic education aims to develop the student, to assure him the formation that will enable him the exercise of citizenship and allow him the means to progress at work and in future studies."*
Section II Schooling - Subsection I Basic education Art. 7º Objectives – The main objectives of Basic education are:	Art. 27º "The curricular contents of basic education will still reflect the following beliefs: I – the spread of essential values of social interest, rights and duties of all citizens, the respect towards common well-being and democratic order; II – take into consideration the scholarship conditions of students in each institution; III – guidelines towards work;"
"e) To promote basic knowledge acquisition that will allow future studies or the inclusion of the student in professional formation contexts, as well as to easy the acquisition and the development of methods and instruments of individual or group work, valuing the human dimension of work;"	
Art. 8º Organization – One of the objectives of the 3rd cycle is:	
"c) the systematic and distinguished acquisition of modern culture, in its humanistic, literary, artistic, physical, sports, scientific and technological dimensions, essential to be included in the active life and to continue studies, as well as scholar and professional guidelines that allow an option of future formation or the inclusion in active life, respecting the autonomous fulfilment of the human being."	
Subsection II Secondary Teaching – Art. 9º Objectives The main objectives of secondary teaching are:	Section IV – About Middle Teaching
"a*) Ensure the development of reasoning, reflection and scientific curiosity and the deepening of essential elements towards a humanistic, artistic, scientific and technical culture that constitutes cognitive and appropriate methodological support to eventually continue studies or to the inclusion in active life;* *f) Favor guidelines and professional formation to students, through technical and technological preparation, in order to enter the labour world;"*	*"Art. 35. Middle Teaching, the last stage of Basic education, which longs at least three years, has the following aims:* *II – the basic preparation of students to work and towards citizenship, in order to continue learning, in a way that they become capable of adapting themselves to new conditions of occupation or future improvement;* *III – the development of students as humans, including their ethic formation and their intellectual autonomy and critical thinking;* *IV – the comprehension of scientific and technological principles of productive processes, associating theory to practice, when teaching each subject."*

Besides the fact of citizenship preparing for a healthy and comfortable life, active citizens should be sensible towards situations of planetary dimension, for example, the wrong use of natural resources and environmental destruction, the weaknesses of financial resources, social justice, beyond many others. These problems demand collective solutions and education is a mechanism that can contribute to the establishment of economical, social and environmental balance, this meaning the search for sustainability (Pérez e Vilches, 2003).

In this sense, many questions can arise: should education in OSH form or inform in order to lead citizens to develop knowledge, skills and preventive attitudes/behaviours towards occupational risks?

Without devaluing the contribute of informative educational processes, what we notice is that, nowadays, prevails a culture of informing students, workers and professionals from areas with a higher frequency of accidents, about how to act concerning the occupational risks. Nevertheless, as it was mentioned, the efficiency of prevention requires another educational focus in school contexts.

The educational processes that focus on OSH usually take place at secondary school onwards, this meaning directed to youngsters and adults. Another question arises: should the exercise of citizenship concerning the OSH and the development of knowledge, skills and preventive attitudes/behaviour concerning the occupational risks begin in basic school?

The following statement reveals the existence of a bridge between social interactions, OSH and preventive education: "childhood and adolescence stages form basic concepts for life; therefore, it seems reasonable to value the children's learning to develop, at the adult stage, the responsible awareness for Preventing Accidents (Brazil, 1979).

Both the Portuguese and the Brazilian educational laws allow the approach of this theme from basic school onwards. For example, the Portuguese law, n. º 441, from 1991, about education, security, hygiene and health at work states the following: "1- The inclusion of security, hygiene and heath at work in the school curriculum should happen at different stages, taking into account the preventive culture in the general board of the educational system and the prevention of professional risks like preparing for active life.” It is clear that this theme receives a systematic approach in the Portuguese educational processes.

The commitment assumed before the international community and the convention n. º 155, named Convention about Security, Workers’ Health and Working Context of International Working Organization (IWO) (2011), from 1981, was signed by Portugal and Brazil. The article 4, items 1 and 2, determines the necessity of implementing national and public politics of preventing professional risks. Article 5. º, paragraph c, stresses the necessity of initial and complementing formation, with the purpose of accomplishing security and hygiene degrees according to the defined patterns which are admissible for Man.

Portugal and Brazil have also signed the Berlin Declaration for the development of a preventive culture in Social Security, from school to work, established by the International Committee for the Education and Formation for the Prevention of the International Social Security Association (ISSA), Berlin 2006, together with the OIT and the World Health Organization: “Define a strategy between the different means which were pointed out (prevention, school, professional formation, business), and also with its contributions, demanding and interactions”.

The European Union also invests in order to integrate security and health in schools and promote better strategies to guide the educational learning processes, aiming the development of safe and healthy behaviour in the countries which form this group (Garcia, 2010: 441). Mainly, we can see the international concern towards this theme, far beyond from Portugal and Brazil. So, what to do in order to focus on OSH in a systematic way, in school processes and contexts? If we have doubts about it, we just need to analyze the statistics, which are far away from reality, for example, of car accidents and working accidents.

The OSH theme should be talked about in a significant way so that the students’ learning turns out to be conscious and according to reality. Just like P. Freire states about the appropriation of knowledge (2006): “(…) in the learning process, the one who learns is the one who appropriates himself of what is learnt (…) uses the things he learns in concrete existential situations”. With the purpose of associating OSH with reality and making it an essential knowledge for life, school education should be understood as an act of developing knowledge, skills and attitudes, aiming a humanized view of life in society.

The teacher should be prepared to build knowledge, skills and attitudes/behaviour with students and this will result in the humanization and in a fairer society, with less accidents and occupational diseases. The teacher should establish mechanisms of educational action that will facilitate the learning process for prevention. In other words, he will be contributing for a preventive culture and developing a preventive pedagogy.

The Portuguese and Brazilian educational laws establish that the teachers’ action depends on the teaching methods and this latter should fill some requirements, as Table 2 shows.

Table 2 – Some requirements for teaching according to each educational law

Characteristics/Requirements	BEL	PEL
Focus on formation processes	Articulation theory and practice	
	Value Professional experiences	Be a teacher in a reflexive, critical and active way
Requirement Act on basic and secondary education	Graduation	
Requirement Act on college education	Masters and PhD	

Through this Table we come to the conclusion that both educational laws have similar demands concerning the requirements for teaching. Nevertheless, there are completely different practices in real contexts. One of them, for example, is that, unfortunately, the requirements demanded in Brazil are not always accomplished and respected, especially concerning the demands in basic and secondary education. Brazil lacks not only qualified teachers but also the recognition of these professionals’ value.

The quality of education reflects, for sure, all these aspects, beyond the necessity of forming teachers with skills to use knowledge concerning OSH and the prevention of occupational risks in educational processes. How will these educational professionals form citizens who are ready to prevent, without being themselves prepared before? Facing all these problems, teachers need training.

According to Miguel (2010): “Historically, Security as a synonym of Preventing Accidents has gradually changed, referring now to a higher number of aspects and activities, including the first actions of repairing damages and even a broader concept, concerning the prevention of all situations causing undesirable effects for work.” Health can also be associated to the concept and workings issues can be enlarged to occupational issues. The author also says that security adds health and the absence of both brings human and social consequences, which demands an education towards citizenship.

Arezes (2006) states that there is a clear concern about the way Man behaves in a labour context, when facing risk, and not about how he understands it. This statement shows the necessity of a formative side of education for SHO. Beyond

information, this demands attention towards reality, the ability of identifying risky situations and the ability of acting accordingly, individually or collectively. Concerning the physical risks (noise…), the same author says that " (…) the risk perception should be taken into consideration when planning, developing and implementing the Audition Conservation Programs, especially concerning the development of formative plans." Arezes also points out some relevant aspects of formation that need to be attached to occupational risk control to ensure efficiency.
Taking into consideration everything exposed before, when and how should formation in OSH begin?

4. CONCLUSIONS

The present study was important to compare the laws of the Portuguese and Brazilian educational systems. Doing this comparison we have not found any obstacles to the questions presented in the research. In both systems there is a possibility of development of the educative adjusted practices with the social development, of productive citizenship (prevention of occupational risks/OSH, others) and full citizenship (critical, reflexive, others).
Content analysis and discourse, that is, the DTA raised in this communication the reflections and discussions about the theme of the OSH and the formation for citizenship. In the previous section the fragments analysed in relation to the Portuguese and Brazil ian education systems and other references were presented, and provided the following most important considerations:
• The need for an education oriented toward citizenship including the training for work, that is, the initiation for active / productive life as an attribute of training / exercise of citizenship;
• Processes of learning for students to discern in a reflective and critical way about the conditions of work activity, safety and health, and to consider risky situations to their physical, mental, and/ social integrity;
• Inclusion of hygiene and health habits for children from the early grades at school. The education systems of both countries Brazil and Portugal allow the treatment of this theme from the primary / basic school;
• The worker must be prepared for citizen participation in social processes and contribute to the routing of public policies and laws in democratic countries such as Portugal and Brazil;
• Train teachers (initial and continuing training) with the skills to introduce and improve knowledge about the SSO and the prevention of occupational hazards in the educational processes;
• The importance of relevant aspects regarding the perception of occupational hazards in training and the needs to link this to with the control for it is efficiency.
The considerations mentioned above deserve an educational treatment appropriate and responsible for all society. The full solution of the problems referred to in the prevention of occupational hazards will not be achieved solely through education. However, the professionals on the education and OSH must through reflection on the importance of educational processes in the prevention of occupational hazards, enhance both the civic education for the prevention and the scientific-technical component.
The educational processes of OSH and the formation of educative professionals to act in this way should be accompany with interest and collaboration by those who developed works, research and other activities related to this area. Another important characteristic is that these educational processes of OSH should be continuous, with approaches and mechanisms that can help students, teachers, janitors and parents to evaluate constantly the processes.
All the participants in the educational community should be aware to safety and healthy praxis, actions and behaviours. That means that the theme OSH must be in the educational plane of the school as one of its priorities.
OSH is an important area to long life learning, because it's always present in daily activities or occupations.
The questions presented in this study show us the need of parameters to limit the educative processes and the challenge to form professionals in OSH and Education areas. These parameters need to be discuss and scientifically elaborated by OSH professionals, teachers and represents of civil society, in means that this theme receives an appropriate and responsible treatment.
Portugal is one of the Union European countries and Brazil is one of the main countries in South America and they are two big countries in the Community of Portuguese-Speaking Countries. So, for these reasons, they should implement the OSH theme to help the other Portuguese-Speaking Countries to develop this area in their educational processes.
The contributions of the educational processes about the occupational risks control can reduce the accidents and diseases, the citizens can have a better and safety life and, consequently, will promote a fairly social organization.

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Risk Assessment in Analytical Laboratories

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ABSTRACT
This study aimed to develop a method of risk assessment applied to tests carried out in analytical laboratories, drawing on a configurable methodology that allows to include multiple indexes with different weights and adjustable scales of the same. To collect the information needed to characterize the method of evaluation was essential to examine existing procedures and observe in detail the various tests carried out in order to record data such as processing times of tasks, information contained in safety data sheets for chemicals used , reagent / culture medium and processed information of the equipment involved in the various procedures, among others. The developed model was applied to two different laboratory settings in the area of public health: a microbiological laboratory and a laboratory analysis of water, in order to prove its usability.

Keywords: Risk Assessment; Matrix Method, Laboratories, Chemical Hazards, Biological Hazards.

1. INTRODUCTION

The multiplicity of risk factors present in the activities of analytical laboratories leads to poor quality results with the use of best known and popularized risk assessment matrix methods. This is because those methods more suitable for accidents risk assessment, fail to reflect with sufficient accuracy the formation of the risk factors most important in that kind of activity. This aspect are the risks associated with chemical and biological risk factors, that in the traditional methods are usually not adequately represented.
The present article thus develop a method for assessing the risks associated with testing carried out in analytical laboratories, inspired by a configurable methodology that allows the inclusion of various indexes with adjustable scales and differentiated weights of them (Nunes, 2010a), so to achieve a better reproduction of the influence of several risk factors present at the workplace. To this end, it was important the analysis of existing procedures and observation of the various tests, including processing times of tasks, information contained in safety data sheets of chemicals used, reagent / culture medium used and information about the equipment involved in the different procedures, among others.
Ultimately, the methods of professionals risk assessment will always consist of mathematical models, more or less validated, containing more or less factors (parameters or variables) according to the complexity that is acceptable to achieve, always bearing in mind a relationship compromise between complexity and usability of the developed methods (Nunes, 2010b).
The development of such models based on configurable methodologies, adjusted to more specialized work situations, results in the availability of methods that, like the traditional matrix methods, maintain a good compromise between complexity and usability, and enable a proper risk assessment, based only on the use of information available in the lab that is applied such as, among others, the Safety Data Sheets (Pité-Madeira, 2007).
In order to prove its usability the model developed was applied to two different laboratory settings in the area of public health: a microbiology laboratory (Graça, 2011) and a laboratory analysis of water (Batista, 2011).

2. METHODOLOGY

For the reasons previously discussed, the development of the method was given particular attention to the configuration of the factors of formation of chemical and biological hazards, not forgetting that the risk exposure associated with them depends on a set of factors related to the procedures used.
The chemical hazards associated with the use of hazardous substances (explosive, oxidizing, extremely flammable, highly flammable, flammable, very toxic, toxic, harmful, corrosive, irritant, sensitizing, carcinogenic, mutagenic, toxic for reproduction and dangerous for the environment, are referenced by Decreto-Lei n.º 98/2010, of August 11st, which stipulated the norms for classification, packaging and labeling of substances hazardous to human health and the environment, discrimination at the level of indications of danger, the nature of special risks attributed and their advice on safety of substances and mixtures.
For biological agents, among other features, it should be noted that biological hazards in the workplace have some characteristics that distinguish them from other groups (Nunes, 2010a):

- The etiological agents are not occupational in nature (they are usually mentioned in the name of the disease and are common to infectious and parasitic diseases not related to work);
- The occurrence of the disease depends on the conditions or circumstances on which work is performed and the occupational exposure, which favors the contact, the infection or transmission.

Anyway, biological agents (bacteria and related, viruses, parasites and fungi) are classified according to the effects they produce on the healthy workers in four groups, in order of its danger, and the agents of group 2, 3 and 4 are necessarily

listed. The list of biological agents known to infect humans is contained in Portaria n.º 405/98 of July 11st, amended by Portaria n.º 1036/98 of December 15th, as provided for in Decreto-Lei n.º 84/97 of April 16th, which establishes minimum requirements for the safety and health of workers from risks related to exposure to biological agents at work.
To ensure inclusion of all factors affecting risk achievement, it was carried out an identification of risk factors associated with each task of each of the procedures / techniques that have been observed and analyzed, taking into account the following aspects:

- Tasks / operations involved in the procedure / technique;
- Measurement of time performing each task (associated with contact times / operator exposure to risk factors);
- The hazardous nature, characteristics and explosion via of the products used;
- Risk of equipment and material used;
- Collective / personal protective equipment use (CPE / PPE);
- Safety practices observed;
- Number of people who perform the procedure / technique;
- Number of times the procedure / technique is carried out each year.

After the identification of risk factors present in each task / operation observed, are established indicators which account for the probability and severity, to take into account when assessing the associated risk.
The probability of accounting is performed through three indexes associated with it:

- Time of contact / exposure (T);
- Number of tests per year (E);
- Percentage of security measures are actually used to control the risk (safety practices observed *versus* CPE and PPE recommended in the Material Safety Data Sheets - MSDS) (C).

The values for the three associated indices are set to the probability with the criteria presented in Table 1:

Table 1 – Indices associated with the probability.

Value	**T (mm:ss)**	**E**	**C**
4	$\geq$ 10:00	E $\geq$ 2000	0 - 33%
3	05:30 $\leq$T <09:59	1500 $\leq$ E < 2000	34% - 65%
2	01:00 $\leq$ T < 05:30	700 $\leq$ E < 1500	66% - 99%
1	<1:00	< 700	100%

The contribution of the indices is taken into account by using weighting factors (A_T, A_E and A_C), on a scale from 0 (overriding the influence of the index for the calculation, excluding it from the model) to 10 (maximum value of the contribution index value for the calculation).
For its part, the accounting of Severity is also performed by using three indices:

- Level of dangerousness / toxicity of the substance (P);
- Number of exposure via (V);
- Number of risks associated with the equipment (R).

The three indices take values associated with the severity according to the criteria in Table 2.

Table 2 – Indices associated with the severity.

Value	**P**	**V**	**R**
4	4	$\geq$ 4	$\geq$ 4
3	3	3	3
2	2	2	2
1	1	1	1

The levels of dangerousness of the substances used - P index, can be more reliably quantified and adjusted to the available information, if they are classified in accordance with paragraph 3 of Annex IV of Decreto-Lei n.º 98/2010 . Its quantification is well established with the information from the material safety data sheets and reflects the observation of the tests, not to mention the exposures via (respiratory, ingestion, skin and eyes), as outlined in Table 3.
In some MSDS available information is indicated as threshold limit values (TLV), time-weighted average (TWA), short duration (STEL) or maximum concentration (Ceiling) to chemicals in humans. Thus, it was necessary to establish a relationship between the lethal dose (LD_{50}) and/or lethal concentration (LC_{50}), with the mentioned and the set of MSDS, thus matching the rate of toxicity with the TLV, as presented in Table 3.

Table 3 - Criteria for establishing equivalence levels of dangerousness of the products used.

Level of dangerousness (P)	LD_{50}	LC_{50}	TLV (TWA/STEL/C)
4 (Very toxic)	$LD_{50} \leq 50$ mg/L (skin) $LD_{50} \leq 25$ mg/kg (body weight)	Aerosols or particulates: $LC_{50} \leq 0{,}25$ mg/liter/4h Gases and vapors: $LC_{50} \leq 0{,}5$ mg/liter/4h	TLV ≤ 3 mg/m^3
3 (Toxic)	$50 < LD_{50} \leq 400$ mg/kg or mg/L (skin) $25 < LD_{50} \leq 200$ mg/kg (body weight)	Aerosols or particulates (rats): $0{,}25 < LC_{50} \leq 1$ mg/liter/4h Gases and vapors (rats): $0{,}5 < LC_{50} \leq 2$ mg/liter/4h	$3 <$ TLV ≤ 9 mg/m^3
2 (Harmful)	$400 < LD_{50} \leq 2000$ mg/kg or mg/L (skin) $200 < LD_{50} \leq 2000$ mg/kg (body weight)	Aerosols or particulates (rats): $1 < LC_{50} \leq 5$ mg/liter/4h b) Gases and vapors (rats): $2 < LC_{50} \leq 20$ mg/liter/4h	$9 <$ TLV ≤ 50 mg/m^3
1 (not classified)	Rats or rabbits: $LD_{50} > 2000$ mg/kg (body weight) or mg/L (skin) Rats: $LD_{50} > 2000$ mg/kg (body weight)	Aerosols or particulates (rats): $LC_{50} > 5$ mg/liter/4h b) Gases and vapors (rats): $LC_{50} > 20$ mg/liter/4h	TLV > 50 mg/m^3

Severity is also a function that takes into account the weighting factors (A_P, A_V e A_R) that define the contribution of the indexes associated with it.
In possession of the six indexes defined for the model, the Level of Risk (RL) per task / operation can then be computed as shown below, so values can be obtained in a percentage scale. For this purpose are used in the denominator values corresponding to the maximum possible values for each of the six indices (N_T, N_E, N_C, N_P, N_V e N_R).

$$RL = \frac{A_T \log(T) + A_E \log(E) + A_C \log(C) + A_P \log(P) + A_V \log(V) + A_R \log(R)}{A_T \log(N_T) + A_E \log(N_E) + A_C \log(N_C) + A_P \log(N_P) + A_V \log(N_V) + A_R \log(N_R)} x 99 + 1$$

After calculating the risk level for each task / operation can be attributed to a classification of risk associated with four different colors according to the criteria in Table 4.

Table 4 – Criteria for classification of risk.

Classification of risk	Associated color
High (RL > 85%)	
Substantial (56% < RL ≤ 85%)	
Moderate (30% < RL ≤ 56%)	
Low (RL ≤ 30%)	

The method thus provides an array of six dimensions corresponding to the number of indices adopted for its formulation. Figure 1 illustrates the development of four dimensions of the matrix (levels) of risk (T, C, P and R) for two fixed indices (E = 1 and V = 1).

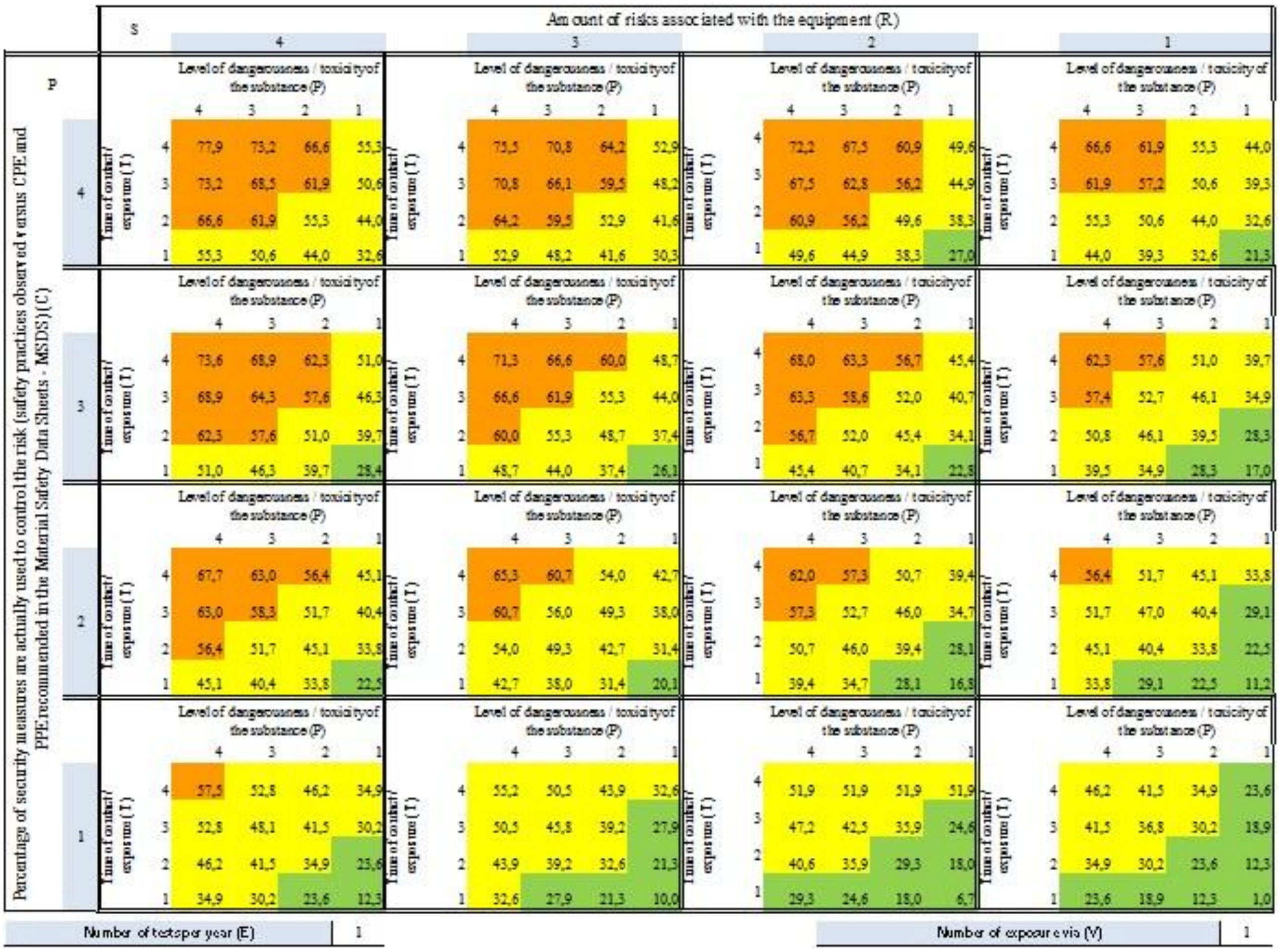

Figure 1 - Development of four dimensions of the matrix (levels) of risk.

In order to have a more global information, was also calculated a Risk Level by test / technique by weighting equation presented below, which also provides values in a percentage scale.

$$RL = \frac{\Delta t_1\, RL_1 + \Delta t_2\, RL_2 + \ldots + \Delta t_n\, RL_n}{\Delta t_1 + \Delta t_2 + \ldots + \Delta t_n}\, x\, 99 + 1$$

Where:

$\Delta t_1, \Delta t_2 \ldots \Delta t_n$ – Duration of each of the n tasks involved in the procedure / test;

$RL_1, RL_2 \ldots RL_n$ – Nível de Risco de cada uma das n tarefas envolvidas no procedimento/ensaio.

Calculating the risk rating for task and based on its evaluation of the criteria in Table 4, have been constructed tables with the results of the calculation of risk levels resulting from the adaptation of the model to each of the laboratories under study in order to prioritize risks involved in a series of tests developed there.

The same results were also used to compile maps identifying, assessing and controlling risks.

The weights adopted for each of the constituent indices of the model were established according to the actual influence that each has in the various types of test carried out in the laboratory study, allowing you to adjust the mathematical model adopted to the specifics of each type of test .

It was observed that this specificity can be effectively achieved if the weights of the model take into account aspects such as:

- Complexity of the procedure and experience of the operator(s);
- Exposures via for products used effectively open during the procedure;
- Conservation status and conditions of maintenance of equipment and other material used;
- Suitability of collective and personal protective equipment (e.g. type of gloves used and not just its use)
- Measures and safety practices observed and their effective relevance to safety and health of operators (operator protection) rather than the quality of procedures (test conditions warrant);

- Number of times the procedure / technique is carried out each year against the total volume of procedures carried out in the laboratory.

The consideration of issues such as listed above, enables the configuration of risk assessment models well suited to each of the study in laboratory settings, consider allowing the most efficient way the available information and contributing to an effective "integration of risk assessment safety and health of workers in all activities of the organization "(Lei n.º 102/2009 - Legal status of OSH promotion and prevention).

Figure 2 shows an example of calculations for the level of risk by task and test, to the test for the "determination of boron by the method of molecular absorption spectrophotometry".

Factores de Ponderação

Probability

At =	10
Ae =	1
Ac =	9

Severity

Ap =	10
Av =	9
Ar =	5

a) Risk level of the task

Task order	Time of contact (ΔT) in minutes	Time of contact / exposure (T)	Number of tests per year (E)	Safety practices observed (CPE/PPE)	Level / toxicity of the substance (P)	Number of exposure via (V)	Number of risks associated with the equipment (R)	Risk level of the task
1	1	1	1	2	1	2	1	21,3%
2	67,7	4	1	3	2	4	3	80,3%
3	61,3	4	1	3	2	4	3	80,3%
4	9,7	3	1	3	2	4	4	78,0%
5	5	4	1	4	2	3	3	80,3%

b) Risk level of the test NR_{Test} = 79,8%

Figure 2 - Example of calculation of Risk Level by task and testing.

3. RESULTS AND DISCUSSION

Due to the nature of the tests to be analyzed at the Laboratory of Chemistry and Toxicology of Water, in the calculation of risk levels, it was decided that the value of the weighting factor times the index of contact / exposure (T) and index of toxicity (P) would be those who would have the highest values of weighting, $A_T = A_P = 10$. This specification is due to the high contact time / exposure and the characteristics of toxicity of chemicals used.

Were also considered high weighting factors for the rate of transmission routes (V) and the percentage of CPE and PPE used (C) during the test, $A_V = A_C = 9$, because in most trials, all transmission routes are open and was found that there was a proper use of PPE recommended in the MSDS.

The weighting of the index for the moderate amount of risk associated with the equipment (C), $A_C = 5$, results from the fact that while the operator is exposed to risks associated with equipment during the tests, these are controlled by scheduled maintenance checks required by both, the institution and the guarantee of the results provided to the customer.

Finally it was considered for the index of the number of tests per year (E), a reduced weighting, $A_E = 1$, because its influence does not show significant on the level of risk, although for different trials the number of tests performed by year can vary from a minimum of 30 to a maximum of 3,000.

The method of evaluation tests selected for this study resulted in valuations which risk levels stood at risk "substantial" or "high" due to the influence of high values assigned to the indices of toxicity factors, exposures via, exposure times and safety practices observed *versus* CPE and PPE recommended.

It was found that the test "Determination of trihalomethanes" considered the most dangerous by the laboratory, achieved a risk level of 85.3%, thus consistent with the existing perception of risk. Although the valuation is already located at "high" (red), the resulting percentage to the level of risk has not been even higher due to the effective use of hood and masks, and the index of toxicity of chemicals also used not be the highest. However, it was duly penalized for the use of nitrile gloves, instead of the recommended butyl rubber.

Since the test of "Determining the oxidizability," obtained the highest level of risk of all tests studied, 96.7%, contributing to this assessment, having been conducted without the recommended PPE, the high toxicity and the number of exposures via. The tests that showed the second highest, are the "Determination of chemical oxygen demand for the determination of silica", 91.5% and 91.1%, respectively. These values also resulted from the high number of exposures via and that have not been used PPE recommended by the MSDS.

The test for "Determining the turbidity" got the lowest score of all the trials analyzed, 58.3%. Although already at a valuation of "substantial", this result was obtained due to the low toxicity index value of the products used, although it has been penalized for not having been used PPE recommended by MSDS.

In the configuration of the model of risk assessment in the context of the Food Microbiology Laboratory was found that the rate of time of contact / exposure (T) and the index of risks associated with the equipment (R) should have the highest weighting ($A_T = A_R = 10$) due to the high contact time / operator exposure to biological agents and reagents / media and the relatively high risk associated with equipment. It was also considered for the rate of exposures via (V) the weighting value $A_V = 7$, because in most trials all transmission routes are open. The weighting of the index number of measures of actual use to control the risk (C) value $A_C = 2$ resulted from the fact that the operator in most cases meets the best practice of microbiological analysis, as specified in ISO 7218 "Microbiology of food and animal feeding stuffs - General requirements and guidance for microbiological examinations ", and many of these safety rules of analysis also can be considered as safety rules for the operator.
It was considered the index of substance(s) toxicity (P) with the weighting $A_P = 1$, since the reagents and culture media used are level 1 – “not classified” (Table 3), i.e., toxicity values are very low or almost meaningless. Also for the index number of tests per year (E) was considered a weight $A_E = 8$, since the number of annual testing still has a substantial value (1800).
By applying the method of risk assessment procedures developed to study, it was concluded that all procedures meet valuations of risk "substantial" (orange). However, the procedure "Clostridium perfringens count at 37 ° C" by ISO 7937:2004, has the highest risk level (78.8%) and the procedure "Salmonella detection VIDAS SLM method" with confirmation of positive results according to EN ISO 6579, has a substantially lower risk level (58.9%).
It was also possible to verify that the procedures related to the "Survey of Salmonella" and "Listeria monocytogenes", in which the organism is more pathogenic for humans but both methods performed by automated equipment through the Mini Vidas, have the lowest risk levels (58.9% and 63.0%, respectively) compared to other procedures studied, since those are more controlled and automated methods in which the operator is less exposed to biological agents.

4. CONCLUSIONS

It was possible to set up and demonstrate a method of risk assessment for laboratory analysis using information that is available to all those who work with the testing of analysis, such as the processing times of tasks / operations and the information contained in the safety data sheets, reagent / culture medium used, information about the equipment used and the associated risks, as well as for collective and personal protective equipment actually used. The flexibility of this method makes it possible to calculate the risk levels taking into account all the variables relevant for each test.
There was also to take into account that the practical component of the work was essential, because without it would have been impossible to analyze and observe the various tests studied and obtain the necessary information for setting up the method of risk assessment developed.
This model of risk assessment, despite having been developed and applied in public health area could be extrapolated to any place where work is to develop laboratory activities.

5. ACKNOWLEDGMENTS

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Liability Risk Assessment at Skarvik Port

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ABSTRACT
The study focuses on a case of company X which owns an oil terminal and a depot in one of the Northern European countries. Company X's facilities are surrounded by the facilities of other oil companies. In case of an accident caused by company X there would be potential liability claims for property damage and business interruption. Insurance risk assessment is a well-developed approach for insurance of a company's own property; it is not normally used for liability risks. This study suggests methodology for determination of liability insurance values. Based on the obtained results and calculations of replacement values, the worst case scenario for company X was chosen. A new methodology was developed to determine liability insurance values in cases like that, including the total limit - maximum insurance value that can be claimed.

Keywords: Risk assessment, Liability risk, Insurance.

1. INTRODUCTION

Accidents in oil and chemical industry might bring very large damages, both to the company where an accident happens and other companies if their facilities lie close to the place of the accident (hereinafter - 'neighbour-companies'). In this case the company may face huge legal liability claims.

For instance, after Buncefield oil depot explosion and fire, which severely damaged Maylands business park, the owners of the depot were found liable for the blast (Taylor, 2009) and had to pay damages of around 700 million pounds (Hemeltoday, 2009).

2. AIM OF THE STUDY

This study focuses on a case of company X that owns an oil terminal located in a port in one of the Northern European countries. Several companies operate in the port close to each other with activities such as storage, loading and unloading of petroleum products and chemicals to and from ships, rail cars and road tankers. The facilities of company X are situated closely to the neighbour-companies. This gives concern for damage claims if there is an accident at company X's facilities which brings destruction of property and business interruption to the neighbour-companies.

The study is conducted for insurance purposes. Based on the obtained results and calculations of replacement values, the worst-case accident scenario for the port was chosen and recommendations were made regarding the liability risk. Consequence modelling for insurance risk assessment is a well-developed approach for insurance of a company's own property. However it is not normally used for liability risks. Therefore a new methodology was developed to determine liability insurance values in cases like that, including the total limit - maximum insurance value that can be claimed.

3. THEORETICAL BACKGROUND

Focusing mainly on accidents with the biggest damage to property, the literature suggests several types of fires and explosions as the most common ones that can lead to such damage. Among them, the Vapour cloud explosion (VCE) occurs in a case of large release of flammable material in the atmosphere, which leads to forming a vapour cloud in the air that can be ignited in presence of an ignition source. In a case of VCE only a certain percentage of the substance released produces a burn, when an ignition source is present. Depending on where the explosion occurred, there are confined and unconfined VCEs. Even a slow combustion process generates overpressure in a case of confined VCE, and a small overpressure while burning, known as a flash fire, is produced in a case of unconfined VCE [Bjerketvedt et. al, 1993]. In order to have an extensive overpressure a sufficient amount of the vapour cloud must be within the flammable region of the material. A flammable region is considered to be the region of the vapour cloud that is between the point of release and the edge of the cloud.

Another very common type of explosion that can be caused either by flammable or non-flammable liquids is the Boiling Liquid Expanding Vapour Explosion (BLEVE). BLEVE is an explosion that occurs due to failure of vessel that contains liquid at a temperature significantly above its boiling point at normal atmospheric pressure [CCPS, 1994.]. BLEVE's effects are mostly determined by the conditions of the contents in the container and of its walls at the moment of the containers failure, mainly because BLEVEs are usually associated with release of flammable liquids from vessels as a result of external fire. That means that if the container with flammable liquid is heated, its metal will be heated too and it will lose its mechanical strength. The heat will be transferred to the liquid and liquid's temperature will rise. Reaching the liquid's boiling point vapour bubbles are formed at the active sites that occur at interface with solids, including vessels walls. A cloud of almost pure vapour and mist is formed due to the rapid vaporization, expansion and loss of containment. After the vapour is ignited it starts to burn at the surface where it's mixed with air. The combustion

propagates to the centre of the cloud and a fireball is obtained. Accidents of this type, that include fireballs, are accompanied with a powerful heat radiation, known as heat flux.
Type of fire that can be very often found in big accidents is the pool fire. Pool fire is a turbulent diffusion fire burning above a horizontal pool vaporizing flammable material, where the flammable material has zero or very low initial momentum [Cowley and Johnson, 1991]. In a case of pool fire the heat is transferred from the fire to the pool, which makes the rate of evaporation, fire size etc. to be influenced, or even controlled, by that feedback. Liquid fuels can burn either in a form of a spill or in an open storage container. The burning duration of a pool fire depends on the form of the fuel material as well as on the chemistry of the fuel. There are two types of pool fires, confined and unconfined.
When a gas has a higher specific weight than the surrounding ambient air, it's known as dense gas [Britter and Griffiths, 1982]. Since most of the flammable gases are denser than air, flammable dense gas cloud remains in the lower part of the atmosphere, largely spreads in lateral direction and do not disperse as fast as a light gas. Within the refinery industry many products are vapours under atmospheric pressure and therefore are stored, or transported as liquids, maintained in that phase at, or near, the saturation temperature at atmospheric pressure by refrigeration and insulation, or at ambient temperature by pressurization [Yellow Book, ch. 4.11]. For a risk assessment purposes three primary ways of release can be considered: rapid, continuous and combined.
All of these fires and explosions were included in the 6 scenarios that were selected for modelling. For the modelling aim it was used software called EFFECTS, based on the "Yellow Book" and "Green Book". The "Yellow Book" provides information about consequence analysis while the "Green Book" describes the relationship between physical phenomena and the resulting damage. For the modelling in this study it was used the latest version of the software, EFFECTS 8, suitable for handling large variety of chemicals due to the database containing toxic, flammable and thermodynamic properties, and because it offers calculation models for accidents with storage and transportation of chemicals [TNO, 2011. EFFECTS].
Since all of the fires and explosions mentioned above lead to hazardous events, in order to identify the consequences of them, Event Tree Analysis (ETA), a technique for risk assessment was used. This technique provides possibility to predict potential accident scenarios in a case of hazardous event, known as initiating event. ETA is an inductive technique because it examines all possible responses that can be cause from the initiating event.

4.METHODOLOGY

The study was completed in following phases:
Selection of the scenarios to model. Company X's safety report as well as the results of the literature review and interviews with Company X's staff and local Environmental Protection Office were discussed and analyzed. 'What-if' analysis, generic event tree analysis (ETA) and brainstorming techniques were used to select the final list of 6 scenarios for modelling. Event tree analysis was used to determine the chain of events leading to the accident.
Modelling of potential accidents at company X's facilities facilities in the port. The scenarios from the final list were modelled using software developed by the Netherlands Organisation for Applied Scientific Research (TNO), called EFFECTS 8.1. Methods of calculation of physical effects ('Yellow Book') and EFFECTS manual were used to calculate necessary input values. Some additional manual calculations were performed.
Assessment of potential liability claims from the neighbour-companies and review of available mitigation strategies Calculation of replacement values for neighbour-companies' tanks, structures etc. was conducted using the data from Company X's Insurance Valuation done by the insurance broker and Summary of property values provided by one of the neighbour-companies.

5. MODELLING

The final list of scenarios was modelled using a software developed by the Netherlands Organisation for Applied Scientific Research (TNO), called EFFECTS 8.1. Methods of calculation of physical effects ('Yellow Book') and EFFECTS manual were used to calculate necessary input values as follows.

Explosion damage contours:
- Total destruction (> 83 kPa)
- Heavy damage (35 - 83 kPa)
- Moderate damage (17 - 35 kPa)
- Minor damage (3.5 - 17 kPa)

The damage is thus dependent upon the overpressure. (TNO Built Environment & Geosciences, 2010)

Table 1 – Thermal radiation damage contours (Dreher, 1999).

Heat flux, kW/m2	Damage level, %
4,7	10%
8	30%
12,6	50%
18	80%
23	100%

Heat radiation levels are also taken from Dreher, 1999:

Table 2 – Thermal radiation effects

Heat flux	Observed effect
35-37,5 kW/m2	Sufficient to cause damage to process equipment. Cellulosic material will pilot ignite within one minute's exposure.
23-25 kW/m2	Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures which can cause failures. Pressure vessel needs to be relieved or failure will occur.
12,6 kW/m2	Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure. Minimum energy required for piloted ignition of wood, melting of plastic tubing.

These values have been translated into damage to structure in accordance to Table 1.
Damage to structures (empirical) at Xd is the damage suffered by a structure if it was situated at the point of study (TNO Built Environment & Geosciences, 2010; Empirical damage to structures).
19 different situations can be found:
The supporting structure of a round storage tank has collapsed (100 kPa)
Brickstone walls (20-30 cm) have collapsed (50 kPa)
Displacement of a cylindrical storage tank, failure of connecting pipes (50-100 kPa)
Loaded train carriages turned over (50 kPa)
Collapse of a pipe-bridge (40-55 kPa)
Displacement of a pipe-bridge, rupture of piping (35-40 kPa)
Damage to a fractioning column (35-80 kPa)
Plating of cars and trucks pressed inwards (35 kPa)
Breakage of wooden telephone poles (35 kPa)
Cladding of light industry building ripped-off (30 kPa)
Collapse of steel frames and displacement of foundation (20 kPa)
Industrial steel self-framing structure collapsed (20-30 kPa)
Cracking in empty oil-storage tanks (20-30 kPa)
Slight deformation of a pipe-bridge (20-30 kPa)
Large trees have fallen down (20-40 kPa)
Walls made of concrete blocks have collapsed (15-20)
Minor damage to steel frames (8-10 kPa)
Connections between steel or aluminium ondulated plates have failed 7-14 kPa)
The roof of a storage tank has collapsed (7 kPa)

6. RESULTS
6 serious scenarios were identified as follows:
Scenario 1, 'Buncefield-type' scenario (see above). Tank with gasoline overfills for 15 minutes, while pump flow is 800 m3/h. It is assumed that 10% of leaked mass turns into vapour, as reported during Buncefield accident (Buncefield Major Incident Investigation Board, 2008).
Scenario 2, BLEVE at LPG storage. Pipe rupture during transfer of LPG to the tank may cause leak of propane, propane ignites and heats the other tank. This eventually triggers BLEVE.
Scenario 3, Leak from a hole in gasoline tank. In this scenario tank starts to leak, the leak is assumed to be detected in 15 min. Estimated fraction of product to turn into vapour is 10%, similar to Buncefield accident (Buncefield Major Incident Investigation Board, 2008).
Scenario 4, Dense gas explosion due to the leak of LPG tank. In this scenario propane is assumed to leak from the bottom of the tank which leads to explosion.

Scenario 5, Rupture of propane vessel. In this scenario it is assumed that propane vessel ruptures from metal fatigue of flanges.
Scenario 6, Diesel pool fire

The selected scenarios were modelled in EFFECTS 8.1 with a custom-made selection of input parameters. Since EFFECTS 8.1 does not have an option for calculating replacement costs, in order to determine the worst-case scenario, manual calculations were conducted. Having in disposal the replacement values for groups of tanks of company X, the replacement costs for neighbour companies' facilities were calculated as following.

The replacement value for one tank was calculated by dividing that value to the number of tanks in the group. Because of the fact that each tank has different volume, the replacement value per unit of volume was obtained by dividing the replacement value per tank by the volume of the tank. Since company X has tanks with different types of roofs, after calculating the replacement values per unit of volume for all the tanks, the average value was calculated for the tanks with the same type of roof and that value was considered to be the replacement value per unit of volume for that type of tank. The procedure was repeated for the other tanks with same type of roof. At the end, from all the values that were obtained the average value was calculated used as a replacement value per unit of volume. That replacement value multiplied with the volume of the tanks that were destroyed gave the replacement value for those tanks.

Having information about the contents of neighbour companies' tanks, the replacements values of the products inside of the tanks and a replacement values for clearance of debris and fire fighting were also included in the calculations.

The secondary damage was also considered, which means that the possibility of an escalation, spreading of fire etc. that increases the risk other tanks which are about 1 diameter away from the last tank that is damaged to be affected, was considered. As a result of all those calculations, the worst-case scenario was obtained.

The results of the study showed that Scenario 1 could be considered a worst-case in terms of liability risk. (See Table 1).

It should be noted that risk of damage to the environment and people is very important but in this study the scope was limited to the damage to property of the neighbour-companies.

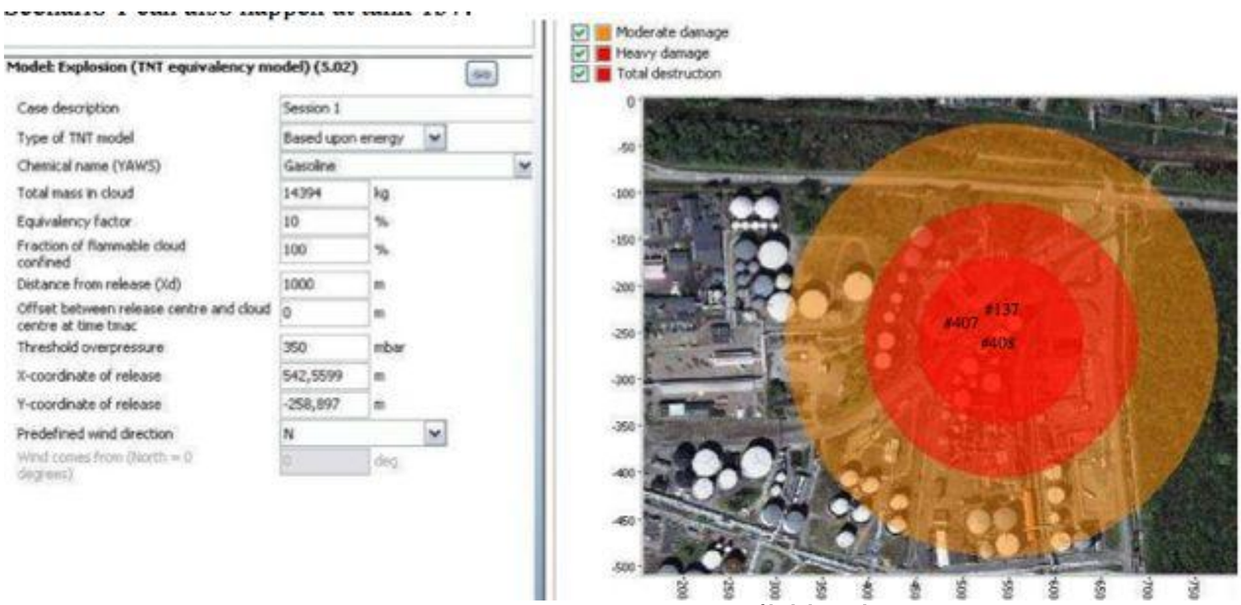

Figure 1 – Worst-case scenario on terms of liability risk.

7. CONCLUSION

Methodology to determine the liability risk was developed and tested using EFFECTS 8.1.

The suggested methodology includes the study of previous accidents, 'what-if' analysis, event tree analysis, modelling of the most probable scenarios in EFFECTS 8.1 and manual consideration of domino effects. Some parameters for the modelling, like fraction of flammable cloud confined, were also calculated manually.

Using the developed methodology worst-case scenario was chosen.

It can be reasonably assumed that Scenario 1 can lead to BLEVE at LPG storage (Scenario 2). But since it is impossible currently to establish the replacement values of BLEVE consequences – Scenario 1 remains the worst-case in terms of liability risk (≈260 million Euro).

The similar methodology can be used for the assessment of liability risk in chemical and oil industries as well as to determine the insurance value of a company's own property.

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The Role of Human Resources as Part of Corporate Social Responsibility in Increasing Competitiveness

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ABSTRACT
Occupational health and safety became a very important issue for managers, especially due to the restrictions imposed by the law, but it should be given more attention since it is a very important part of corporate social responsibility. Occupational accidents severely deteriorate the human resource within an organisation and hence it has a negative impact on the image of the organisation, and the image is closely related to corporate social responsibility. Nowadays, in order to be socially responsible the organisations have to combine the care for employees (health and safety) with the care for the community and the environment. This paper presents the link between technology and human resources, the impact of this link on corporate social responsibility and a model that can be used by managers in assessing the impact that human resources have on corporate social responsibility and implicitly on the competitiveness of an organisation.

Keywords: Health; Safety; Management; Responsibility; Competitiveness.

1. INTRODUCTION

Due to globalisation and rapid technologic development Corporate Social Responsibility (CSR) became a widely debated issue during the last years, and is often associated to aspects related to competitiveness and good cooperation with the environment within the seven means: natural, demo-psycho-linguistic, socio-cultural, political-judiciary-administrative, socio-economic, technologic and military and responsible use of the seven categories of resources: natural, human, social, artificial materials, information, financial and time (Popa, 2002). According to a report of the European Agency for Safety and Health at Work in 2004, Occupational Safety and Health (OSH) is an important aspect of CSR, "since workforce safety is one of the aspects used to measure companies' overall progress in CSR: product and workforce safety and health, labour standards and working conditions, human rights, equal opportunity and access to employment" (Zwetsloot, Starren, 2004). The same report states, rightly, that: "economic and strategic arguments often form the basis for CSR (including OSH). If moral competence is organised and integrated in a structured way in the daily work of an organisation, OSH will be a logical element of the CSR policy. In this way, not only CSR but also OSH aspects form part of the organisational policy and are therefore considered in a structural way."

Organisations all over the world are being forced to take into consideration their influence over the environment and the community. It is no longer accepted for an organisation to increase its prosperity on the expense of the community. In other words, now organisations must focus both on increasing their venues and being a role model in the society. CSR is a prominent feature of any business and many organisations started to include a CSR program in their strategic plans.

For a company to be publicly considered socially responsible, it has to build a strategic approach and accept the fact that it has to be transparent: show, share and commit to people, let them know what the CEO does, let them know that the organisation is accountable for it (Stawiski, Deal, 2010).

Corporate Social Responsibility is a concept through which organisations take into consideration both the interests of the community, by assuming responsibilities for the impact of their actions on the consumers, suppliers, employees, stakeholders and community, and for the impact on the environment. CSR as a tool for increasing competitiveness is based on four pillars: community, environment, workplace and market place, as shown in figure 1(Izvercianu, Radu 2011). As global competitiveness continues to take momentous trends, the notion of Corporate Social Responsibility (CSR) is proposed as an impressive strategy to invigorate small and medium-sized enterprises (SMEs) operations and competitiveness (Turyakira, Venter, Smith, 2010). Starting from this issue the authors aim to create a model to analyse the impact that the human resources have on each of the four pillars and implicitly on CSR. The pillar "community" requires the involvement of the organisation in the problems of the community and giving special attention to philanthropy, volunteering, living standard of the community, etc. The pillar "marketplace" means transparency, rejection of corruption, business ethics and a good relation with the clients, suppliers, business partners, investors and other stakeholders. For the pillar "workplace" the organization must consider the health and safety regulations, the balance between the professional and personal life of the employees, the rights of the employees, diversity, etc. Unfortunately the pillar "environment" receives attention only to the extent of not breaking the law. This pillar involves ecological policies (recycling, use of products made of recycled materials), use of some ecological products, principles of ecology (ISO and EMAS), reducing the impact of the organisation on the environment and preservation of the natural resources.

Figure 1 – The four pillars of CSR.

2. THE HUMAN RESOURCE – PART OF CSR

When analyzing the CSR pillars, we can observe that the human resource is a very important element, and it is part of each one of them. Each pillar includes the human resources factor, as shown in figure 2. In this paper we will pay more attention to the human resources department, because the CSR culture starts within this department (Armstrong, 2009). CSR has a great positive impact on the human resource within the organisation, such as increasing their motivation, loyalty and dedication. If the employees are not involved in the CSR program, than CSR is just a Public Relations exercise (Adine Mees and Jamie Bonham, Canadian Business for Social Responsibility). In order not to confuse CSR with Marketing and Public Relations, the CSR program should involve their human resources in all four pillars. Of course when we deal with human resources we also have to deal with another resource: the technological one, because nowadays any activity performed by humans involves technology, to a larger or smaller extent, depending on the degree of the technological advancement. In the relation with the community and the marketplace the activity of the human resources is streamlined by the technology, also the technology is the one that eases the work of the employees and increases the productivity, but unfortunately in relation with the environment the technology has in most situations a negative impact (extracting gold with cyanides pollutes the air, although it is cheaper and more effective for the organization to use this techniques than another one), that is why the organisation, through its employees, must be careful on how it deals with environmental issues. Further we will detail the relation technology – human resource in the pillar "workplace".

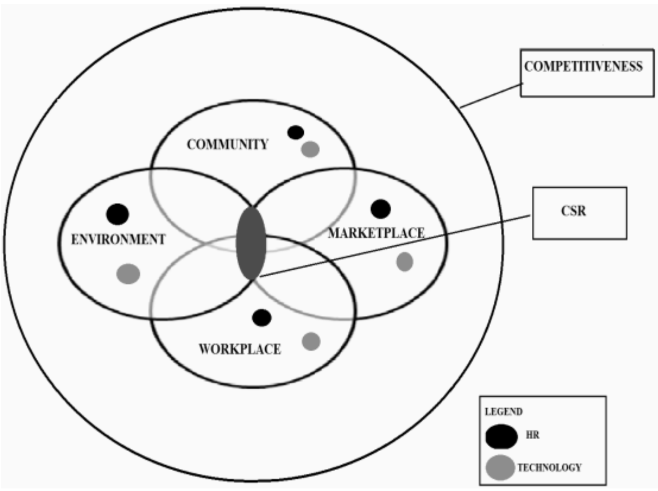


Figure 2 – HR included in CSR

Within the workplace a special attention is given to health and safety. In most situations the safety and comfort of the employees are increased due to technology, except for the situation when the technology is not properly taken care of, is old/outdated or incorrectly used, but in order to avoid technological deterioration or accidents due to the intense use of the equipment the maintenance interferes. The maintenance is not reserved only to plumbers or mechanics. This is the responsibility of every employee in each department and takes place in almost every work environment. The maintenance is by its nature a dangerous activity and that is why the employees who deal with it are exposed to risks such as: physical, chemical, biological or psychosocial. Of course introducing new advanced technologies requires employees training costs, in addition to the purchase, but in the long run it reduces the costs. The technologies that ensure the safety and health of the employees decrease the number of labour accidents and implicitly the costs of the organisation. Fewer accidents mean reduced absence due to illness and therefore a normal number of working hours, thereby increasing the productivity. Safer working methods thanks to technology ensure that the work is done faster and with fewer workers.

Advanced OSH technology also leads to maximisation of the recruiting processes, employee motivation and retention. The impact that OSH has on CSR is reflected the image of the organisation.
The technology also allows a balance between the personal and professional life of the employees. For example there are people, who would like to work, but due to different reasons, they cannot leave their homes. In this situation a responsible organisation can give them the opportunity to work from home due to technology. For the professional development of their employees the organisations implement training systems which include courses delivered by professionals certified in certain fields of activity and e-learning training modules. In addition, the employees, within multinational, have the opportunity to work across the excellence centres of the group. Performances are easier assessed due to technology, and the employees can access real time feedback. As for the human rights, an important part of the CSR, the technology has an important role by contributing to the education of the employees in terms of human rights through e-learning platforms is an example of responsible involvement of the organisation by using the technology, and by knowing their rights employees pay more attention to OSH programs.
In order to be socially responsible an organisation has to offer equal opportunities, so, due to technological development, an organisation can, for example, hire as a PC operator a blind person due to Braille keyboards and printers, but, of course, this means paying more attention to OSH programs. Multicultural relationships are also eased by technology: employees from different parts of the world get in contact easier.
CSR policies are effective if all the elements of its pillars work properly. If, for example, the human resource element within the “workplace” pillar presents OSH problems, the whole pillar is in problems and this has a negative impact on the CSR policies.
In order to better verify the role that CSR plays in organisations or is desired to be played, the authors performed a survey on a selection of 120 respondents representing managers and executive in different fields of activity; and launched it in the virtual world (e-mails, forums, etc.) for access to different opinions.
According to this recent survey done by the authors among highly educated people 81.8% of the respondents are familiar with CSR, but the same percentage does not work in socially responsible organisations, 63.7% of the population would like to have tasks related to CSR, but unfortunately only 9.1% have such tasks, so employees are open minded when it comes to CSR and all they need is a chance to be part of this. Starting from these results the authors think of creating a model to analyse the final effect that human resources have on CSR, and by extension on the competitiveness of the organization.

3. CORPORATE SOCIAL RESPONSIBILITY AS COMPETITIVE ADVANTAGE

Although the main objective of an organisation is increasing its wellbeing, the pressure coming from the community force it to redefine its objectives, by including CSR in the strategy of increasing the competitiveness (Izvercianu, 2010). We must change the executive manager thinking, there`s a need for a mature approach of liable practices which can not be solved with minimum efforts. We must teach good practice in company management and work (Izvercianu, 2005). One issue that has to be changed is the thinking related to the health and safety of the human resource and its impact on CSR, because healthy workplaces are good for the business. So, we can state that CSR is the link between social development and increasing organisational competitiveness. CSR has an extremely important role both in the marketing plan and in creating a good reputation and positive image within the community. In the market competition, the organisations try to differentiate from their competition, thus for the vast majority of the companies the brand represents an important advantage.
Among the benefits of CSR we can mention: a good risk anticipation and management, improving the reputation, increasing recruiting ability, personnel development and employee retention, increasing competitiveness and market share, cost reduction, increasing change management, easier access to capital, a better relation with the Public Administration and mainly an improvement in the attention give to health and safety issues.
Starting from a classical model of implementing management policies as presented in figure 3, the authors propose a model of assessing the impact of the human resource on CSR. This model eases the job of managers, with great benefits for the organisation.
In a classical management cycle there are five stages: identification, planning, decision making, execution and control (Popa, 2002). Starting from this a CSR cycle would look like the one presented in figure 3. First of all, a manager has to identify the issues related to CSR within the organisation, then to pay attention to the people he involves in the process of implementing CSR policies, then together with them develop a plan which will be put into action. Of course there will be a training need and all the objectives and action that are to be taken are to be communicated to the rest of the employees in order to involve everyone. After implementing the plan, an assessment is compulsory, in order to identify what went right and what went wrong and to improve the plan if necessary. It is very important to consider OSH for each stage of the CSR cycle that is why the authors propose a more detailed one, as presented in figure 4.

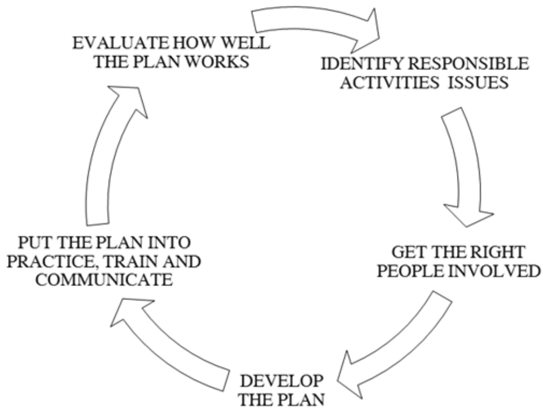


Figure 3 – The CSR cycle

This model, presented in figure 4, is based on the four pillars of CSR and the data will be collected through check lists. This kind of model is expected by most managers and it helps them eliminate errors during the management process. Due to this model managers would able to better prevent and solve crisis situations, because they are the real decision takers in the organizations. In this model the authors consider the influence that the human resources have on each pillar of the CSR. According to the proposed model when evaluating the impact that the human resources have on CSR, we first have to analyze the impact it has on each pillar. We will establish a set of variables (V_1, V_2 … V_n) which are analyzed according to a set of control lists (LC_1, LC_2 … LC_n) and have an intermediate effect (E_i). Figure 5 is an example of a control list that can be used to identify the risks in the workplace. The intermediate effect is the result generated by all the control lists for each pillar. It is very important that at least one of these variables makes reference to OSH in each pillar. For example in the community pillar one of the variables will explicitly take into consideration the employee's health because as a community member he/she pays health related taxes in order to ensure a good level of health for that community. In the marketplace we must refer to the fact that the products launched in the market should be "health keepers" and made by healthy people in order to avoid different unpleasant situations such as contaminations or epidemics. For the workplace pillar the OSH variables will consider all the health and safety rules and laws that apply in the country where the organization performs. An example for the environment pillar OSH variables is the environment protection measures with impact on human life (employees and community members). After establishing the intermediate effect for each pillar the next step is to elaborate a set of action plans (P_1, P_2 … P_n) for each of them and then to analyze the advantages (A) and disadvantages (D) for each of them in order to reach the optimum solution for each pillar (S_{opt}). Once applied, this solution has a final effect on each pillar, which leads to a final effect on CSR. Like for any strategic plan, after determining the final result an action plan is due to be created function of what the analysis stated. If the final effect of human resources on CSR is a positive one, the action plan is a preservation one, if it is negative then a correction must be done. Having access to such a model the decision takers are able to better establish their strategies in order to increase the competitiveness. When we speak in terms of competitiveness, we can state that the essential resource is the human resource and correlating the CSR programs with the OSH ones is vital for the prosperity of the organization.

We must not forget that when we consider the human resource within an organization we should also consider the impact that Occupational Health and Safety have on CSR. As stated before the major social concerns include the welfare of the key stakeholders in the business, especially employees. Thus, OSH forms an integral part of CSR and this is confirmed by its inclusion in all the major measurement and reporting guidelines and tools developed for CSR (Sowden, 2005). As we can see in figure 4 the proposed model follows the CSR cycle, presented in figure 6, but gives more instruction on what can be considered in order to assess the relation human resources – occupational safety and health and the impact of human resources on CSR. The model can also be used as a basis for an information platform or simple can be used in Excel Worksheets. Now, in order to create a platform of general use, the main concern is finding those variables that are applicable to any organization and a set of specific variables (applicable only to an organization). The specific variables are the one that differentiates the organization from its competitors. Another concern is collecting all the possible good practices in order to generate to best solution, suitable for the organization that uses the proposed model.

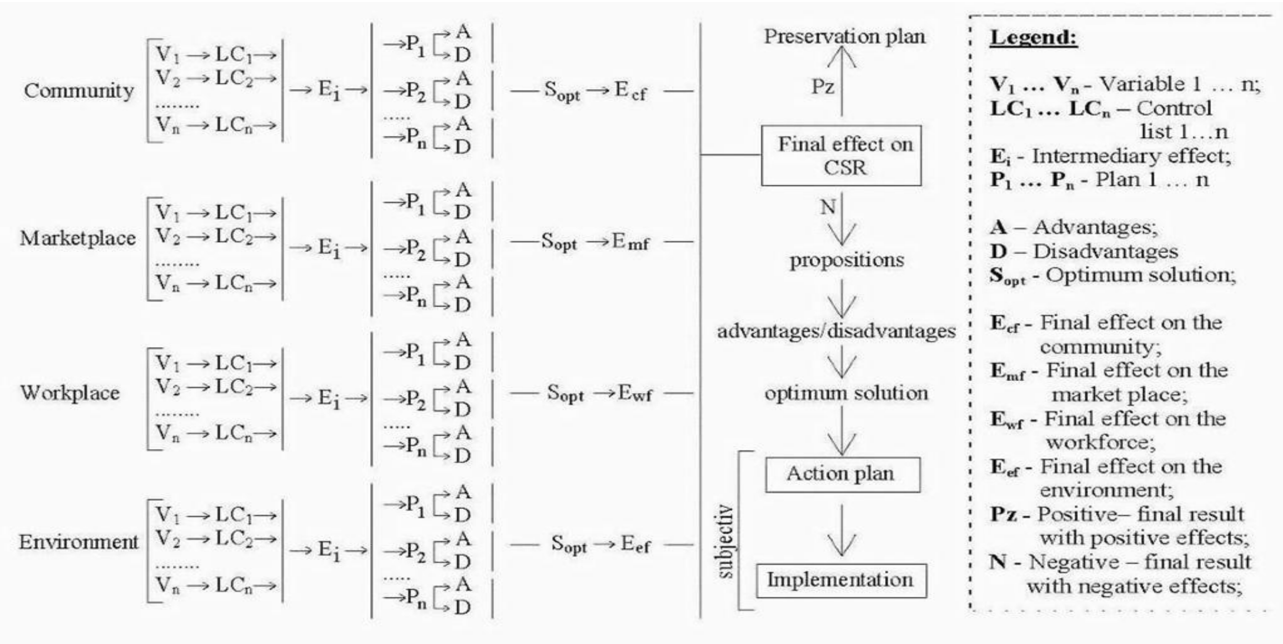
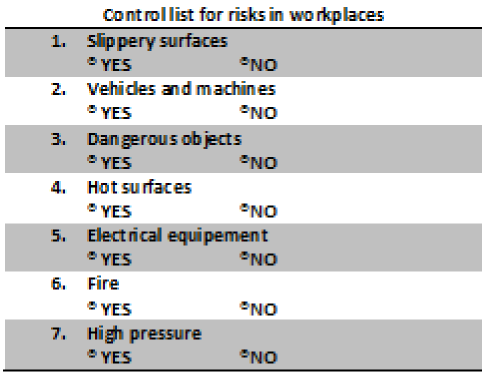


Figure 4 – The HR's role in CSR



Control list for risks in workplaces

1.	Slippery surfaces YES NO
2.	Vehicles and machines YES NO
3.	Dangerous objects YES NO
4.	Hot surfaces YES NO
5.	Electrical equipement YES NO
6.	Fire YES NO
7.	High pressure YES NO

Figure 5 Control list for the hazards in workplace

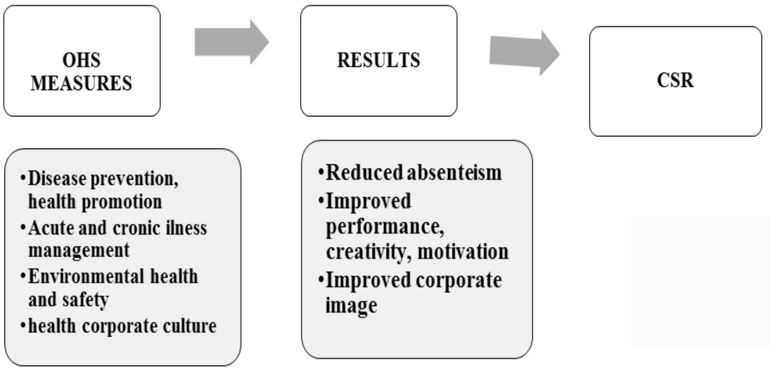


Figure 6 Pathways to CSR through OSH

4. CONCLUSIONS

Important element of strategic development, CSR has become an important and growing priority for companies of all sizes and type of activity. Safety and health is an essential component of CSR and this gives managers and OSH professionals many opportunities and challenges. Improving safety and health is not only important from human point of view (to reduce the suffering of workers), but also as a way of ensuring the success of the organization, its economic development on long term.

In the statement of launching the Lisbon Strategy in 2005, the European Commission pointed out that Corporate Social Responsibility plays a very important role in the sustainable development of the old continent and more and more organizations started to be aware of the importance of including CSR in their activity, especially for recruiting and retention. The human resources department is the key to implementing CSR politics. The future organization is forced to make great changes so that CSR becomes part of its strategy. The human resources managers – vital for encouraging innovation, collaboration and personal development – have to use the traditional skills to increase CSR, thus an expert system to analyze the human resources impact on CSR is of great help. What is more important is that such a tool can be adapted to be used in analyzing other human resources impacts such as sustainability or competitiveness.
In order to better analyze the human resources impact on CSR, and furthermore on competitiveness, the managers have to analyze the influence that human resources have on each pillar of CSR, especially the impact of OSH on human resources. That is why the model proposed by the authors solves this issue. An organization's impact on society changes over time and that is why it is very important to monitor and analyze all the activities, in order to prevent and solve any crisis situation. The model proposed by the authors gives managers the possibility of better centralizing the information, helps them in complying with the OSH regulations, helps them in their efforts to prevent and monitor the labor accidents, eases their planning activities, reduces costs and increases productivity and employees motivation.

5. ACKNOWLEDGMENTS
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Occupational Risk Assessment - An Element of Sustainable Enterprise

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ABSTRACT
This paper presents an occupational risk assessment model in sustainable enterprise. The research is done by integrating cooperative sciences: engineering, management, informatics, psychology, etc. The sustainability of enterprises generates value and develops opportunities so that this concept became a concern for everybody. The complexity of this paper is argued by the adopted procedure and by the multidisciplinary way of solving the theme and the estimated results (using modern means of information and communication technology, management and psychology). The manner in which the evaluator's psychology can influence the way of approaching occupational risks in enterprises is presented. The proposed informatics system for risk evaluation in sustainable enterprises is also presented. In the final part of the paper some conclusions and perspectives of the scientific research will be presented.

Keywords: Occupational risks; sustainable enterprise; occupational safety; sustainability; risk management; risk.

1. INTRODUCTION

The human factor is a key element in the company. Thus, the associated risks are inherent in an assessment.
Occupational risk assessment is the activity that identifies existing risk factors in workplaces and quantifies the risk dimension. Occupational accidents and illnesses involve direct and indirect costs as follows: human costs for employees and their families, financial costs for companies / organizations (absences in case of accident or illness, costs for insurance, productivity, profit, competitiveness, etc.) costs for the entire society (becoming a greater burden on health systems) (Dragoi, Draghici, Rosu, Radovici, & Cotet, 2010).
A currently used classification of the risk factors divides them, after the way they affect the human body, in risk factors of work accidents and risk factors of professional sickness, but without a rigorous limit between the two categories (European Commission, 2011). According to Work Safety and Health Law no. 319/2006 (published in Romanian Official Monitor no. 646/26.07.06):
The work accident means "the hurting of the human body and occupational acute intoxication that are happening during working process or during work duties that cause the loss of work capacities for at least 3 days, invalidity or death";
Occupational disease is that "disease produced by the exercitation of a profession, caused by physical, biological, chemical agents from the working environment and the overload of the body's organs and systems during the working process".
The occupational safety and health problem is of great interest because of the wish to reduce / eliminate the duration and the consequences of employees' exposures to different occupational risks. At international and national level, there are strategies of improvement of the statistical indicators concerning accidents and occupational diseases. National statistics regarding working accidents, occupational diseases and absence from production due to occupational causes and accidents are not a reflection of reality and that is why the economic and social effects of those elements are hard to evaluate and stand as a base for coherent national strategies (Pece, 2003).
At international level, there are a lot of available references, guides, specifications, national and international models aiming to the management of occupational health and safety that had evolved in different proportions from country to country. Although there isn't yet a national standard for health and safety management systems in Romania, concerns for a management approach in this area are concurrent with implementation and research of different models and international standards (OSHAS 18001, The DOE (USA), The RATP (Paris), The Enterprise Mission Conseils (Paris), etc.). In Romania the only method to solve this problem: health and safety at work, is the one of the National Institute for Research and Development. This is a time and resource consuming method because there isn't a developed software, only rules and checklists to be completed manually (without using the computer).
Thus the authors aim to cover all practical cases that can occur in different work systems in terms of occupational risks, using a user-friendly software that allows resumption of the evaluation process at any time and from any point. This software is an important pillar in health and safety risk assessment that can be applied at any level of the enterprise.

2. MODELS FOR OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT

In order to show the way in which different countries, not only Europe, are aligning to the existing references, there will be presented in the following, four representative models (Ericson, 2003)(Macdonald, 2003)(Draghici, Vacarescu, & Prelipcianu , 2009):
i) DOE Model – In accordance with the orders of the Department of Energy from USA (DOE) – DOE O 4114.1A; DOE O 225.1A; DOE O470.2A; DOE FRAM – from 1999 and up-date in 2001, all the subordinated organizations of this department were obliged to implement management systems, in order to minimize the risks for environment, safety and

health, with the purpose of safety in exploitation and performances increasing. In essence, it is about implementing the fundamental concept of integrated management, and about the safety and correct handling principles integration in all work processes aspects. The model basic functions are:

• Defining the activity aims; the missions are transposed in activities, the objectives are clarified, the tasks are identified and the resources are allocated;

• Risk analysis; the risks associated with the activities are identified, analyzed, and hierarchies are established;

• The development and implementation of the risk control system; the standards and the applicable requirements are identified and selected by consensus, the control modalities and the risks reduction are identified, the safety level is established and the control tools are implemented;

• The activity accomplishment under controlled conditions; the safety of the process is checked;

• Feedback and continuous adaptation; the information for feedback are gathered, the defining and planning opportunities for the activity are identified.

ii) RATP Model (Department of Public Transportation Paris). The activity analyze is the started point for the implementation of a management system for occupational safety and health (MSOSH) in the department of Equipment and Systems Maintenance (ESM). For the correct implementation of the MSOSH there is a strong need for the management implication that assume: specific organization regarding the defined objective like hygiene, safety and work conditions; stages for the safety plan and well defined objectives; actions for forming; periodical audits; communication – general integration of the MSOSH in the enterprise general management.

It is of great importance the knowledge of the real “field” situation for adequate measures. All workers have to adopt this vision in order to protect their own work safety and health and the others, too. For the new vision it implementation is not enough to argue in front of the general manager or the managers council with the argument “there will be a reduction of occupational accidents and diseases”. It is necessary that other arguments and interests to be presented such as: better communication between the prevention agent and the actors; the existence of a common ground for internal communications that help several services to work properly; The MSOSH imposes periodical consideration for organizational changes (such as activities, environment, structures), procedures, studies etc.; a significant improvement of social climate due to transparency. The success conditions are really importance: the managers’ effective commitment, the implementation of a management centre.

iii) Entreprise Mission Conseils Model – was elaborated by the Association Enterprise Mission Conseils from France. The system is detailing the OSHAS 180001 requirements as response to Work Code, art. L-230 “General Principals for Prevention”. According to these the company’s manager take the necessary measures to assure safety and the workers health protection, with the following preventive measures: avoiding risks and risk evaluation for those that can not be avoided; the disproof of the risks source and the adaptation of the work to humans; replacing the dangerous with less dangerous; priority for collective protective measures than individual protective measures; adequate instructions establishment.

For the model implementation, the manager plays an important role in the improvement of the occupational health and safety process. Because of this reason, the manager needs to know the regulations that must be followed and the correspondent responsibilities. The manager will have to establish measures for the change of the employees’ behavior towards risk and to know how to stimulate each individual for their own interest regarding their own protection and the others protection, too.

iv) OHRIS Model was promoted by Germans, Bavaria in 1988 and represents the results of united efforts of Resort Minister and big enterprises, and was made to attend the requirements of European Community to introduce the new orientation for the activity of occupational safety and health accomplishment. This model suggests that no matter of the organization type, there have to be established an optimal occupational safety and heath management that contain eight elements: the duties and responsibilities of top management; legal requirements of other nature; preventing, analyzing and corrective measures; measures in case of emergencies, supply; control; MSOSH audit; human resources. For the management system design, the model adopts the delimitation accepted by the scientific theories on three action plans:

• The normative plan, in which is established the administrative way of the enterprise constitution; the enterprise basic principles; the politics; the objectives; the organizational culture that wishes to be implemented;

• The strategic plan, in which the established objectives by the normative plan are transposed in strategies on medium and long term and in programs of action;

• The operative plan, in which the strategies and the programs are blending with actual actions, necessary for attending the proposed objectives.

The enterprise’s leaders established, through the organization chart, job description, and other internal documents the organizational structure and the necessary functioning for the politics and strategy implementation in the field of occupational safety and health, and also, the competences and the responsibilities for the leading and execution position. The top management is naming a responsible with the management of occupational safety and health and integrates this function in the enterprise management.

3. SCIENTIFIC RESEARCH SCENARIO

a) Risk Assessment in Sustainable Enterprises

The European Commission launched in April 2000 the tool of "triple basis line" on the request of measuring their value, having as subordinated: environmental, economic and social issues.

In another theory, a forth base line appears, now very important, and that is the technological responsibility, an important element in the development of any organization (Izvercianu, 2011). This new approach is presented in Figure 1, where by integrating the four responsibilities you get this concept, sustainability. The company is subjected to the concept of "sustainable development", because development in a sustainable manner meets any requirements for existing company to operate continuously in an indefinite future without reaching key resource depletion. From these considerations in sustainable enterprise, the technology must become itself a resource with a specific management, namely technology management.

One of the directions towards which the sustainable enterprise must fundamentally guide itself is technology management. Durable sustainability, with all its attributes will be based on technology and especially on the management, which is not simple, of multiple forms of the approach of technology in the enterprise.

Technology management is defined essentially as involvement and commitment of technology for an action in conjunction and simultaneously with all functions of an enterprise (Izvercianu, Lobontiu, & Draghici, 2007).

These responsibilities, technological environmental, economic and social, lead to a sustainable development and thus sustainable enterprises management becomes a management that integrates the quadruple (Izvercianu, Lobontiu, & Draghici, 2007). Technologies can be embedded in people, materials, cognitive and physical processes, facilities, equipment and tools (Izvercianu, 2011).

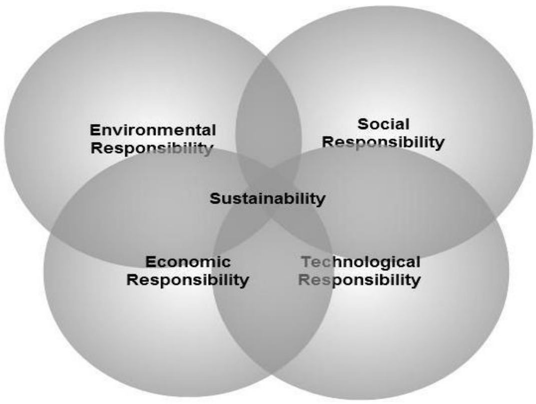

Figure 1 - The responsibilities of the sustainability (Izvercianu, 2010)

Risk is an element present in any enterprise. Its sustainability needs risk identification within all four responsibilities of the sustainability: technological, environmental, economic and social. The essence of this development model is to establish the relationship between the human activities and the natural environment, which cannot diminish the perspectives of the next generation (Dumitrescu, 2011).

In identifying risk in each responsibility, technological, environmental, social and economic, comes by default the manner in which that the evaluator evaluates the enterprise, practically the final report is influenced by his temperament. A study of this influence is imminent to get, at the end of the evaluation, a full report identifying occupational risks in the enterprise.

Identifying the temperament (choleric, sanguine, phlegmatic and melancholic) of the risk assessor is an essential element in this process. Depending on the temperament some risks may be omitted or passed being considered unimportant for the moment (Hillson, 2007). By combining various types and kinds of psychological temperaments, the authors have obtained a clear classification of types of attitudes towards risk with these influences (risk-aversion, risk-neutral, risk-seeking, risk-tolerance). This model of risk aversion allows a correct identification of the assessor, and by identifying the manager's psychology it can be obtained a proper report of workplace risks. Thus each evaluation report contains the assessment report and how the manager's temperament influenced the enterprise's evaluation (Ivascu, & Izvercianu, 2011).

The authors made a chart, Figure 2, for highlighting the influence of temperament and nervous system on risk assessment in sustainable enterprises. For graphics, the Gliffy software was used. Gliffy is a Web 2.0 diagramming application where it can be created professional-quality flowcharts, diagrams, floor plans, technical drawings, and so much more. Founded in May 2005 in San Francisco, California, by Chris Kohlhardt and Clint Dickson. [13].

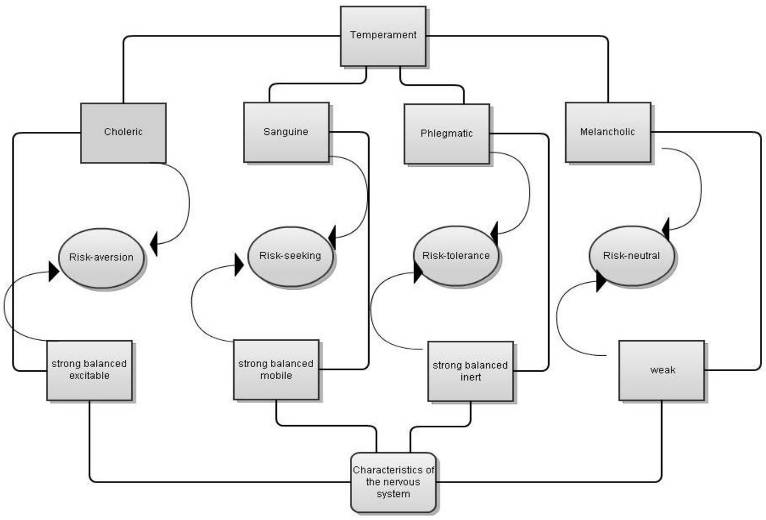

Figure 2 – The types of attitudes towards risk

Starting with the stage of hazards identification, the enterprise's evaluation is influenced by temperament. The logic diagram associated to the timing in which the temperament influences the occupational risk assessment in sustainable enterprises is shown in Figure 3.

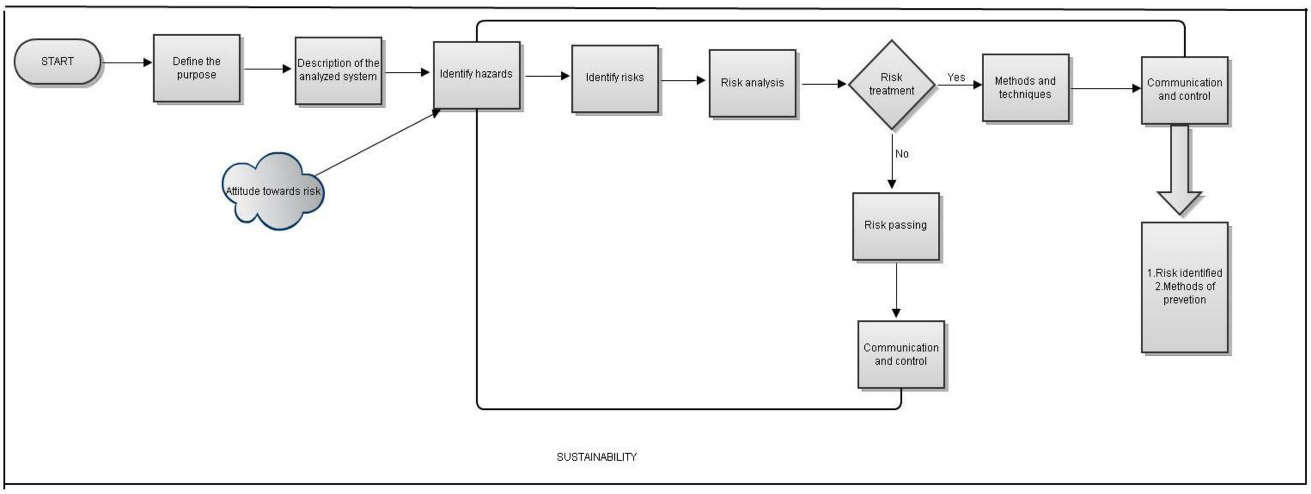

Figure 3 - The temperament influences

Basically, for example certain hazards may be omitted, others may be identified without leading to an imminent risk and thus the assessment becomes dependent on the assessor's temperament.
From this stage until the completion of the evaluation, temperament is an element of influence.

b) Occupational Risk Assessment Model for Sustainable Enterprises

The approach proposed by the authors aims to cover all practical cases that can occur in different work systems in terms of occupational risks, using a user-friendly software that allows resumption of assessment at any time from any point on the required responsibility, that can be technological, environmental, economic or social. With this tool, safety responsibles (managers at various levels) within organizations can better define their strategies, policies and tactics to act pro-actively investing in intelligence, learning, communication and knowledge to develop the safety organizational culture. Human resource is essential to any enterprise, occupational risk assessment is imminent (Hunag, 2011).
The logical scheme for risk assessment in an enterprise is structured in the version proposed in Figure 3. As shown, the steps are: defining the purpose, description of analyzed system, identification of hazards, within the four responsibilities, risk identification, risk analysis, risk treatment, communication and control.
This scheme will be associated to the evaluation platform, realizing hazards identification on each responsibility and within every responsibility being presented the causes (hazards) for safety and health risks.
Often it is found that approaches for sustainability are understood only as protecting the environment and natural resources, either as compliance with environmental legislation or by voluntary measures to implement an environmental management system ISO 14001. In some Romanian organizations we find voluntary implementation of environmental management systems for occupational health and safety after OSHAS 18001 standard. Less common are SA8000

standard implementation, on certifiable systems to ensure decent working conditions (European Commission, 2011). The standard ISO26000: 2010, on corporate social responsibility, is embryonic in Romania. The European Commission proposed the following definition: "Corporate social responsibility is a concept whereby companies integrate social and environmental concerns in their operational activities and their interaction with the relevant actors on a voluntary basis". CSR objective is to contribute to sustainable development of the company.

The computer system for occupational risk assessment in organizations has the role / main benefit to identify risks of the organization and then, based on identified risks, the system will provide the user (risk responsible) a number of measures to counter, treat or pass the risks identified (Ivascu, & Izvercianu, 2011).

The database underlying the system of occupational risk assessment can be made public. In this way, the company may develop and highlight the corporate social responsibility through active participation in enrichment of information from public databases with questions about risk, consequences and measures specific to their business. Thus, there is a continuous improvement of the information system and a widening of the area of application.

Through these integrated concepts the information system proves its two other benefits: advertising and communication (self-help enterprise).

The preliminary results of the research are presented in Figure 4, including the pages contained in the platform. On the first page there is the evaluator identification, then on the next page the mandatory element is the psychological test. Then the hazards' identification takes place, in the four responsibilities of sustainability, after that the identified risk analysis, and finally, communication. Communication includes the final report, preventive measures, associated diseases and risk aversion influence of the evaluator of the process.

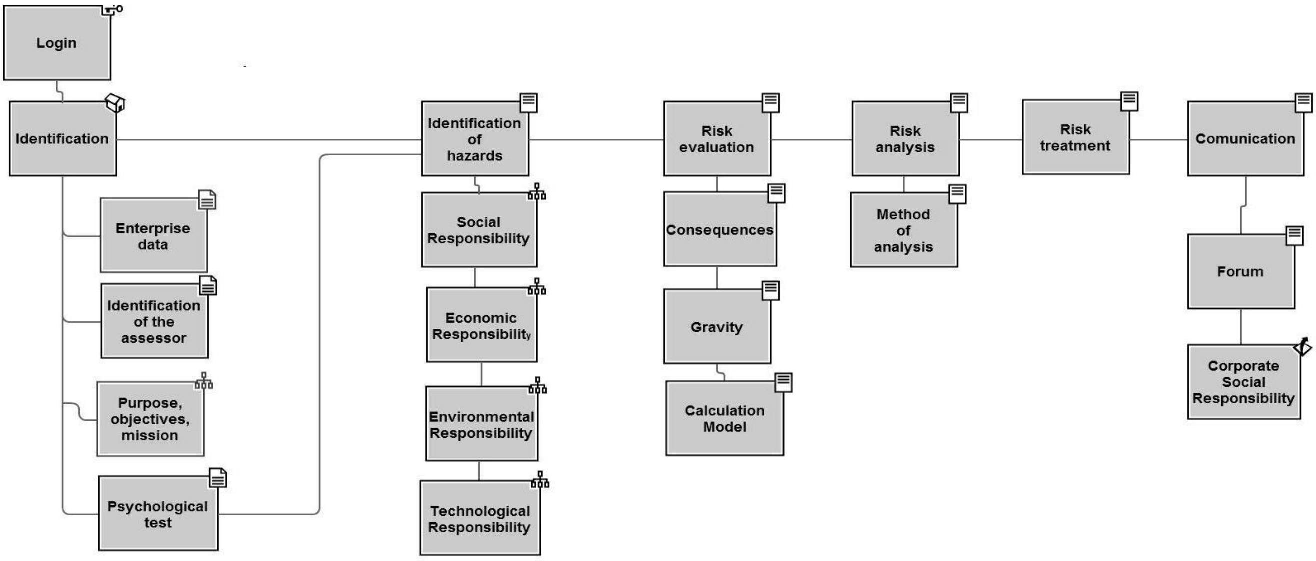

Figure 4 - The proposed logical diagram for risk assessment

4. CONCLUSIONS

This paper presents an occupational risk assessment model in sustainable business. Preliminary results have been focused on identifying the assessors' attitudes towards risk.

The developed logic scheme is the base of the computer system that can be applied to any level of the work system. Since its conception it has been tested in an enterprise with the possibility of continued modifying and testing. Occupational risk analysis and assessment for real work system were better designed and the classic procedure in accordance to OHSAS 18001 has been updated by identifying new risks and implementing preventive and corrective measures.

The information system will be developed using WampServer software, version 2.1 of 01/07/2011 and comprising: Apache 2.2.17, Php 5.3.5, Mysql 5.5.8, XDebug 2.1.0-5.3-vc6, XDC 1.5, PhpMyadmin 3.3.9, SQLBuddy 1.3.2 și webGrind 1.0

Implementation of risk management promotes early and ongoing occupational risk identification so that risks that may occur will not affect the objectives of the enterprise. Risk identification determine future decisions, identify new alternatives or opportunities within the organization. Understanding the disadvantages of all the factors is very important. This increases the probability of success and reduce losses in the enterprise.

5. ACKNOWLEDGMENTS

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Noise delimitation on civil construction equipments - Propagation and interference

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ABSTRACT
Nowadays urban society lives alongside a physical agent called noise in every segment of its Day-to-day life. The World Health Organization – WHO (2011) acknowledges that sound pollution (noise) is the third main cause behind environmental problems in the world, losing only to air and water pollution. Urban vertical expansion can be observed in many cities, not only in the great national and regional metropolises, but also on medium-sized and even small cities. This form of expansion, generally called "verticalization", shows a process that distinguishes itself physionomically by the construction of edifications with diverse floors and results in various dimensions of interpretation connected to elements of modernity within the urban space. Such expansion contributes to the urban thickening, which means an intensification of the usage and occupation of soil (Martins, 2009). Vertical edifications (residential or commercial) will increasingly proliferate. Construction processes will become even more modernized, new construction technologies will appear and, along with them, new equipment and machines adding noise to the environment and therefore possibly harming those who work or live near the construction sites. The economic activity of Construction in Brazil as a lever for development and growth through the large number of workers it employs. The objective of this work, which is part of a larger investigation, was to map the spread of noise generated by equipment slam into a work of urban vertical construction, determining its scope and interference. We conducted a pilot study that could validate the methodology proposed in the research project, through the measurement of noise emitted by equipment pre-mold pile. Data were collected in the field using a sound level meter mark of QUEST, equipped with octave band filter. Was given an imaginary grid on a cartesian plane with a widened (by 10 meters) grid, measurements being performed at all points of the grid, with the limitations of law values. After the initial survey and identification of the intensity data were processed using the software and then surf 8 curves generated noise propagation. The background noise in the workplace was also surveyed. After the survey, the collected data fed the software, which automatically made the grid interpolations having as a final result a chart, that is, the mapping of the noise in the area. Then, we observed that the variation of sound levels were between 80 and 105 dB(A). We measured the noise of traffic lanes in the vicinity of the site, for local traffic although not intense during the work period. The noise from the lanes situated in the vicinities and the existing barriers can be verified in the noise reach mapping. It became evident through this study that we get a sound mapping tool with information that can help managers to plan the sites within the legislation and improvement of working conditions and mitigate interference that may occur in the neighborhood.

Keywords: Definition of noise, construction equipment, propagation and interference noise, safety, construction.

1. INTRODUCTION

The activities in the Construction Industry have in their day-to-day noise as an integrated part of the sector. Generated on a frequent basis for machinery, equipment and tools used, the noise is routinely noted. On the other hand machinery, equipment and tools make the work environment more functional and are indispensable due to several factors. According to Maia (2001), in the use of construction machinery, equipment and tools increasingly faster has become the occupations of workers in this industry noisier.

It is also acknowledged that noise can disturb the work, rest, sleep and communication between human beings, while also harming the hearing and causing of provoking diverse psychological reactions. The human being is easily adaptable to various environments. So, tiredness, fatigue and disincentive may exist without being noticed. Pereira (2005) reports that the urban dweller lives inside an atmosphere of noise, suffering the pressure brought by a plethora of sounds both in moments of leisure and at work

Yorg and Zannin (2003) investigated the perception of noise by man, which found that the man is so accustomed to the noise in their daily tasks that, when asked if he realized the noise level to which it was exposed in their environment labor and / or in their urban environment, the answer given was: "We are already accustomed to these noises, with the time we get used to ....". This statement reveals that the repeated and continuous exposure to noise is not perceived in a conscious way or as cumbersome. However, it may highlight that the effects of exposure continue to act effectively against the health of these individuals.

Psychological reactions, such as motivation and disposition, may be modified negatively through the noise. The concentration and learning ability can be affected by the disorder and aggression resulting from exposure to noise, and this reduction in capacity and awareness can lead to accidents in the workplace (Petian, 2008).

The Brazilian laws regarding the environment (on Federal, state and municipal levels) show relative concern to the safekeeping of the environment, trying to keep human intervention on it in check.

The Brazilian Constitution (1988), on its 225th article, states that "An ecologically balanced environment is a right of every citizen, and it is up to the government and the general populace to defend and preserve it for the present and future generations" (Brasil, 2011a).

Federal Law n.9605 (February 12th, 1998), on its 60th article, states that "to build, reform, extend, install or otherwise run establishments, workplaces or potentially pollutant services without license or authorization from the organs responsible for environmental safekeeping, or opposing legal laws" is considered to be a crime punishable by fines and imprisonment (Brasil, 2011b).

The National Environmental Council - CONAMA (Brazil, 2011c), consultative and deliberative organ of the National Environmental System, established by Law 6.938/81, Decree 99.274/90 establishes the standards for various resolutions of environmental preservation. Resolution No 001 of 08 March 1990, sets forth the criteria for noise emission standards, as a result of any industrial, commercial, social and recreational activities, including advertising. This resolution recommends that the noise generating activities should follow the guidance of ABNT - Brazilian Association of Technical Standards, which can be seen that the noise levels are determined in NBR - Brazilian Regulatory Standard 10151, which deals with Acoustics - Assessment of noise populated areas to ensure the comfort of the community, where parameters are set for noise levels outdoors and outdoors. This NBR also states that local authorities can be determined in accordance with the habits of the population, daytime and evening. Since the NBR 10152 - Noise level acoustic comfort for determining allowable levels of noise for indoor environments.

The National Program of Education and Control of Noise Pollution - SILENCE established under resolution 002, 8 March 1990 (Brazil, 2011d), coordinated by IBAMA - Brazilian Institute of Environment and Renewable Natural Resources, has the aim of raising awareness and teaching the population as well as training of technicians to receive complaints and determine the steps combat noise pollution, and also to encourage the production of equipment with less loudness.

The Norm 15 Ministry of Labour - Decree 3214/78 establishes the maximum tolerance to occupational noise, predicting that a continued exposure to noise above 85 dB (A) can cause permanent hearing loss. (Brazil, 2011e).

The Code for the Environment and Ecological Balance of the city of Recife - city where this investigation is taking place – (Brasil,2010f), capital of the northeastern state of Pernambuco (Deriving from the Law n. 16243 signed on September the 13th of 1996, and published on the Official Municipal Log on September the 13th and 14th of 1996), states, in its subsection II (regarding sound emissions) – determines (in its 49th article) – The emission of sounds and noises deriving from any industrial, commercial, social or leisure activities, including propaganda, shall obey the interests of health, security, public tranquility and standards established within this Law.

Unique Paragraph – Are therefore subjected to the effects of this Law, every activity that can potentially create sound disturbances to the neighborhood, related by the Law of Usage and Occupation of the Soil and other municipal legislations.

The noise prevention and control of noise pollution in order to safeguard human health and well-being of people is the fundamental task of the State, under the Portuguese Constitution and Law on the Environment. Since 1987, this matter is governed by Portuguese law by Law No. 11/87 of 11 April (Law on the Environment), and Decree-Law No. 251/87 of June 24, which approved the first general regulations on noise. Decree-Law No. 292/2000 of 14 November, which approved the legal regime on noise pollution, revoked the decree of 1987 and reinforced the principle of prevention of noise.

The transposition of Directive No. 2002/49/EC of the European Parliament and the Council of 25 June on the assessment and management of environmental noise, made essential to make adjustments to the legal regime on noise pollution approved by Decree-Law No. 292 / 2000 of November 14, as amended by Decree-Law No. 76/2002 of March 26, Decree-Law No. 259/2002 of 23 November and Decree-Law No. 293/2003 of 19 November in order to bring them into line with the standards set forth herein, in particular the adoption of harmonized noise indicators. Decree-Law No. 146/2006 of 31 July states that the prevention and control of noise pollution are key issues for the protection of health and the environment.

Directive 2002/49/EC defines ambient noise as "unwanted or harmful sound was generated by human activities, including noise emitted by means of transport, road, rail and air transport and sites of industrial activity." Royal Decree 1367/2007 of 19 October, also backed by Law 37/2003 of November 17, zoning laws on the acoustic quality objectives and their acoustic emissions.

According to the what's been researched, on the majority of the cities of the world the legislation regarding environmental noise is directed to activities revolving industries, leisure and transports (public or otherwise), however, only two countries have a specific legislation regarding environmental noise from edifice workplaces. Such countries are the USA (only in the city of New York) and Chile, where a project is taking place regarding the ordinance and evaluation of this kind of noise that, although temporary, emits levels that cause disturbance to the populace.

Urban vertical expansion can be observed in many cities, not only in the great national and regional metropolises, but also on medium-sized and even small cities. This form of expansion, generally called "verticalization", shows a process that distinguishes itself physionomically by the construction of edifications with diverse floors and results in various dimensions of interpretation connected to elements of modernity within the urban space. Such expansion contributes to the urban thickening, which means an intensification of the usage and occupation of soil (Martins, 2009). Vertical edifications (residential or commercial) will increasingly proliferate. Construction processes will become even more modernized, new construction technologies will appear and, along with them, new equipment and machines adding noise to the environment and therefore possibly harming those who work or live near the construction sites. Maia (1999) points to the economic activity of Civil Construction in Brazil as a lever to development and growth due to the great number of workers it employs.

Brazilian Civil Construction will register an expansion of 8,8% on the GDP (Gross Domestic Product) in 2010, after a 1% growth percentage in 2009, as estimated by SIDUSCON-PE (Civil Construction Syndicate of São Paulo, 2011).

The industry meets the State of Pernambuco about 11 thousand industries of different segments. Industries are divided into: - Manufacturing industry (8192) - Construction (2713) utilities (160), mineral extraction area (132); The industrial sector employs 287 654 000 employees, divided into the following areas: Industry transformation (200,338), Construction (69,720), public utility industrial services (15,329) and mining (2267) (FIEPE, 2010).

You can join the economic growth of the state of Pernambuco in Recife, and thus, the increase in urban noise, new buildings (residential, commercial, leisure, etc. ..) due to new ventures in the state such as: building of an oil refinery, a shipyard, a new city to get the games in 2014 world Cup football and improving the population's purchasing power.

Among the subsectors of the industry, the biggest increase was in construction (8.0%). The construction industry accounts for 5.65% of the sectoral composition of employment is the second published on the website of the City of Recife (Brazil, 2011f). The vertical urban sprawl can be seen in many cities, not only in major national and regional metropolises, but also in medium-sized cities and even in small. This form of expansion, usually called the "vertical", expresses a process that distinguishes the physiognomic construction of buildings with several floors and involves several dimensions of interpretation related to elements of modernity in the urban space. This expansion contributes to urban consolidation, which means an intensification of use and land cover (Martins, 2009).

More and more vertical buildings (residential or commercial) to proliferate. Modernize the construction processes, building new technologies emerge and with them new equipment and machinery adding noise to the environment and, consequently, there are people who live or work in the vicinity of new construction. Maia (1999) points out the business of Construction in Brazil as a lever for development and growth through the large number of workers it employs.

With the rapid industrialization in all countries of the world, plus the immediate economic needs of the companies installed, are generated constant assaults of man to man and the environment (Lago, 2006).

In the construction supply chain, in addition to its economic importance, the activity of construction also has an important social role in the generation of jobs (representing 6% of total employed persons, which characterizes the sector as the employer of the country more) and combating housing deficit (Gonçalves, 2003). The industry that both feeds and grows the economy, also contributes to the increase in environmental noise, making the people living in the vicinity of the works remain in the execution of works with a level of discomfort by the noise from the equipment used.

Several studies have been conducted on the noise, but most of them includes the occupational area, the assessment of workers exposed during their working day to physical risk noise (Petian, 2008). As an example cited is the work of Fernandes et al. (2008) on the noise exposure of workers in the construction sector which underscores the importance of this study due to the effects this can have on workers' health.

According Ausejo (2009) who conducted an investigation into the noise and feedback through a tool available on the web is necessary to know the people and legislation for the conduct of local action plans and specific noise as defined by the European Directive 2002 / 49/CE. The author attempts to assess the area studied subjectively aims to complement the results obtained by measurements and simulation techniques As a partial result of a research project.

The noise in a neighborhood of a small town in Spain has been studied by Michael (2009) which analyzed responses obtained on the Internet targeted questionnaires were designed following the international standard ISO-15666 (2003).

The noise nuisance due to the firing of shots was the theme in the work of Brink (2009) found that, at the request of the Swiss Federal Institute for the Environment (BAFU), the extent of the problem in order to provide the basis for the regulation of noise. Was used in this investigation two scales to assess the discomfort discomfort reported by the inhabitants of the region. Environmental noise also verified by Feijoo (2009) was to research the reactions to noise at night due to leisure activities. The noises of people talking about drinking and causing nuisance generating possible disturbances in the exposed individuals, one being insomnia. Some of the issues investigated in this study are related to the evaluation of the existing noise at night in Santiago de Compostela, establish the level of outside noise and analysis of how exposed people are affected, especially at the level of interference with sleep. Tartine et al. (2009) assessed the noise exposure in and out of the house night, noting that the high levels of sound they produce pleasure and which can also be a harmful element for those who work (bartenders, disc jockey, attendants, etc.), and these locations.

The music coming from the house night (bars, restaurants and clubs) may also represent a disturbance to people living nearby. The music is especially seen as a source of irritation during the night, when the excitement wanes and people need to rest quietly. In this work, Tartine et al. (2009) also made an assessment of sound pressure level inside the nightclubs to actually existing knowledge of the noise, a quantification of grievances / complaints about the activities and musical entertainment at night and talks high and its location (versus noise complaint). The noise disturbs the sleep, peace or the welfare of neighbors and harmful use features of the property, although there is no intent to harm or disturb, justifying the application of the rule of art. 1277 of the Civil Code of 2002, for what should be considered is the quality of life and health of humans and non-economic activity (Freitas, 2006).

Andrade (2009) identifies the main noise sources are perceived from the neighborhood (neighbors, appliances and construction - 89.2%) first and second with 10.8% coming traffic. In their study, Ballesteros et al. (2010) reports that the noise emitted by construction situations are pollutants, presents a methodology for assessing the environmental noise emitted by construction equipment used in different stage of implementation, to a case study in Spain. Jakovljevic (2008) cites a study conducted in Serbia where the objective was to determine the main factors of road traffic noise and the factors that influence the annoyance caused by noise in an urban adult population, and evaluate its predictive value. A cross-sectional study was conducted in 3,097 adult residents in the center in Belgrade (1217 men and 1880 women) aged between 18 and 96 years. We performed a measurement of environmental noise during the day, afternoon and night in every street of the city. We administered a questionnaire including socio-demographic data and evaluation of the estimated noise of the discomfort using a discomfort on the verbal scale.

Gangolells et al. (2009) presents a systematic approach to address the potential adverse environmental impacts during the pre-construction. The proposed methodology serves as an evaluation tool for construction projects in order to measure the environmental performance of its construction activities, also provides a basis for future comparisons and for ecological and environmental labeling. Within the methodological framework, nine categories of environmental aspects are proposed: atmospheric emissions, water emissions, waste, soil amendment, resource consumption, local issues, transport issues, effects on biodiversity, and incidents, accidents and potential emergency situations .

Finally, one can verify that the investigations have a tendency to quantify and qualify the ambient noise in relation to traffic, leisure, etc. Investigations focusing on the noise emitted by construction methodology have not yet, perhaps because it is a temporary noise, but with a sound pressure level noise that adds to the existing one additional discomfort. The methodology for this indicator and will try to be uncomfortable in the proposed research presented in this work plan. So, the object of this work, which is part of a wider investigation, was to map the proliferation of noise generated by the equipment known as the pile driver in a vertical construction site, determining its reach and interference.

2. MATERIALS AND METHODS

This study is inserted inside the author's doctoral thesis project on which shall be determined on the perception of interference and noise emitted by vertical urban construction works in order to be able to establish a coefficient of discomfort of those who live or work in the vicinity of these sites. The proposed work aims to comply with a set of specific objectives, such as evaluating qualitatively and quantitatively the interference of sound pressure levels emitted in urban areas by vertical constructions and their perception by the people who live or work in the neighborhood, set the spread of sound pressure level of equipment and implement guidelines for developing a methodology for acoustic mapping of these sites, to allow aid in the management of the construction (site layout, hours of operation) and in urban planning to improve the quality of life.

With the work place chosen for the pilot study, we began the pile driver noise quantification project, and through the location's blueprint we could visualize the property's limits, and based on its configuration, it was possible to determinate an imaginary grid with landmarks placed onto a Cartesian plan, on which initial coordinates stayed within the terrain's limits, and with a widened (by 10 meters) grid, with measurements made on all landmarks of such grid, having as noise limitations the values specified by Brazilian legislation. Each collected point matched the Cartesian coordinates (x,y). In order to obtain the Sound Pressure Level (SPL), we used a sound-meter from Quest Technologies (series number: QIE070075), installed with an octave band filter. On the geo-processing stage, initially we extracted images generated by the NOAA satellite from the Google Earth software, and then the same program was used to extract the geographic coordinates. Later on, we filtered the data through Software Surfer 8 from Golden Software, and after the creation of the isolines of propagation, we compiled the information through AUTOCAD 2010 from Autodesk, thus generating the noise propagation maps. The background noise in the workplace was also surveyed.

3. RESULTS

It was the mapping of the noise generated by the yard in a Pile obeying several steps, first the plant was acquired lease of the bed where they could view the property boundaries and based on the configuration of their physical arrangement was developed an imaginary net of points obeying a spacing of 10 (ten) meters, and the amount of points dependent on the extent of the property field survey consisted of a pathway for all the points determined by sampling at each grid point was established Cartesian coordinates, (x, y). to obtain the sound pressure level (SPL), we used a sound level meter Quest Technologies model 2900 serial No.: QIE070075. They were then extracted from the NOAA satellite images generated through the Google Earth software, geographic coordinates and extracted with the same program. In a second stage treatments were performed using the data of the Golden Software Surfer 8 Software, after the generation of contour propagation was conducted to compile the information through the software, Autodesk Auto CAD 2010, generating in this way maps propagation of noise. According to figure 1 the site studied is inserted in the neighborhood of the Madeleine in Recife-PE, specifically the Road Arlindo Gouveia, s / n, with latitude 8 ° 3'22, 53 "S and longitude 34 ° 54 '14.34 "W. This plot has an area of 5019 m ^{2}, where he was being held to pile driving using pre-shaped.

Figure 1 – Map of location of site

Initially a plan was made from the planimetry is preparing an imaginary grid (Grid) points to the realization of the way as shown in figure 2, we collected a total of 72 points.

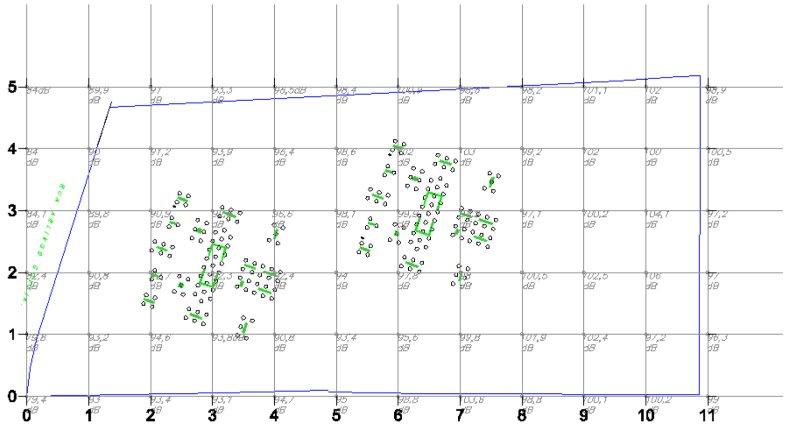

Figure 2 – Grid points to measure

The interpolation of the noise of the work was performed using the software Surfer 8 using the kriging method for the preparation of maps were used AutoCAD version 2010. We observed that the variation of sound levels were between 80 and 105 dB (A) Figure 3 and 4. We measured the noise of traffic lanes (background noise) around the yard, though not intense during the period of investigation, we obtained a variation between 53 and 75 dB (A).

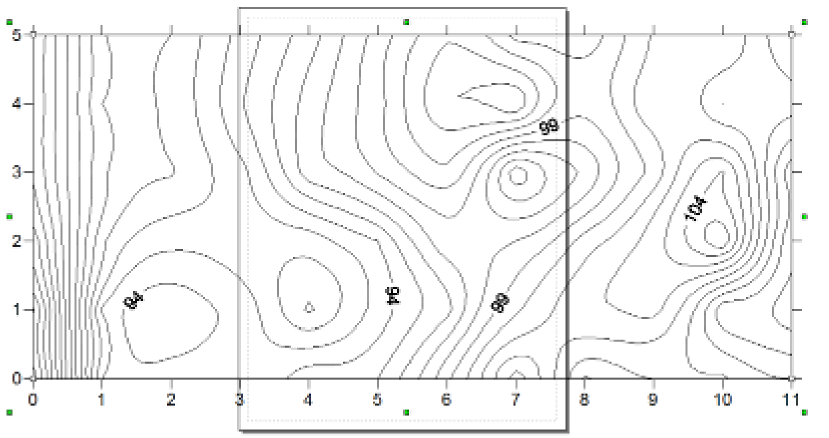

Figure 3 – Map of noise propagation

Figure 4 – Map of noise propagation grid points to measure

4. CONCLUSION

We carried out the mapping of noise generated by a pile driver on a construction site, and with that information, it is possible to trace the curves of noise propagation and determine the influenced areas of the equipment, thus classifying the risk area.

After the survey, the collected data fed the software, which automatically made the grid interpolations having as a final result a chart, that is, the mapping of the noise in the area. Then, we observed that the variation of sound levels were between 60 and 110 dB(A). We measured the noise of the lanes of traffic (background noise) on the construction site's vicinity, even though the local traffic was not intense during the working hours. Then, the isolines obtained through sound mapping were traced by the software (SURF 8). The Cartesian plan was defined in the limits of the construction site. The noise from the lanes situated in the vicinities and the existing barriers can be verified in the noise reach mapping Noise pollution is an invisible, continuous and slowly attacks the individuals causing damage to both hearing them and throughout the body - physically and psychologically.

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Modelling of the Interaction between Water and Fire

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ABSTRACT
Substances or products needing to be discovered which would allow us to stop the phenomenon of oxidation-reduction among the combustible material and oxidant, motivated by the activation energy, has led the mankind to study and develop various extinguishing agents. The one witch needs to be highlighted is the water. Water is one of the most intriguing elements in the nature, which has motivated us to do a thorough study on this substance. As an extinguishing agent, water has great advantages such as availability, non-toxicity, low cost, easy storage and transportation. It has many features that contribute strongly to its efficiency in fighting fires, such as, low density, low viscosity and mechanical resistance. It has other properties, such as heat resistance, the absence of chemical reaction and high evaporation and decanting times, which makes water an excellent agent to study. The study that will be developed will focus on creating models of interface between water and fire, i.e., how the water exerts its action of extinguishing agent on the fire.

Keywords: fire; water; modelling; interface; sprinklers.

1. INTRODUCTION

The need to discover substances or products to interrupt the oxidation-reduction phenomenon between a combustible and the oxidizing agent, caused by an activation energy, has led to the study and development of diverse extinguishing agents, namely water.

Water is a triatomic compound whose molecules contain two Hydrogen and one Oxygen atoms, exhibiting particular characteristics that make water one of the most intriguing elements in Nature, leading to detailed study on this substance.

Analysing water, the simple fact that it is liquid at room temperature is surprising, since most of the similar compounds to the molecule H_2O are gases.

A different feature is that water at 0ºC (32^{o}F, ice) is less dense than liquid at similar temperatures – exactly the opposite of what may be observed regarding most substances. Even disregarding the physical causes for such fact, man has been able to enjoy this characteristic in his leisure activities.

As extinguishing agent, water displays main advantages as availability, non-toxicity, low cost, easy storage and transportation.

Water has features that greatly contribute to its efficiency in firefighting, such as low density, low viscosity, mechanical strength and adhesive properties, resistance to heat, the absence of chemical reaction and the high evaporation and decantation time, becoming an admirable subject for analysis.

By reducing the oxygen content in the surrounding of combustibles, by the ability to cool flame and combustible, or by achieving the physical splitting of combustible and oxidizer, water is undoubtedly one of the more frequent extinguishing agents, especially given its incremented cost-effectiveness ratio.

The present study, in the scope of a doctoral thesis, we intend to study the interface between water and fire, that is, how water acts as fire extinguisher agent. This study will be performed both at an experimental and numerical level and water and fire interface models will be developed. The study will focus jet, spray and nebulized water, used in firefighting systems and fire sprinkler networks, as well as in the equipment for their operation.

2. STATE OF THE ART IN WATER FIRE SUPRESSION

Along with sand, water is one of the longest extinguishing agents used by man, even though its use was greatly developed through human society's technical and technological improvements.

It should be noted, however, that water is not an extinguishing agent for any circumstances and usable in all fires. Its use is banned in firefighting on installations or equipment under electrical tension and in Class D fires, involving light metals, carbides or acids. It is also not recommended for fires in flammable liquids at high temperatures, since it enables the dissociation of the water molecule into Hydrogen molecules (H_2) (high-energy combustible) and Oxygen (O_2) (oxidizer), originating a violent reaction and fire expanding.

Water should also not be used in sensitive equipment or facilities nor in places with very low temperatures (water freeze may damage or disable the extinguishing equipment).

No doubt that water is involved in combustion suppression, through physical phenomena such as lowering the combustible temperature at a lower level than the ignition temperature and/or by causing a mist that will occupy the space between the combustible and the oxidizer, preventing combustion development phenomenon due to the physical barrier created between the combustible and oxidizer, resulting in extinction by smothering.

Analysing the physical properties of water, we found the particular characteristics making it an excellent extinguishing agent:

- 1 gram of water absorbs 1 calorie to raise its temperature from 14ºC (57.2ºF) to 15°C (59ºF), at normal pressure. Yet, the same gram of water absorbs 540 calories to vaporize at normal pressure. This feature is designated latent heat of vaporization, extremely high in water in comparison to most liquids known. This ability to absorb energy make water one of the elements with the highest ability to cool combustion temperatures, allowing water an excellent extinguishing capacity by cooling method.

- On the other hand, when water changes to steam it increases about 1640 times in volume, causing the smothering effect in addition to the cooling effect, due to its ability to occupy the space where air was, containing oxygen (which is the main oxidizing element in the atmosphere).

Water use as extinguishing agent has evolved in recent years, with its subdivision into increasingly smaller particles, allowing for an exponential increase in firefighting effectiveness, since this increases the cooling capacity because of the increase in the specific surface area of contact between water droplets and combustible involved in combustion. If this temperature is lowered to a level that is inferior to the ignition temperature, it will be relatively simple to extinguish by cooling.

On the other hand, if we consider the increased volume occupied by a cloud of water steam, compared to the volume of liquid water in its origin (1640 times smaller, as aforementioned), it is possible to prevent the contact of oxygen from the air with the combustible material, and to extinguish the combustion by smothering method.

As previously stated, the division of water droplets to a size of several hundred microns in diameter allows an extremely high efficiency in fire extinguishing, combining the effects of smothering and cooling, particularly manifest in flammable liquid fire.

Water Mist Fire Suppression Systems (WMFSS) are commonly used in the fire protection engineering, aiming to protect the environment, replacing the once widely used halogenated hydrocarbons. WMFSS benefit from high efficiency, reduced damage caused by water and environment safety.

Recently some researchers have dedicated his research to spray fire suppression systems. They are developing experimental methods and modeling techniques to analyse the discharge characteristics of firefighting sprinklers and nozzles, as well as the physiological effect of the different forms of water application on the device that supports the nozzle. The study we intend to carry out contemplates this issue.

A sprinkler system is an automated system consisting of water pipes fitted with sprinklers arranged at appropriate intervals and heights, designed to automatically detect, restrain or extinguish fire through water discharge.

Automatic sprinklers are individually activated when a certain temperature is reached and are connected to a piping network with pressurized water. The system includes:

- Source of water supply
- Pumping station
- Piping network
- Alarm devices
- Control station and alarm valve
- Sprinklers

Due to the heat from the fire, the sprinkler temperature increases until the operating point and the ampoule containing liquid with high expansion coefficient bursts (or melts the fusible element), thus allowing to spray water directly on the fire source.

The performance of these sprays in fire suppression is determined by the ability to penetrate fire and to reach the burning surfaces below, while spraying water throughout the fire surroundings. Spray penetration and dispersion is limited by the initial droplet size and the spray featured velocity, depending on injection conditions and sprinklers configuration (Marshall *et al*., 2010).

Sprinkler systems are divided in:

- **Standard sprinkler systems**, or regular, with water spray heads equipped with a thermal detector element (metal fusible element or glass bulb) operating element by element, activated by temperature, depending on the fire progress. These systems are used when the permanent presence of water in a given space is not wanted, but only in case of fire, with more or less accurate information and more or less rapid progress.

In turn, this sprinklers system is divided in:

- **Wet pipe systems** – automatic sprinklers are installed in a piping system containing water, connected through an open control station to a water supply source that is immediately discharged when the sprinkler(s) open by the action of fire. This is the most common system.
- **Dry pipe systems** – automatic sprinklers are installed in piping systems containing air (or nitrogen) under pressure so that the control station keeps water above it, opening only if one or more sprinklers operate, causing air pressure loss. These systems are used in areas where there is a risk of water freezing in a wet pipe system, due to low ambient temperature.
- **Wet and Dry systems** – during hot season the wet systems are in use and during the cold season are switched to dry. The system has limited application due to its higher cost.
- **Pre-Action systems** – results from combining, in the same area, of a dry system with an additional fire detection system. The control station is opened by associating the command from the detector and/or

sprinkler moving water to the piping system but discharging only at the operating sprinkler. There are different sub-types of pre-action systems:

- **Non-interlock systems** – allowing water in the sprinkler piping, whether the control station has received command from fire detection or from sprinkler activation;
- **Single interlock systems** – allowing water in the sprinkler piping subsequently to detection system activation in the control station;
- **Double interlock system** – allowing water in the sprinkler piping only with both commands on the control station, from fire detection and sprinkler activation.

- **Deluge systems** – where all the spray heads operate at the same time, because they are open, not equipped with heat detectors. It has an uniform water distribution connected to a water supply system through control station, usually closed, and open by operation of a detection system installed in the same sprinklers area of by remote manual control. When the control station opens, water runs through the piping and acts simultaneously in all spray heads.

Deluge systems are used when a uniform simultaneous discharge is intended, and in the whole area covered by the sprinkler system, in order to ensure fire extinction.

The water curtain systems are used to prevent fire spreading and exposure belongs to these systems.

The automatic fire extinguishing systems, using sprinklers with an increasing effectiveness, allowed major breakthroughs in terms of active safety in buildings. It became, however, essential to evaluate the performance of sprinklers, which has been carried out through numerical and experimental tests.

With the emergence of Fire Dynamics Simulator (FDS), currently in version 5 and announcing soon its version 6, it is possible to model fire phenomena. With computational fluid dynamics (CFD) systems, it has been possible to focus the study on the interaction between the plume of fire and the sprinkler sprays. *Nevertheless, detailed knowledge of the characteristics of the initial spray, quantification through the analysis of volume flow of dispersion in the soil is not yet satisfactory, which has led to further studies and trials in this domain.* (Ren, N. et al, 2011).

In September 2005, have been published the results of the study entitled 'Numerical modeling for compartment fire environment under a solid-cone water spray' by Yao, B. and Chow, W. K., presenting surprising conclusions regarding the previous notion that the size of drops of water projected by a sprinkler should be homogeneous and the least possible. The authors state that a mathematical model was developed to simulate the behavior of fire in a compartment, under the action of a solid cone spray of water, similar to those discharged by a spray from a water sprinkler system. The smaller droplets were more significantly affected than the larger, due to greater heat transfer and entrainment effect. The larger the droplet, the slower the rate of velocity and decrease of diameter. For a higher rate of heat release, the smoke layer was warmer and the speed of the droplets decreased more slowly, while the diameter of the droplets decreases rapidly.

The action of the solid-cone water spray significantly affects the compartment fire environment. The characteristics of the water spray such as droplet size, the variation of speed and rate of water application play a determining role. Due to efficient entrainment of hot gases and production of water vapour, it is reasonable the use of a water spray with a range of droplet sizes to effectively control fire in a compartment, also producing through indirect action a decrease in oxygen concentration. These tests support our studies and represent a significant difference regarding previous knowledge.

Ren, N., Baum, H.R. and Marshall, A.W. (2011) had carried out the project 'A comprehensive methodology for characterizing sprinkler sprays', concluding that detailed measurements performed during the study allowed to reveal a strong relationship between geometry and the resulting spray from standard sprinklers. The measured volume flow and the droplet size distribution showed a strong dependence on the elevation and azimuth angles of the spray. The correct specification of quantities is essential for an accurate prediction of the dispersion and distribution of spray density of water thrown to the ground.

Cooking oil fires are difficult to extinguish because of the high temperatures reached and the ease of reigniting. Diverse tests performed allowed to conclude that water spray systems are efficient in extinguishing fires in cooking oils, as well as in non-reigniting. The spray angle, discharge pressure and flow rate of water are key factors to determine the effectiveness of water spray. (Kanabus-Kaminska, J.M., *et al.*, 2004).

Large-scale trials have been carried out to analyse the environmental damage caused by fires in which sprinklers were used, compared to those where only firefighters intervened. It is now possible to state that:

a) In case of fire, the use of sprinklers reduces greenhouse gas emissions by 97.8%.
b) In case of fire, the use of sprinklers reduces water use by 50 to 91%.
c) In case of fire, the use of sprinklers reduces damages caused by fire.
d) In a test with sprinklers, the flashover did not occur and the fire was contained to the compartment where it originated.
e) In a test without sprinklers, the flashover occurred before the firefighter's arrival, causing more damage and increased release of greenhouse gases.
f) Emissions of gases in a fire without sprinklers were significantly higher than those occurring with sprinklers.
g) Less persistent pollutants such as heavy and solid metals were detected in wastewater samples in the test with sprinklers than in those in which sprinklers were not used.

h) The impact of effluents in a fire without sprinklers is more severe due to increased pollution load in wastewaters.
i) Wastewaters from a fire with no sprinklers have a pH between 11.6 and 12.1, while those from sprinklers use have a pH of 7.9. It should be noted that the environmental agencies consider a pH of 9.0 not compatible with the environment and seriously harmful above 10.0.

Wieczorek, C. J., Ditch, B., and Bill, R. G. Jr, (2011) had made tests with which they concluded that the use of sprinklers, in addition to providing greater life safety and less property damage, are a key factor for sustainability."

Automatic fire suppression systems have the purpose of, in the area protected by them, circumscribing and extinction of a fire through the discharge of an automatic extinguishing product and can additionally perform detection and structures protection. These systems may employ in addition to the extinguishing agent water, we particularly focus in this paper, foam-forming products, dry chemical, carbon dioxide or other extinguishing gases, since approved and appropriate to the class of fire they are intended.

When the spaces allocated to a given use-type are partial or totally protected by an automatic extinguisher system, the alarm information of the system should be linked to the alarm of the automatic fire detection system covering those areas.

The use of water through an automatic extinguishing system has known several developments, and water can today be used in a pulse system caused by pressures between 20 bar and 200 bar, allowing application in the form of spray, considered the more efficient system for water use, as it combines high efficiency in extinguishing, with minimal collateral damage, due to use of very little water. According to NFPA 750, water spray is a spray in which 99% of the droplets have a size below or equal to 1000 µm (Yi-Liang Shu, et. al., 2008).

The high cooling capacity, coupled with the smothering effect on combustibles, the removal of flammable gases from the ignition source through the cloud of water vapour and wind effect originated, in addition to the reduction of radiated heat, make this system one of the most efficient available today. The water pulse system is now used in several ways:

1) Through individual equipment consisting of a kit-bag, made up of bottles of water and air under pressure, connected to a nozzle that allows the projection by discharging a small quantity of water finely pulverized.
2) Kits identical to those in 1) but adapted for transportation on motorcycles.
3) Fire fighting vehicles with the embedded installation, the hose and nozzle being used over reels, as in regular firefighting vehicles.
4) Vehicles with the system connected to a gun nozzle.
5) Systems coupled to helicopters, specifically designed for firefighting in buildings or at great heights or where access is difficult.
6) Static cannon systems, in order to specifically protect an area of high fire risk.
7) Stationary fire protection where there is a need to ensure a high efficiency, whether in combat or in the maintenance of living conditions for the occupants (e.g.: subways, sea transportation, industrial units, data processing or command and control centres).

A firefighting system with pulse water projection is mainly based on the projection of water with a very high pressure (between 80 and 200 bar), allowing the division of water drops into particles of very small size that upon projection, in milliseconds, at high speed, directly at the core of combustion, are extremely effective.

There are mainly two different types of pulse spray: application of air under pressure that projects water previously compressed by special nozzle (Figure 1) and pressurized water through an ultra-high pressure pump (over 80 bar), using a nozzle for high-fragmentation of water droplets.

In the first case, used especially in smaller equipment, such as those carried on backpacks, motorcycles or helicopters, the air is pressurized in a pressure chamber, for a high discharge speed. The extinguishing agent – water is pressurized to 6 bar in an adjacent chamber. The 'shot' is implemented through a valve that splits the two chambers and with high speed opening. The valve opens for only 20 milliseconds.

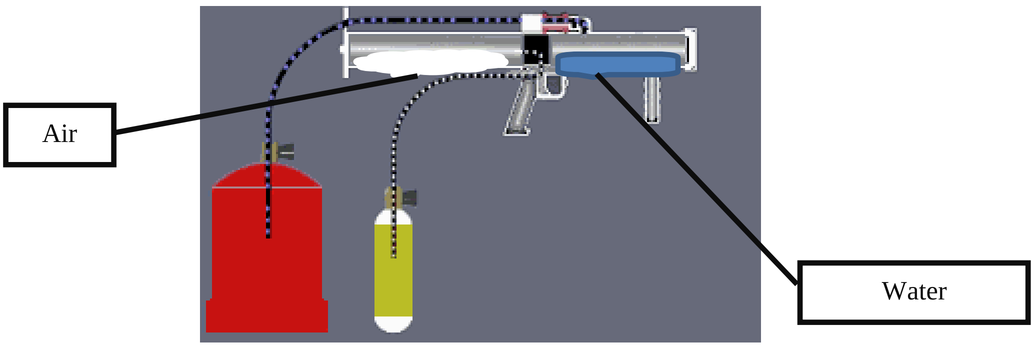


Figure 1 – Pulse water spray system

The resistance of water to air originates the fragmentation in particles with an average size of 100 µm, against the 700 µm from the equipment used until the emergence of this technology. This allows a much higher cooling capacity than the achieved until now. According to one of the manufacturers, laboratory testing in which fire was confined in a room was contained by such a system, the temperature decreased from about 1000ºC (1832ºF) to 40ºC (104ºF) in a few seconds. The advantages of using pulse technology are based on two principles:

1) The smaller the water particle is the greater is the ability to absorb heat.
2) The higher the water particle velocity, the larger amount of water reaches the base of the fire.

In addition to the mobile or transportable systems for fire protection by spray water – pulse spray is now commonly used in fixed installations, for high efficiency demands.

The fixed firefighting systems with water spray are composed of a supply of demineralized water, at high pressure (between 80 and 200 bars), a network of stainless steel pipes with much smaller diameters than those of a regular firefighting piping and a network of diffusers generating intense mist over the target to protect. The high speed of discharge allows mist to penetrate through gas and reach the combustion source, including major fires or locations out of direct reach from discharge.

Depending on the intended application, a different type of diffuser is used, both in terms of released flow (between 1,26 l/min and 40 l/min, at 120 bar, for instance), angle of coverage and installation height. The three main types are open nebulizers (sprays), sprinklers with thermal activation through thermo-sensitive glass bulb and nebulizers combined.

The nebulized water, provided by high pressure systems, owes its extinguishing efficiency to the combination of three main factors: cooling, smothering, and attenuation (absorption of radiant heat, protecting the surrounding objects).

The reduction of water droplets to a micrometer-size (down to 50 µm), produces a large surface area for capturing heat, allowing the micro-droplets in contact with the flames and combustion gases to rapidly convert into water vapour. Through its latent heat of vaporization it absorbs 540 cal / g of water used, due to the phase change observed. It should be noted that in traditional sprinkler systems, water remains liquid, hence its cooling power is only of 1 cal / gram of water spent.

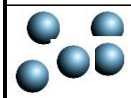
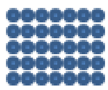
SYSTEM		Nr of droplets	Size of droplet (average)	Surface in contact	Evaporation time
	Conventional system	1	>1000 µm	1	1 sec
	Low and medium pressure system	40	300 µm	10	0,1 sec
	Nebulized water system	8000	50 µm	400	0,003 sec

Figure 2 - Peculiarities of water droplets

Besides a cooling effect, water mist has smothering potential. The expansion caused by rapid evaporation of water droplets – an increase in volume 1640 times – causes a displacement of the same volume of oxygen in the combustion surface, while the rest of the room remains with regular oxygen levels (between 17% and 19 %), leading to an improvement in accessibility and permanence of rescue and firefighting personnel.

Radiant heat is responsible for the phenomenon of combustion reaction. The mist generated on-site heavily reduces this phenomenon, protecting surrounding objects and significantly contributing towards fire extinguishing.

Small drops of water mist have a settling effect on smoke and corrosive gases, combustion products remaining in the environment. This effect allows keeping the air clean and breathable, preventing damages caused by smoke inhaling, usually those who are more relevant in casualties due to fire.

Water mist systems are now undergoing extraordinary increase in implementation, for their firefighting potential and especially for sediments and smoke control, being particularly valued for transportation networks, such as the subway, the navy, telecommunications and data processing centres, industrial units, turbines and transformers, paint booths and, in general places where there is a need to limit the damage caused by water and smoke, with the least interruption in the activities.

The extreme efficiency in water use is one of the greatest advantages of pulse technology: the system works, with no concern for a constant water supply. A small amount of water needs transportation near the fire, making this system extremely mobile and user friendly.

3. CONCLUSIONS

The best way for man to learn how to improve his ability to extinguish fire depends on knowing how the most applied and successful extinguishing agent interferes with the phenomenon of combustion.

Much has been researched and different technologies have been developed for the application and monetization of water in firefighting, but much more needs to be explained that we can make an efficient use in the process of fire extinguishing.

Only with the mastery of knowledge, recognizing under what conditions does water stop sooner the phenomenon of combustion, can fire be extinguished more efficiently and quickly.

A simple variation of application equipment and technology allows different extinguishing efficiency by water, which intervenes in a primarily physical proceeding. First of all, water causes the cooling of combustion products, with a variable rate of heat transfer, depending on the contact area between the particles of water and combustibles. The increase in the total area of contact, for the same volume of water, is inversely proportional to the size of water particles, achieved under different pressures and specific equipment for water projection.

It is considered as major goal for the intended study, the creation of numerical and experimental models that allow knowing the different effectiveness of water mist, regarding the classes of fire in question and the different pressures used. Consequently, the different dimensions of the particle of water intervening in the process of fire extinguishing.

The development of these models will allow those in the field to know in advance the results to expect for each solution, and consequently to choose the technology that best meets the intended purpose.

On the other hand, through those models, those in the field are given means to analyse the effectiveness of the use of certain equipment and its cost/effectiveness. Firefighters often use water mist equipment just because it is available, without knowing if that is the most efficient system and its cost of use.

The research on firefighting systems with water use includes knowing the state of the art in this domain.

The use of automatic fire extinguishing systems will deserve special attention, in order to determine if the efficacy demonstrated by these systems is accompanied by the efficiency in water spending.

On the other hand, we should also devote special attention to the use of nozzles and the different forms of application of water over fire provided by such equipment, following the studies presently conducted by the Department of Fire Protection Engineering, University of Maryland, in the United States of America.

The efficient use of water as extinguishing agent, its interference with the environment and the damages caused to users will be one of the areas to examine, in order to forward useful results that enable those on the field, who perform daily tasks in extremely aggressive conditions, to improving their intervention in firefighting.

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Urban Fire Risk Evaluation and the Municipal Emergency Plans

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ABSTRACT
Urban fires cause a large number of casualties per year, in addition to property and environmental damage. Every effort should be made to minimize the effects of a severe fire, emergency planning is expected to encompass fire risk assessment, preventive measures, and effective solutions, thus assisting the implementation of mitigation, preparedness, response, and recovery programs. Municipal Emergency Plans are key tools towards such achievements, along with the Civil Protection Departments, Local Governments, Official Services and Technical and Scientific Institutions.
Despite the efforts to assure the submission for approval of Municipal Emergency Plans to the Portuguese Civil Protection Committee, to comply with the Portuguese Directive witch define the Criteria and Technical for the elaboration and operation of the Municipal Emergency Planning (Resolution nº 25/2008), the urban fire risk hasn't yet been appropriately addressed, compromising the efficiency of the approved fire hazard response and mitigation plans.
This paper presents a Fire Risk Evaluation Method, suiting average-skilled users, allowing the elaboration of a Fire Risk Chart. Moreover, it enables planning and implementing the most appropriate actions, when both prevention and intervention are required, before or during any particular fire emergency situation. With a Method based on a Risk Matrix and designed according to 11 determining factors, the buildings' fire risk may be easily calculate and a risk chart may be consistently drawn up.

Keywords: urban fire; emergency planning; fire risk assessment.

1. INTRODUCTION

For a Municipal Emergency Plan to effectively assure Fire Safety, the buildings stock must be previously assessed as well as the different vulnerabilities presented by the different buildings typology and diverse residential areas in the municipality. Therefore, fire risk assessment and Fire Risk Charts will allow taking the appropriate preventive measures, improve planning and enhance an efficient intervention.
There are currently several fire risk analysis methods, namely the; Gretener Method, Euroalarm Method, ERIC Method, FRAME, ARICA and FRIMO. These are particularly suited to calculate the fire risk inside a building, considering its architectural and structural features, and its fire load. The complexity of most of these Risk Analysis Methods currently available has hindered their use by the officials from a lot of Municipalities, Municipal Civil Protection Departments or Fire Departments, preventing the fire risk assessment and firefighting planning towards an efficient intervention.
Being essential to calculate the fire risk in buildings, a Risk Assessment Method was devised, based on 11 determining factors, to allow fast and easy calculation the buildings fire risk level, and to create a fire risk chart. Each factor is assigned a Coefficient of Severity (CS), according to the conditions presented, influencing the final result in a certain degree, determined by a Weighting Coefficient (WC) resulting from the numerous analysed fires and by the authors' experience in Fire Safety of Buildings in Portugal.
Once the buildings from a particular urban area are classified, the risk chart for that area is to be prepared, whose data are to be recorded in an information system to be accessed by the Civil Defence Authorities and Fire Departments.

2. URBAN FIRE RISK ASSESSMENT MATRIX

In the present study the buildings were grouped according to their typology. Having analysed different building classification methodologies, the final choice was the separation into five different types of buildings, thus defining five areas, each containing a specific building typology and related activities, allowing the analysis with the coefficients matching the building's characteristics. The typology corresponding to zone 5 (old buildings or commercial or industrial buildings with high fire risk) was divided in six different typologies (5A to 5F), according to age and characteristics of the old buildings (5A to 5E) and 5F for commercial or industrial large volume buildings from after the 19th century.
The Risk Assessment Matrix presented in this paper (Table 12), evaluating the risk for each of the aforementioned building types, is based on different factors considered to affect the fire risk in buildings. Each of those factors is involved in the calculation in a determinate degree, designated as Weighting Coefficient (WC) and indicated in the matrix header. The range of the WC valuation is [1; 10] and represents the degree of influence that such factor holds over the fire Risk Level in a particular building.
Each factor is assigned a grade, entitled Severity Level (SL), which is determined by meeting or not the criteria defined in the corresponding Table. The SL represents the intensity each factor bears to the final Risk Level. The value for this coefficient is also comprised between [1; 10].
It should be emphasized that in order to render the analysis of different building typologies comparable it was necessary to create an Equalization coefficient (E) to assess the different buildings.
The Risk Level for the building is therefore achieved through:

$$\mathrm{RL} = \mathrm{E}\sum_{i=1}^{n} WC_i \times SL_i \qquad (1)$$

- Where i = index of the factor to consider, being n=11

The eleven factors to be considered and respective criteria for analysis are presented below.

2.1. Accessibility

As shown in Table 1, this factor has a weighting coefficient of 5 points, depending on the access conditions for rescue vehicles.

Table 1 - Severity Levels according to accessibility

ACCESSIBILITY Weighting Coefficient (WC = 5)				Severity Level (SL)
Classification	Access Road Characteristics	Building height $\leq$ 9m Acessible to VLCI a)	Building height $>$ 9m Accessible to VUCI, VTTU, VE or VP a)	
Reduced	Only walk-behind material or very small vehicles. Does not meet any of the requirements.			8 to 10
Restricted in any of the indicated items	Usable width	3,5 or 7 m on escape routes that provide escape in a single direction	6 to 10 m on escape routes that provide escape in a single direction	4 to 7
	Usable height	4 m	5 m	
	Minimum bend radius	13 m to the axle	15 m to the axle	
	Maximum of slope	15%	10%	
	Carrying capacity	Total weight 130 kN (40 kN on front axle and 90 kN on rear axle)	Total weight 260 kN (90 kN on front axle and 170 kN on rear axle)	
	Punching shear resistance	____	Force of 170 kN on a 0,2 m diameter area	
	Distance between building and parking for Emergency Assistance vehicles	Not exceeding 30 m or 50 m if building on Old Urban Centers		
No restrictions	Meets the requirements for the previous classificarion			1 to 3

Note: VLCI (Veiculo Ligeiro de Combate a Incêndios) – Rapid Intervention Fire Car; VUCI (Veiculo Urbano de Combate a Incêndios) – Fire Tender; VTTU (Veiculo Tanque Táctico Urbano) – Urban Fire Truck; VE (Veículo com Escada) – Pump Ladder; VP (Veiculo com Plataforma Giratória) – Turntable Ladder.

2.2. External environment

Fire risk in buildings is also determined by its surroundings, particularly the greater or lesser probability of fire 'importation' from neighbouring buildings. The SL therefore depends on the typology of the building site and how the building is implanted regarding the other buildings. We included a simplified radiation factor, considering the parallelism of the neighbour buildings façades. This factor holds a weighting coefficient of 4 points (Table 2).

2.3. Water Availability

This factor evaluates the water availability in the Fire Fighting System and to supply the firefighting vehicles. Firefighting difficulties due to lack of water determine the valuation of this Weighting Coefficient with 7 points (Table 3).

Table 2 - Severity Levels according to External Environment

EXTERNAL ENVIRONMENT **Weighting Coefficient (WC = 4)**			$F=\frac{100}{d^2}$	**Severity Level (SL)**
Restriction	Building in a row of buildings with identical typology, similar hazard, horizontal continuity with adjacent buildings and eventual structural continuity among buildings. Firefighting apparatus only have access to one of the façades of the building.	d < 4 m	F > 6,2500	10
		4 m ≤ d < 8 m	1,5625 < F ≤ 6,2500	7
		d ≥ 8m	F ≤ 1,5625	4
Some implications	Building inside a block, single standing and with walls among neighbour buildings with minimum Fire Resistance Level of REI 60. Firefighting apparatus only havefree access to two façades of the building.	d < 4 m	F > 6,2500	8
		4 m ≤ d < 8 m	1,5625 < F ≤ 6,2500	5
		d ≥ 8m	F ≤ 1,5625	3
No restrictions	Isolated buildings and/or easy to access at least three of the building's façades by rescue and firefighting equipment.	d < 4 m	F > 6,2500	4
		4 m ≤ d < 8 m	1,5625 < F ≤ 6,2500	2
		d ≥ 8m	F ≤ 1,5625	1

NOTES: 1) d – Distance to neighbour building, source of radiation due to fire.

2) The annalist may rank the buildings' fire resistance level according to specific features.

Table 3 - Severity Levels according to water availability

WATER AVAILABILITY **Weighting Coefficient (WC = 7)**		**Severity Level (SL)**
Reduced	External fire hydrant more than 50 m from the access door to the building, with no water storage tank for firefighting use inside the building	9 to 10
Restricted	External fire hydrant between 10 and 50 m from access door to building, with no water storage tank firefighting use	7 to 8
No restrictions	Water storage tank for firefighting with no accessory equipment	6
	Water storage tank for firefighg use, with no fixed firefighting system, but with pump and equipment to supply water to the distribution system	5
	External fire hydrant less than 10 m away fromaccess door to building, with equipment to set water distribution	4
Very good	Fixed firefighting system	3
	Fixed firefighting system and water storage tank for firefighting use.	2
	Automatic Fire Extinguishing System (Sprinklers)	1

2.4. Materials, products and equipment

This factor represents the greater or lesser probability of ignition of existing equipment, materials and products, and specially the higher or lower intensity and speed for the fire to spread. The weighting coefficient awarded this factor is 8 points (Table 4).

Table 4 - Severity Levels according to Materials, Products and Equipment

MATERIALS, PRODUCTS and EQUIPMENT	Weighting Coefficient (WC= 8)	Severity Level (SL)
High fire risk	Liquids with flash point of FP< 38ºC (100,4ºF) and solids with flash point of FP< 100ºC (212ºF). Products likely to become explosive in contact with oxygen or spontaneous combustion. Dimensionless Activation Coefficient R_{ai} = 3,0.	10
Moderate fire risk	Liquids with flash point (FP) between 38ºC ≤ FP ≤ 100ºC. Solids with flash point between 100ºC ≤ FP≤ 200ºC (392ºF). Solids able to release flammable vapors. Dimensionless Activation Coefficient. R_{ai} = 1,5.	5
Low fire risk	Liquids with flash point FP > 100ºC and solids with flash point FP > 200ºC. Dimensionless Activation Coefficient. R_{ai} = 1,0.	1

2.5. Technical facilities

Given the technical complexity of some of the equipment in a building, this factor was identified, being awarded a weighting coefficient of 7 points (Table 5).

Table 5 - Severity Levels according to Technical Facilities

TECHNICAL FACILITIES	Weighting Coefficient (WC= 7)	Severity Level (SL)
High fire risk	Facilities powered by electricity, in the presence of liquids with flash point of FP < 38ºC or solids with flash point of FP < 100ºC. Mechanical equipment with probable production of sparks in the presence of these materials or subject to overheating. Facilities that use, produce or process flammable chemicals. Facilities that use open flame.	10
Moderate fire risk	Facilities using electricity in the presence of liquid materials having a flash point, FP ≥ 38°C, or solid materials with flash point ≥ 100°C. Mechanical equipment with possible production of sparks, with no probable presence of the aforementioned materials Possibility of overheating of the facility or part thereof, with no predictable presence of flammable gases.	5
Low fire risk	Facilities with reduces probability of short circuits, arcing or other potential electrical sources of ignition Non probability of mechanical motion to produce sources of ignition. There are no chemicals in the vicinity of the technical facilities. In case of overheating, not expected to affect the surrounding material or to cause any source of ignition.	1

2.6. Electrical Installations

The electrical installations were assessed separately from the technical facilities due to their specificity and to the large number of times fire originates from electrical installations, being awarded a weighting coefficient of 9 points (Table 6).

Table 6 - Severity Levels according to Electrical Installations

ELECTRICAL INSTALLATIONS	Weighting Coefficient (WC = 9)	Severity Level (SL)
High fire risk	Featuring at least one of the following: equipment, products or electrical installations with serious problems of insulation. Power consumption above the contracted power. Lack of compliance with safety rules as defined in applicable technical regulations.	10
Moderate fire risk	Electrical installations, even if partially remodeled, with protection of different circuits provided by residual current operated circuit-breakers to the appropriate installed power and with the corresponding earthing, yet presenting several original circuits, with poor safety conditions and non complying with the safety regulations in force.	5
Low fire risk	Electrical installation in good safety conditions, in compliance with the safety legislation in force and used in accordance with good service practices, with no surcharges and whose operating conditions do not present an immediate risk.	1

2.7. Characteristics of the occupants

The mental, emotional, and physical characteristics of the building occupants govern their behavior in case of fire, and even its onset. Given those characteristics, the occupants' behavior will be affected by the building's architectural features, being awarded a weighting coefficient of 8 points (Table 7).

2.8. Fire Department Response Times

The speed of the first intervention plays a pivotal role in the success of the fire extinction. This factor allows pondering how quickly the firefighters will perform the first intervention. The SL is affected by the minutes the first intervention vehicles will take to arrive on the scene of the fire. The Weighting Coefficient is 6 points (Table 8).

Table 7 - Severity Levels according to Characteristics of the Occupants

CHARACTERISTICS OF THE OCCUPANTS Weighting Coefficient (WC = 8) Type of occupant		Building type	Severity Level (SL)
Severely limited by age and physical and / or mental condition	Occupants are not capable of realizing an emergency alarm or react to it. Unable to react autonomoulsy.	Building with more than 9 m high	10
		Building with less than 9 m high	9
		Building up to 2 storeys or with maximum distance to run less than 30 m	8
		One-storey building. Maximum distance to exit < 15 m.	7
With partial limitations	Some difficulty in mobility and/or perception, but able to react if guided and/or directed.	Building with more than 9 m high	6
		Building with less than 9 m high	5
		One-storey building. Maximum distance to exit < 15 m.	4
With no limitations	The occupants react autonomously, seeking to implement the evacuation of the building as quickly as possible.	Building with more than 9 m high	3
		Building with less than 9 m high	2
		One-storey building.. Maximum distance to exit < 15 m.	1

Table 8 - Severity Levels according to fire department response times

FIRE DEPARTMENT RESPONSE TIME	Weighting Coefficient (WC= 6)	Severity Level (SL)
No capacity for 1st intervention	Minimum time (Tm) between alert reception and the arrival on Site (TO): $T_m \geq 30$ min	10
1st intervention will hardly be efficient	Minimum time (Tm) between alert reception and the arrival on Site (TO): 10 min $< T_m \leq 30$ min	7
1st intervention possibly efficient	Minimum time (Tm) between alert reception and the arrival on Site (TO): 5 min $< T_m \leq 10$ min	3
1st intervention with a high probability of being efficient	Minimum time (T_m) between alert reception and the arrival on Site (TO): $T_m \leq 5$ min	1

2.9. Safety Organization

In the course of their use, buildings should be provided with organization and safety management measures (self-protection measures), whose existence and implementation will determine the fire Risk Level through the SL indicated below, being this factor awarded a weighting coefficient of 10 points (Table 9).

Table 9 - Severity Levels according to Safety Organization

SAFETY ORGANIZATION	Weighting Coefficient (WC= 10)	Severity Level (SL)
With major limitations	No measure of self-protection implemented	10
	Safety instructions are only placed in some of the locations	9
	Implemented only 2 of the 6 measures for self-protection, and not considered the most important	8
	Implemented the 2 measures for self-protection regarded as essential	7
Implemented with significant limitations	Implemented 3 of the 6 measures of self-protection but not considered the most important	6
	Implemented 3 of the 6 measures of self-protection considered the most important	5
Satisfactorily implemented	Implemented 4 of the 6 measures of self-protection but not considered to be the most important	4
	Implemented the 4 measures of self-protection considered to be more important	3
	Implemented 5 of the measures of self-protection	2
	Measures of self-protection (1 to 6) fully implemented	1

The six self-protection measures to consider are: Prevention Measures, Intervention Measures, Safety Registers, Safety Instructions, Training in Fire Safety and Fire Safety Simulations.

2.10. Smoke control

Smoke is responsible for most of the victims in an urban fire, also causing extensive damages to the buildings and the environment. The SL varies according to existence of smoke detection and exhaust systems. The Weighting Coefficient for this factor is 5 points (Table 10).

Table 10 - Severity Levels according to Smoke Control

SMOKE CONTROL	Weighting Coefficient (WC= 5)		Severity Level (SL)
One-storey buildings but highly vulnerable to fire	Absence of smoke control	Smoke control systems unavailable	4
	Smoke control is not assured	Devices or smoke control equipment available but not integrated in a system duely designed and suitable for smoke control in the specific building	2
	Smoke control achievable	Instalação de controlo de fumo devidamente projectada e instalada, satisfazendo as medidas regulamentares	1
Buildings with more than one storey and h ≤ 9 m	Absence of smoke control	Smoke control systems unavailable	7
	Smoke control is not assured	Devices or smoke control equipment available but not integrated in a system duely designed and suitable for smoke control in the specific building	4
	Smoke control achievable	Smoke control systems suitably installed and designed and meeting the regulatory codes	2
Buildings with height h, between 9 m < h ≤ 28m	Absence of smoke control	Smoke control systems unavailable	9
	Smoke control is not assured	Devices or smoke control equipment available but not integrated in a system duely designed and suitable for smoke control in the specific building	7
	Smoke control achievable	Smoke control systems suitably installed and designed and meeting the regulatory codes	4
Buildings with height h > 28 m	Absence of smoke control	Smoke control systems unavailable	10
	Smoke control is not assured	Devices or smoke control equipment available but not integrated in a system duely designed and suitable for smoke control in the specific building	8
	Smoke control achievable	Smoke control systems suitably installed and designed and meeting the regulatory codes	5

2.11. Municipal Emergency Plan

The Municipal Emergency Plan defines the tasks of the various departments, services and structures at a municipal level that may be engaged in relief and support activities in case of serious accident or disaster. The intervention is structured and articulated among all teams intervening, consequently the factor has a Weighting Coefficient of 6 points (Table 11).

Table 11: Severity Levels according to Municipal Emergency Plan

MUNICIPAL EMERGENCY PLAN	Weighting Coefficient (WC = 6)	Severity Level (SL)
Does not include	The Emergency Plan does not define the Urban Fire Risk as a risk of the Municipality	10
Brief reference	The risk of fire is typified, but none of the other factors (1-6) are explicitly addressed regarding that risk	8
	Some of the factors are addressed, namely the urban fire hazard, disregarding important aspects (such as preventive measures to implement)	6
Partially addressed	The Urban Fire Risk is properly treated, but without achieving a complete discussion of the 6 points in reference	3
Fully addressed	All of the 6 points listed are treated with the appropriate methodology to minimize the consequences of an urban fire	1

Analysing the criteria to classify the different factors involved in calculating the SL, it is possible to produce the Risk Assessment Matrix (Table 12), since, as aforementioned, for each building typology, duly pondered, the sum of the different Severity Levels, multiplied by the Weighting Coefficients (WC), defines a value that falls into one of the established intervals, defining a Fire Risk Level for that building, having been pondered its typology through the Equalization Coefficient (E). The Risk Level (RL) will achieve a value within the interval [38, 1200].

Each building typology presents, as a result of E, a range of values for RL, whose amplitude, divided into 5 equal parts, allows setting classification levels between Very Low, Low, Medium, High and Very High Risk Level. A specific risk level may be accepted according to the safety levels required, but corrective measures should be taken for High or Very High Risk Levels.

3. CONCLUSIONS

Considering it is difficult for most Civil Defence officers to map the urban fire risk in their area of influence, it was designed a fast and reliable Fire Risk Assessment Method to allow forecasting fire risk in different building typologies. This method is not intended to oppose existing methods of fire risk assessment that mainly target the scrutiny of the building's features, since they are complementary, allowing Firefighting and Civil Defence officers an overall fire risk assessment, focusing primarily on the external factors affecting the building. The resulting matrix enables a comparative study of features from different buildings typologies, allowing the enlargement of studied areas and supporting the establishment of accurate Risk Charts.

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ANNEX 1 - EXAMPLE OF APLICATION

The building from the 1930's is located at the "Rua da Rosa, Bairro Alto", in Lisbon. With a ground floor, two stories and attic; the ground level lodges a restaurant and a grocery store. Storage areas for residents occupy the 2nd and 3rd floors. The building is classified as 5C typology.

Figure 1 – Building in Rua da Rosa, Lisbon

Evaluation:

1. Accessibility – building with height h< 9m, street layout with 3,5 m=> SL = 7
2. Surrounding area – Building in a row of buildings with similar typology, identical risk and horizontal continuity. Firefighting means can only reach one of the building's façades => SL = 10
3. Water availability – with restrictions, given the poor conditions of the Fire Hoses on the street => SL = 8
4. Materials, Products and Equipment – given the existence of a restaurant with cooking oils, and a grocery store with solid materials with PI < 100ºC/212ºF => SL = 8
5. Technical Premises – presence of restaurant and respective kitchen => SL = 8
6. Electrical Installations – although the restaurant is recent and the power supply system was redesigned, the same is not true for the rest of the buildings => SL = 6
7. Dwellers' Characteristics – with partial restrictions; building up to 9m high => SL = 5
8. Response time – despite the proximity to a fire station, traffic issues and road width imply Tm ≈ 8 min => SL = 3
9. Smoke Control – h < 9 m, but the existing smoke control equipment only covers the restaurant, with no connection to an appropriate system for smoke control throughout the whole building => SL = 4
10. Safety Organization – implemented 3 of the self-protective measures, even though not the most important ones => SL = 6
11. Municipal Emergency Plan – the Lisbon's MEP addresses urban fire risk, but ignores some important aspects => SL = 6

Inserting these Severity Levels in the Risk Assessment Matrix (Table A.1) we obtain a Risk Level for this building of 593, corresponding to **High Risk** Level.

Table A.1 – Risk Assessment Matrix in building example

FACTORS Weighting Coefficient (WC) / TYPE OF BUILDING a)			Equilibrium Coefficient	Accessibility WC = 5	Outdoor environment WC = 4	Water Availability WC = 7	Materials, products and equipment WC = 8	Technical installations WC = 7	Electrical Installations WC = 9	Occupants Characteristics WC = 8	Fast intervention of the fire fighters WC = 6	Smoke control WC = 5	Self-protection measures WC = 10	Municipal Emergency Plan WC = 6	PARCIAL	Risk Level	
Urban area characterized by the existence of old buildings	5C	*Type* ***C*** ("gaioleira" construction, 1880-1940)	**1,20**	7	10	8	8	8	6	5	3	7	6	6	**494**	**593**	**High**
				35 / 7,1%	40 / 8,1%	56 / 11,3%	64 / 13,0%	56 / 11,3%	54 / 10,9%	40 / 8,1%	18 / 3,6%	35 / 7,1%	60 / 12,1%	36 / 7,3%			

Table 12: Risk Assessment Matrix

	TYPE OF BUILDING a) / FACTORS Weighting Coefficient (WC)		Equilibrium Coefficient	Accessibility WC = 5	Outdoor environment WC = 4	Water Availability WC = 7	Materials, products and equipment WC = 8	Technical installations WC = 7	Electrical Installations WC = 9	Occupants Characteristics WC = 8	Fast intervention of the fire fighters WC = 6	Smoke control WC = 5	Self-protection measures WC = 10	Municipal Emergency Plan WC = 6	PARCIAL	Risk Level	
1	*Implementation area with a low buildings, which is largely familiar;*		0,50	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	211	Low
2	*Urban area consists predominantly of isolated buildings with a maximum of four floors above ground;*		0,80	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	338	Low
3	*Predominantly urban area consists of buildings with a maximum of 10 floors above ground, for housing, possibly with some commercial and small industry;*		1,00	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	422	Medium
4	*Urban area consists of buildings over 10 floors, to housing and public services, including shopping centers;*		1,15	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	485	High
5	*Urban area characterized by the existence of old buildings or occupation essentially commercial and industrial activity that store, use or produce explosives or highly flammable.*	5A *Type A (built before 1755)*	1,60	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	675	Very High
		5B *Type B* (Pombalina construction, 1755-1880)	1,50	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	633	Very High
		5C *Type **C*** ("gaioleira" construction, 1880-1940)	1,20	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	506	High
		5D *Type D*(building with masonry walls and floors in concrete or brick and joist (1940-1960))	1,00	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	422	Medium
		5E *Type **E*** – Industrial buildings from the late nineteenth century	1,50	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	633	Very High
		5F Type F - Buildings large volume, intended for commercial or industrial building after the nineteenth century	1,15	5 25 5,9%	5 20 4,7%	5 35 8,3%	6 48 11,4%	5 35 8,3%	6 54 12,8%	6 48 11,4%	6 36 8,5%	5 25 5,9%	6 60 14,2%	6 36 8,5%	422	485	High

* *NOTES:*

For each building in the study, is assigned the Level of Severity (score) in each of the factors, which multiplied by the weighting coefficient that determines the corresponding score. The sum of all scores gives the total amount of risk, which allows to classify this type of building. In the area with the greatest potential risk, the characterization was divided by 5 Types of buildings defined by CM Lisbon in his study of the old urban centers, which was complemented with the Type F, which includes buildings large volume, intended for trade or manufacturing, construction later in the nineteenth century.

a) Classification of Urban Areas by their risk of occurrence and spread of a fire in the zone, set in Article 18 of D.R 23/95 of 23 August, which approves the General Regulation of Building Services Systems and Public Distribution Drainage Water and Wastewater.

Education in Prevention using Information and Communication Technologies (ICT) at construction works

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ABSTRACT
This study describes the use of information and Communication Technologies (ICT) in the field of education in prevention at construction works. The aim of this paper is to compare tools more commonly used in the daily communication for education in prevention at work in construction sector. Different ways of communication found were classified and analyzed in this paper, using related literature. In the last decades the majority of improvements in many industries were due to implementation of Information and Communication Technologies (ICT), however the use of ICT in construction works is not reached the same level as other industries. Construction industry has been blamed many times for his slowly implementation of ICT. This delay is especially present in the training and education of workers in prevention, fortunately this tendency is changing from recent time to now.

Keywords: ICT, Education, Construction, Prevention.

1. INTRODUCTION

Construction industry has been slower than other industries to adopt new technologies due to some particular characteristics of the industry. For example, on a construction site the worker has to travel to the work and take the technology with him, because he has no a stable working environment. Many times the worker and the technology are subject to the natural elements.
Nowadays, the construction changes initiatives are setting specific targets in order to solve the addressed problem. Some of these targets are:

- Reduction in construction time
- Reduction in capital cost of construction
- Reduction in waste
- Reduction in accidents

On one hand, majority of studies about adoption of ICT technologies in construction are focused in reduction construction time, and capital cost of construction. Examples of that are papers by Kumaraswamy (Kumaraswamy et al 2006), Adriaanse (Adriaanse, Voordijk, and Dewulf 2010), and Froese (Froese 2010).
Lower number of researches has been developed in order to reduce the accidents, but some examples of Mobile IT tools that have been developed to undertake safety inspections. One example is an SMS/WAP and MMM based system which allows data to be collected electronically using the supervisor's phone. It then sends problem notifications to the subcontractors who can respond via SMS when the problem is rectified. Other example is the application of virtual exclusion zones for cranes, using a camera mounted on the crane (Bowden et al 2006).
On the other hand, ICT in education has been studied by many authors at many educational levels. Majority of the studies are focused in the official levels of the education system (primary, secondary, and university). Examples of that can be found in the studies from authors like (Hadjithoma and Karagiorgi, 2009), (Morris 2010) , (Donnelly, McGarr, and O'Reilly 2011), (Castro and Chirino 2011).
Unfortunately we have no found specific literature focused in construction worker´s education in occupational health and safety using ICT.

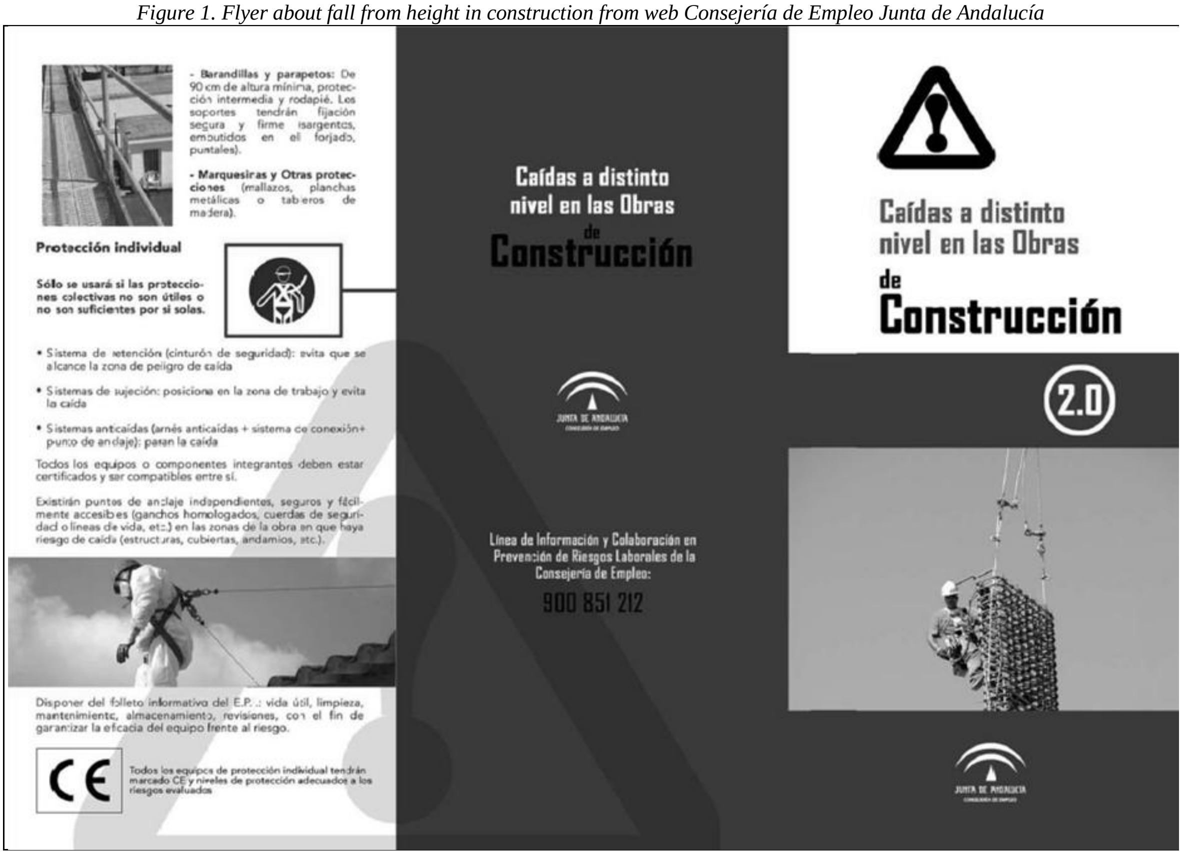
2. EDUCATION TOOLS

In Spain, education of workers in prevention is compulsory by law (Ley 31/1995, de 8 de noviembre de 1995, de Prevención de Riesgos Laborales). Law establishes safety education must be developed in an adequate way, but it is not specified in the law what are the adequate tools for this adequate way of the education. This lack of specifications is a motive for concern for people who are legally responsible of the education, because in case of accident it is not easy to probe that education given was the most appropriated.
According to the literature, education of workers in prevention can be carried out using different ways (images, audios, and text) individually or in a combination of them. In addition, they can be classified in two groups depending on their use of traditional methods, or new technologies.

2.1. Traditional Tools
In the group of traditional methods are included static pictures and text, printed in banners, flyers, guides or book.

2.1.1. Static Pictures
Communication using static pictures is very common in health sector. Delp (Delp, 1996) studied the use of static pictures to improve the communication between medical staff and patients. In the construction sector, the use of pictures can be carry out with real pictures printed on a paper. Impact of the images will depend on the worker´s level of the identification with the picture. Some authors (Pink, 2001; Banks, 2001; Rose, 2001) pointed that impact of the images will depend on the context of the worker who receives the information, so a similar context between picture and worker will be more effective than other context not similar or not related.
Drawing and graphics are used for education in prevention when a new worker is welcomed in a company. A new worker use to receive a flyer and/or a little book whit useful preventive measures.
Examples of flyers which include preventive measures can be found at websites as Consejería de Empleo de la Junta de Andalucía.

Figure 1. Flyer about fall from height in construction from web Consejería de Empleo Junta de Andalucía



The most usual way of using preventive images in construction is using safety pictograms. Majority of these pictograms in Spain are described in the law (Real Decreto 485/1997, de 14 de abril, sobre disposiciones mínimas en materia de señalización de seguridad y salud en el trabajo).

2.1.2. Text
Use of texts in the education in prevention at construction is not always as effective as images. Texts are less effective than images and pictures, because in some cases of migrant workers, they have no knowledgement about the language of the message. Although messages can be translated to different national languages with presence in the construction site, frequently worker is not able to read in his own native language. For this reason, in many cases preventive texts comes together with images in order to a better understanding and transmit the message more effectively.

2.2. ICT Tools.
In the group of ICT Technologies are included audios and videos.

2.2.1. Audios

Use of audio is not very extended in construction workplace. The main reason is the high acoustic level present during development of many tasks in construction. Although that, audios can be played at other places less noisy. Audio files can be a very useful teaching tool, because in nowadays can be played in many different devices as cell phones, iphones, smart phones, pc tablets, etc.

A message can be recorded one time, and can be played whenever the worker wants. It is not necessary translate the message repeatedly. Recording one translation can save money, because it is not necessary a personal translator at the moment of play the message.

Use of the audios files must be restricted to safe zones. A bad use of the audios at risky work places can increase the possibility of an accident happens, as occurs with the use of phone when you are driving.

Massive safety messages through loudspeakers, similar to the warning messages of the airport facilities are limited by the fact mentioned above the high noise pollution on site.

2.2.3. Videos

The most complete way of education in prevention is using a combination of the different single ways, for this reason videos are the most effective tool, because they are made with images in movement, audio, and in addition they can include text. Play a video is very easy in today´s world at any place, and at any time using an ipad, an iphone, or a laptop. A marketing and publicity study (Oller and Giardetti 1999) concluded that a image is the best way to capture the attention, and image in movement like a video is better than a static image. As same as audios, videos can be played at many electronic devices.

Some examples of preventive videos elaborated for educational purposes, can be found at the following official web sites

- Consejería de Empleo de la Junta de Andalucía (Consejería de empleo, 2010).
- Instituto Asturiano de Prevención de Riesgos Laborales (Instituto Asturiano de Prevención de Riesgos Laborales, 2011).
- Portal línea de Prevención tv (Fundación Laboral de la Construcción, 2011).

Videos available in cited websites address typical occupational and safety problems like ergonomics issues, first aids, or warning signs into the workplace. At web site from Consejería de Empleo are available preventive videos about construction and other sectors that are not construction like agriculture, metal industry or food industry. In a same way, at web site from Instituto Asturiano de Prevención de Riesgos Laborales are available videos about, construction sector and other industries. The most specific web about construction is the web enabled by Fundación laboral de la construcción. Specific issues about construction are developed deeply in the videos available at the web.

Figure 2. Image from video about pictograms and Personal Protection Equipment at construction site from Portal línea de Prevención tv

3. EFFECTIVENESS

Effectiveness of all tools cited is strongly conditioned by WHO receives the message (Banks, 2001; Pink, 2001; Rose, 2001). A same message can have different meaning for different persons. Many factors are present in the person who receives the message, culture, social level, and qualification will change the perspective of the message.

In a similar way not all worker have the same level of skill, in consequence, device to transmit the message should be elected properly for each worker (Bust, 2008). A very advance tool, in its last version available it is not useful if the person designated to use it, is not qualified in the use of the tool.
In a study made by Bowden (Bowden, 2006) concluded that with any introduction of new technologies into the construction industry the technology itself is only a part of the solution, the effects on the people and processes involved should also be considered. The successful implementation of new technologies and the resulting new ways of learn will require different skills of future teachers in prevention and workers. The attitude of that is the way we have always done it, is very extended at construction workers, and it is not easy to change. The most extended reason for this way of thinking is that they think they do not have time to change.

4. CONCLUSIONS

Lack of education in prevention of construction workers, and the evolution of the IC technologies are the reasons to promote teaching prevention using ICT. Use of ICT is not the only solution to solve the problem of education in prevention at work, but it is a very powerful tool that can help to improve the education effectiveness. In order to improve the effectiveness of education in safety and prevention, it is necessary to incorporate and extend the use of ICT tools in the construction industry. Government and authorities must promote the use of ICT tools in order to reduce the social problem of accidents at work. Institutional informative campaigns must be developed stimulating the use of ICT tools in education at prevention. In the same way, construction companies should be aware that traditional tools can be a waste of money and time, comparing with new tools, because their lower effectiveness. Remain in the past can be comfortable but expensive.
The incorporation must be done having in consideration that not all workers have the same level of skill. Each worker must be educated in prevention according his learning capacity, using an appropriate ICT tool. Resistance to change from workers must be considered as an important barrier in the integration process. This resistance must be reducing by managers and foremen enabling a positive environment with use of ICT.
Videos are the most effective teaching method because they include pictures in movement, audio and text. Literature studied concluded that different tools were more effective together because they complement each other. In addition in today´s world it is very easy for anybody play a video anytime and anywhere using portable devices. Past decade have a video player was very expensive and the device was big and not portable. It was impossible play a video without a big video, a big television and a current switch in the room. Fortunately this issue is not a problem today.

5. FUTURE RESEARCHES

Specific literature focused in the issue of this paper has not been found. Development of tools and specifications for an adequate education in prevention must be studied deeper in future researches.

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Clients' Ergonomic factors Knowledge and its Influence on the Ergonomic Intervention

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ABSTRACT
Ergonomic Tridimensional Analysis (ETdA) is a new ergonomic approach that makes possible the identification and description of several ergonomic contexts defined by common areas were clients or consumers are subject to similar activities normally carried out by professionals. The ETdA ergonomic evaluation is made by three dimensions: Professionals, Analyst and Clients, using specific and suitable observation tools. ETdA methodology is used to identify critical ergonomic factors in two commercial areas with free circulation of people, highlighting some problems that in others situations may not be noticed. According to the establishment in analysis, different ergonomic factors were identified being the clients to report higher classification than the professionals, on average. To improve the success of the ETdA implementation, it is important to study the clients' socio-demographic characteristics, namely, age, gender and ergonomic issues perception. Based on a statistical analysis it was possible to verify that clients' profile characteristics can influence the ergonomic evaluation of commercial areas and it should be taken into consideration when it comes to the ergonomic intervention implementation.

Keywords: Client; Ergonomic Factors; Ergonomic Tridimensional Analysis; Weighting Table.

1. INTRODUCTION

Nowadays, competitive business strategies are changing and companies are no longer the economic centre of the market economy. They became a scene for different 'actors' who, over time, have different roles within organizations. This market approach provides that organizations come to be seen as a socio-technical system (Querelle &Thibault, 2007) comprising a set of different but interrelated subsystems involved: supplier, customer, employee, patient and managers (Vink, Imada & Zink., 2008). This whole process of change will have impact in the distribution chain where clients are assuming a vital role (Lindon, Lendrevie, Rodrigues & Dionisio, 2000).

In this marketing context, where competitive advantage and value creation are increasing, micro-marketing (customer specific marketing) is the driving force transforming retail competition. According to Swann (2001), it is important to maintain a good relationship and effective communication with clients, identifying their needs and expectations. A great effort to improve organizational adjustments that correspond to clients' expectations is required from the organization. These adjustments can be related with issues, such as: utility, functionality and products' aesthetics, environmental adjustment, prestige, usability and pleasure (Kalid & Helander, 2004; Sojka, 2003; Tsao & Chan, 2010).

As clients are intrinsically linked to the organizations, the total quality management philosophy must be focused not only in workforce satisfaction, but also in clients' expectations and satisfaction. Processes of improvement are often multidimensional (considering all the organizational participants), cross and serially correlated (Jarrett & Pan, 2007).

Much has been done in macro ergonomics domain, however in human work activities only workers participation in the workspace design process was considered an added value to the process. In fact, Robertson et al. (2008) proposed that enhancing workers' control over their work environment allows them to influence decisions about where and how they might lead to improved physical health and performance. They also refer that teamwork is a fundamental means by which corporations conduct organizational activities and meet business goals in a global economy. According to the International Ergonomics Association (IEA) ''Ergonomics (or human factors) is concerned with the understanding of interactions among humans and other elements of a system, in order to optimize human well-being and overall system performance'' (IEA Council, 2000). Therefore, the optimization of the performance of the overall system (economical goal), the organizations' strategies and goals must also consider the human wellbeing (social goal) (Dul & Neumann, 2009; Kogi, 2006).

In the common areas, where professionals' activities are related with a clients or consumers' service provide or products sales, the human wellbeing is related with its users, both the clients and professionals. In these situations, macro ergonomics approach must also recognise that customer, client or user is an active part of the ergonomic context.

The Ergonomic Tridimensional Analysis (ETdA) was developed to be used as an auxiliary tool during ergonomic analysis and intervention in common areas where professionals and clients interact and can be exposed to the same ergonomic risk factors (Loureiro, Leão & Arezes, 2009). It can be considered as a continuous model that presents a realistic (in occupational and usability terms) overview of these areas, allowing the diagnosis of the studied conditions and identification of the critical Ergonomic Factors and consequent adjustments representing the ergonomic intervention.

The proposed analysis is multidimensional since it considers all the organizational participants, namely the clients, professionals, and managers.

In ETdA model, specific observation tools were assembled: an evaluation form and a checklist for direct and indirect observations (professionals and analyst dimensions) and ETdA questionnaire (clients' dimension).The three dimensions results' summarization is done through a weighting table. This tables support the analyst in its final task: real perception of the ergonomic situation and elaboration of the priority for the list of changes to be implemented, are developed. The process involves exploratory data analysis, inference and decision-making.
Based on this line of research, the aim of this paper is to investigate how clients' profile influences the ergonomic evaluation on Commercial Areas with Free Circulation of People (CAFCP) and in what way it should be taken into consideration when it comes to implementing the ergonomic intervention. The ETDA questionnaire used as an observation tool in clients' dimension, allows not only the clients evaluation on ergonomic issues but also to collect information about factors not directly related to work but which might contribute to define this dimension profile, including clients' age, education level, gender, professional activity (Macdonald & Bendak, 2000).
Hopefully, the ergonomic evaluation of clients will help to highlight some problems that in others situations may not be noticed. It also will benefit the professionals' ergonomic context, by facilitating the ergonomic intervention. To improve the success of the proposed adjustments it is important to study the clients' socio-demographic differences.

2. MATERIALS AND METHOD

A study based on two different Commercial Areas for Clients and Professionals (CAFCP), namely a wholesale retailer (CAFCP 01) and an entertainment retail chain (CAFCP 02), was performed. These commercial areas comprise large open spaces where a wide variety of products are displayed and comprising different ergonomic contexts with specific professionals' activities.
Since the purpose of this study is to understand the effect of the clients' profile in the ergonomic evaluation, differences in the business target market were taken in consideration. In fact, even though both areas are focused on client service and on client buying experience, clients 'population of the CAFCP01 is undefined and in opposite the market target of CAFCP 02 are professional customers. These can be business owners, self-employed professionals, freelancers or institutions.
The variables analyzed with the ETdA model are called Ergonomic Factors (EFs) and allow the ETdA operability. They can be divided into two major groups:

- intrinsic (individual: work postures, general physical activity, communication/inter-relation and attentiveness),
- extrinsic (environmental: noise, lighting, thermal environment and risk accident or occupational: professional training quality, job content, decision making, restrictiveness) (Loureiro et al., 2009)

It is possible for the observer to skip one or more of the EF depending on the purpose of the investigation or the contents of the job. In this study case, due to the jobs' content, repetitiveness EF was not considered for the analysis. Each EF is assessed utilizing an evaluation scale (Hakkarainena, Ketolab &Nevalab, 2010).
This current study is based on results obtained from the ETdA observation tools applied in these areas. According to the severity of the analysed situation, critical EFs were identified for each CAFCP. For each of the identified EF, weighting tables were developed. Clients dimension profile, namely gender and age differences were also ascertained and its influence on the decision making was analysed.

2.1. ETdA: Ergonomic factors identification

The Ergonomic analysis was conducted using the ETdA methodology created explicitly for CAFCP, allowing the critical EF identification.
In order to encourage the participation of the entire organization in the ergonomic analysis, ETdA planning was carefully defined with the two commercial areas managers. This is a very important issue in the ETdA application since it creates co-responsibility in the ergonomic intervention decision making. A multiplicity of ergonomic contexts was identified on both commercial areas. Therefore, areas were divided in sectors according to the identified professional activity. The observation tool for the professional dimension was delivered by sector, thus making it possible to obtain a global and by professional activity profile. The questionnaire was previously tested in order to be used in the survey (Khalid & Helander, 2004) and the results of validation (sensibility, validity and reliability) contributed to its improvement (Hedlund, Åteg, Andersson, & Rosén, 2010; Loureiro, Leão & Arezes, 2010). Briefly, it comprises three major parts; clients' characterization, clients' ergonomic evaluation and one open question. It was suitably adapted to each type of commercial business and applied randomly during three months. Labour force available in the store was used contributing to the success of this particularly task.
In the Analyst dimension, direct and indirect observations (checklist) were used to classify the ergonomic contexts previously identified.
The scores for the clients and professionals' are sorted in an ascending order, according to the seriousness of the situation, usually in a 3 to 5-point Likert scale. To make easier a combined analysis of the dimensions' results, a scale recoding of the categories was done into a three-point scale, similar to the evaluation scale used by the Analyst (a rating of: 1 point indicates a negative evaluation; 2 points represents an acceptable situation but with suggestions to be implemented and 3 points is related to a positive evaluation)With this procedure it is then possible to observe through a comparative exploratory analysis, which ergonomic factors have the highest percentage in "bad evaluation" category.

The final task of the ETdA methodology is the weighting table assembly to support the Analyst in the ergonomic intervention decision. This procedure will simplify and summarize the results of the dimensions, leading to the 3-dimension matrix assembling (Kettenring, 2009). A methodology of colours in a 3-point scale is used: red (R), representing a critical situation yellow (Y), medium-term intervention and green (G), identifying a non-critical situation .The dimensions' results on average are added and the obtained value is related to a colour within the weighting table. This procedure will support the Analyst in the ergonomic intervention decision- making. Since the scores are integer numbers and the individual results are higher or equal to 1 and lower or equal to 3, the values ranged between 1.5 and 2.5 are considered as score 2, values between 1 to 1.5 are scored as 1, and values between 2.5 to 3 are scored as 3.

2.2. Clients profile characterization

Clients' dimension profile is obtained through the study of the ETdA questionnaire supplementary variables. These variables are related to a specific group of questions presented in the ETdA questionnaire, namely questions related with clients characterization (age, gender, professional occupation, qualifications, ergonomic issues perception). With the defined profiles and the different answer categories related to the ergonomic evaluation, several correlations can be studied. For instance, it is possible to verify if the influence of gender in the ergonomic perception is significant.

3. RESULTS AND DISCUSSION

3.1. Critical Ergonomic factors identification

Considering the set of the evaluated EF, results show that in Commercial area 01, restrictiveness (use of technology in a commercial transaction), and lightning quality were critical ergonomic factors. In this commercial area, 21.49% of the professionals versus 6.43% of the clients consider "bad" this specific EF.

On average clients' reported a higher classification (M=2.57, SE=0.496) than professionals (M=1.87; SE=0.532). This difference was statistically significant ($t(263) = 5.164$, $p<0.001$), representing a medium effect size ($r = 0.314$). Mann-Whitney U test was used to follow up these findings, U= 3.99, Z= -4.89, p< .001; r= -0.30.

Through direct observation, analyst determines that there was at least one situation that might be restrictively to professionals and clients that circulates on the area. This identified problem is related to the replacement products task. That is, the carts that carry the products are placed in the corridors, and remain there until the products are placed in the respective shelves. Analyst ranked with a satisfactory evaluation (2) this EF. The ETdA weighting table for restrictiveness (CAFCP 01) is represented in table 1

Table 1 – ETdA weighting table for restrictiveness and lightning quality (CAFCP 01).

Ergonomic variable	ETdA results (Pe+Ce+Ae)/3	Weighting' results	Decision- making
Restrictiveness	2.48	Y	Medium-term intervention
Lightning quality	2.40	Y	Medium-term intervention

A similar study was done with the lightning quality variable. Results show that 3.39% of the clients versus 4.9 % of the professionals consider "bad" this EF. On average clients' dimension reported a higher classification (M=2.94, SE=0.182) than professionals' dimension (M=2.23; SE=0.529). Mann-Whitney U test was used to follow up these findings (U= 1.954, z= -11.987, p< 0.001, r=-0.733). This explains why clients' dimension evaluation is higher than professionals' dimension evaluation. The Analyst rates with a 2, the lightning quality EF since it were identified several workstations for professional use only and equipment for clients' exclusive use with brightness and reflecting surfaces (table 1).

In CAFCP 02, observation tools exploratory analysis indicates that 62.2% of the clients consider likely the possibility of an accident occurs versus 28.6% of the professionals. Results shows that on average clients' dimension reported a lower classification (M=2.39, SE=0.522) than professionals' dimension (M=2.74; SE=0.538). This difference was not statistically significant ($t(1) = 1.118$, $p> 0.05$), representing a small size effect. Mann-Whitney U statistic was used to follow up these findings; U= 8.80, z= -4.93, p< .001, r=-0.32). The Analyst rates with a 2, the risk accident ergonomic factor.

A similar study was done with the thermal evaluation variable. Results showed that 69% of the professionals and 35.8% of the clients' answers were related with the negative evaluation. The hypothesis that tests if the distribution of the professionals and clients thermal evaluations is the same across both dimensions is rejected (U= 274.50, Z= -13.716, p< 0.001, r= -0.9), and they are not statistically significantly related (χ^2 (2) =0.801, p>.05). On average professionals' dimension reported a lower classification (M=1.29, SE=0.459) than clients' dimension (M=2.89; SE=0.352). It is interesting to observe that the biggest standardizing residual value obtained through the chi-square test, is associated with a positive evaluation in clients' dimension and a negative evaluation in professionals' dimension (Loureiro, Leão & Arezes, 2011). This suggests that when clients think that the temperature level is "good", more professionals than expected consider the temperature as an ergonomic risk factor. Analyst has identified the Grocery, dairy and butchery sections, Fish and Freezing area, Fruits and vegetables as the most critical areas and rates with a 2, this EF.

The ETdA weighting table for risk accident and thermal environmental evaluation (CAFCP 02) is represented in table 2.

Table 2 – ETdA weighting table for risk accident and lightning quality (CAFCP 02).

Ergonomic variable	ETdA results (Pe+Ce+Ae)/3	Weighting' results	Decision- making
Risk accident	2.37	Y	Medium-term intervention
Thermal evaluation	2.06	Y	Medium-term intervention

3.1. Clients profile characterization

Clients' dimension is characterized through an exploratory analysis. From table 1 it is possible to see that, on average, clients' age in CAFCP 01 is lowest than in CAFCP 02. Comparing the skewness Z-scores, it is possible to observe in CAFCP 01 age distribution has too many low scores. In opposite CAFCP 02 shows frequent scores clustered at older people. In either commercial area male population prevails (table 3).

Table 3 – Table of descriptive statistics for the supplementary variables (age and gender) related to CAFCP 01 e 02.

ETdA supplementary variables	Descriptive statistics	CAFCP01	CAFCP02
Age	Mean	28.91	49.03
	Std. Deviation	11.371	15.001
	Z-score of Skewness (Skewness/Std. error)	3.13	-0.28
	Z-score of Kurtosis (Kurtosis/ Std. error)	-2.335	-2.43
Gender	Male (%)	54.46	65.10
	Female (%)	44.46	33.30

In CAFCP 01, approximately 50% of the clients are student from senior high school and this seems to be related to an asymmetrical age distribution ($\chi2$ (30) =72.846, $p\leq 0.001$). About 94.45% of the respondents have much knowledge about ergonomic issues, and most of them are regular clients (65%).
Most of the CAFCP 02 clients are businessmen or retired. Generally, they reported a senior high school qualification. A deeper study reveals the clients' qualifications are highly associated with the clients´ occupations ($\chi2$ (155) =192.212, $p\leq 0.001$). Clients have considerable knowledge regarding to ergonomic issues and they are regular visitors of the analysed areas (85%).
In both CAFCP, there are no statistical differences between genders regarding the importance to ergonomic issues. Several correlations between the defined profiles and the risk ergonomic factors identified in each CAFCP were studied. Results show that in CAFCP 01 restrictiveness and Lightning quality' evaluations were significantly affected respectively by both gender and clients' age (table 4). The obtained results show that men are more demanding with regard to situations that may cause some restrictiveness. Regarding the clients' age, those who have age above 40 years rated this EF with a bad score. This could indicate that they are more sensible to light variations.

Table 4 – Mann-Whitney U and Kruskal-Wallis statistics (CAFCP 01).

Ergonomic variable	Gender	Age
Lightning quality	U= 5.340, z=1.421; p >0.05, r~ 0.1	H(5)= 0.14.00, p< 0.05
Restrictiveness	U= 4.305, z=-2.061; p <0.05, r = -0.14	H(5)= 1.564, p> 0.05

In CAFCP 02, the ergonomic factor "risk accident" is highly associated with both clients' age (χ^2 (5) =21.020, $p<0.001$) and clients' gender (χ^2 (2) =12.059, $p<0.05$). The most representative group with age above 66 years old reported the occurrence of an accident as "likely". This group corresponds to the one with less education level. Related to the gender, women gave the lowest evaluation meaning that they could have greater feelings of insecurity than men. Wester-Herber & Warg (2002) research suggests that men tend to have more knowledge related to ergonomic issues and estimate the possible effect of an accident to be smaller than women estimate.
Results shows that the negative evaluation for thermal evaluation was significantly affected by clients' age, (H(5) =11.94, $p<0.05$). In fact, people with ages above 42 years old rated negatively this EF. It is also possible to observe that women are more sensible to temperature variations (χ^2 (2) =7.154, $p<0.05$; z=1.6).
The fact that in CAFCP 02 clients are, in average, older than those of the CAFCP 01, should be taken into consideration when it comes to weight the dimensions results. In fact, these findings can influence the decision-making regarding the ergonomic intervention.
Finally, in the CAFCP 01 the analyst must find the situations that can be more restrictiveness regarding the man's point of view and must take into consideration that lighting measurements, although within the recommended values, are close to the lower levels and it may affect the visual acuity in older clients.
Considering the cost of workplace accidents, the CAFCP organizations should evaluate all the possible options for accident prevention. This must include not only the work accidents possibility, but also the hypothesis of the clients'

involvement in some accidents. Therefore, in CAFCP 02, and due to the clients' age profile, the decision making of the Analyst must also consider the identification of risk behaviours that can have a negative impact on clients, in particularly on those situations where clients have to make load handling or push the shopping trolley when it is full. Research by Kwong and coauthors (Kwong, Lai, Spicciolato &Wong, 2010) illustrated that expert recommendations regarding trolley specifications and customer expectations of trolley features are equally important in the development of a customer-oriented shopping trolley that minimizes the risk of musculoskeletal.

4. CONCLUSIONS

The ETdA (Ergonomic Tri-dimensional Analysis) development follows the ergonomics future tendency since it allows the participation of the entire organization in the identification of critical situations and in the proposal of intervention. The clients' visit regularity can help to obtain more reliable information as it can be related to clients' commercial area recognition and consequently to their different ergonomic factors knowledge.

Even though the main issue of the use of supplementary variables is to contribute to the dimension profile definition, it is the authors' believe that the obtained dimensions profile can also be relevant for the Analyst decision-making regarding ergonomic intervention. Findings also reveal that clients' profile characteristics can influence the ergonomic evaluation of a commercial area with free circulation of people and it should be taken into consideration when it comes to the ergonomic intervention implementation.

In fact, gender and age differences are often reported in research studies, but the reasons why these differences occur and their implication on ergonomic intervention are rarely studied. Perhaps, taking all these differences into consideration, together with a tridimensional ergonomic analysis of areas with free circulation of people, could help those involved in implementing the proposed adjustments. This will contribute to improve not only the professional working area, but also the common areas were professionals and clients interrelate.

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Indoor Air Quality in Primary Schools and in Homes and its Impact on Children´s Health - Study Design

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ABSTRACT
Children spend most of their time indoors, basically at home and at the school. Beyond the fact that children are particularly vulnerable to indoor air pollution scientific evidence shows that exposure to poor indoor air quality can cause or contribute towards short and long-term health problems including asthma, allergic reactions and respiratory tract infections. The main objective of this study is to make a contribution towards the understanding of the effect on children's health of the exposure to indoor air in schools taking into account also the contribution of the home environment. It aims at to respond to the question: what is the health effect on children of ages 8 -10 of the indoor air quality in schools considering also the effect of the "historic" exposure to indoor air at home. To achieve that objective, a large survey on indoor air quality in schools and homes and on the health related outcomes is set up in Porto, Portugal, from November 2011 to March 2013. The target population involves 20 public primary schools, 420 houses and 1600 children's. The study includes: a) measurements on priority indoor air quality parameters: specific volatile organic compounds, formaldehyde, carbon dioxide, carbon monoxide, nitrogen dioxide, ozone, particulate matter, radon, temperature, relative humidity, ventilation rate and biological agents; b) a checklist for the physical characterization of buildings and indoor spaces and description of occupants' time daily activities; c) three health questionnaires and d) several clinical tests and biomarkers. The data gathered will allow for the undertaking of the risk assessment and risk management related to the exposure to indoor air pollution and will contribute to support public health policies and prevention strategies, good practices regarding building design, construction and management as well as maintenance and day-by-day use. This paper describes the study design involved in this survey.

Keywords: Indoor air exposure; Respiratory effects; Schoolchildren; Homes; Study design; Field studies.

1. INTRODUCTION

Scientific evidence shows that exposure to poor indoor air quality (IAQ) can cause or contribute to short and long-term health problems including asthma, allergic reactions and respiratory tract infections (Jantunen et al., 2011; Arvanatis et al., 2010; Madureira et al., 2009). Sensitive groups of population such as children and elderly or people already suffering from e.g. respiratory or allergic diseases may be particularly susceptible to adverse environmental conditions such as those due to indoor air pollution. Asthma and allergic diseases are the most prevalent diseases among children. It has been reported that more than 1/3 of children in Europe has having bronchial asthma or allergy and the rate of respiratory illness is increasing year by year (Oliveira Fernandes et al., 2008; Zhao et al., 2008).

The Fifth Ministerial Conference on Environment and Health (Parma, Italy, 2010) adopted the Parma Declaration and the Commitment to Act containing a set of targets for the environment and health process under four Regional Priority Goals (RPGs): 1) ensuring public health by improving access to safe water and sanitation; 2) addressing obesity and injuries through safe environments, physical activity and healthy diets; 3) preventing disease through improved indoor and outdoor air quality; and 4) preventing disease arising from chemical, biological and physical environments (CEC, 2004; WHO, 2004). For the first time in history time-bound targets for the implementation of specific commitments to protect children's health were set.

Children spend most of their time indoors, basically at home and at the school. As they are particularly vulnerable to poor IAQ, once their bodies are still under development, they may have altered sensitivity to exposure to xenobiotics, they breathe a greater volume of air relative to their body weight than adults, their immune system is immature to respond effectively to environmental attack and they have a longer lifetime ahead of them and therefore a longer foreseen span of exposure (Simoni et al., 2010; Heath and Mendell, 2004; Viegi et al., 2004).

Although there has been considerable interest in the health effects of indoor air pollution, many questions still remain without enough clear or complete explanation in particular in what regards the contribution to children's health of exposure to indoor air pollution from home and school environments. Therefore, this is one major area where lack of knowledge is a strongly limiting factor for health risk assessment and management (ECA, 2000).

A large survey on IAQ and health related outcomes are to be conducted in Porto, Portugal, from November 2011 to March 2013. The Institute of Mechanical Engineering of Faculty of Engineering of Porto (IDMEC-FEUP) and the Institute of Public Health of University of Porto (ISPUP), responsible institutions for the survey, involve an interdisciplinary group of researchers covering several different disciplines such as built environment, engineering, chemistry, public health and medicine.

The main objective of this study is to respond to the question: what is the health effect on children of ages 8 -10 due to the IAQ in schools taking into account also the effect of the “historic” exposure to indoor air at home and, hence, to make a contribution towards the understanding of the effect on children’s health of the exposure to indoor air in schools, taking into account also the contribution of the home environment.
The study shall provide useful data for undertaking risk assessment and risk management related to exposure to indoor air pollution and will allow for better define public health policies and prevention strategies, good practices regarding building design, construction and management as well as on maintenance and day-by-day use.
This paper describes the study design involved in this survey.

2. MATERIALS AND METHODS

A cross-sectional study will be developed in order to evaluate the IAQ in a sample of public primary schools and investigate the health outcomes focused on asthma and respiratory symptoms of a representative sample of ca. 1600 children’s aged 8 to 10 years old.
In order to understand the effects on children’s health resulting from the exposure to indoor air pollution, also a case-control study will be implemented to measure the effect of IAQ at home, the major indoor micro-environment where children spend most of their time indoors. This study will be focussed on the assessment of the IAQ in homes of asthmatic children, as a particularly susceptible group with an increased risk of respiratory and allergic symptoms when exposed to an adverse indoor environment, and in a representative sample of non-asthmatic children.
The survey phases are to take place between November 2011-March 2012 and November 2012-March 2013, covering only the winter period.
The study received the approval of the Ethical Committee of the University of Porto.

2.1 Target Population

Since the objective of the study is to make a contribution towards the understanding of the effect on children’s health of the exposure to indoor air in schools, taking into account also the contribution of the home environment, the target population is made of children’s aged 8 to 10 years old attending the public primary schools stock of a restricted geographical area, i.e., of the city of Porto; in order to make the organizational procedures easier.

2.2 Sample Size: Selection Procedure of Buildings, Indoor Spaces and Children’s

The determination of the sample size is a question that arises early in the stage of planning of any similar study. Samples larger than necessary may constitute a waste of resources whereas small samples may lead to inaccurate data potentially useless for the proper judgement and representativeness of the results. The purpose is to find a balance allowing for both: a desirable accuracy (or bearable uncertainty) and an appropriate confidence level at reasonable cost.
Therefore, the number of schools was fixed based on the required size for the student sample to reach the health related objectives between IAQ and respiratory symptoms. Referred to the figures obtained in recent studies in Portugal, the prevalence of asthma in children is of approximately 10%, while it is estimated that 10% of non-asthmatic children have symptoms and that the exposure to poor indoor air lead to a two times higher risk of having symptoms. A sample of 1600 children was established. Then, assuming 20 children per room and 4 classrooms per school, it results that the number of required school became 20.
In the schools with more than four 3^{rd} and 4^{th} classes, four classes will be randomly selected among those with similar conditions. Classrooms selected for monitoring have to be representative of the school building characteristics. Besides, it is preferable to use, for the study, a classroom that is occupied most of the time during the school hours with potentially that same high occupation all along the whole week. In the case there are just four classes or less, all of them are to be selected. This leads to cover an overall number of 80 classrooms.
Based on the data on the children health outcome obtained through the parents’ questionnaires, 420 homes (140 homes of asthmatic and 280 homes from non-asthmatic children) will be identified without distinction between standalone houses, houses in a row, and apartment blocks and indifferently to the age of the building. In the home assessments, sampling will be performed in two locations: in the child´s bedroom and outdoors. The figures of the samples size involved in this study are summarized in Table 1.

Table 1 - Sample size

Study	Buildings, indoor spaces and children’s
Cross-sectional	- 20 public primary schools - 80 classrooms - 1600 children’s (8-10 years old)
Case-control	- 140 homes of asthmatic children (one bedroom per home) - 280 homes of non-asthmatic children (one bedroom per home)

2.3 Buildings Characterization

In order to characterize the buildings (schools and homes), their design plans and related documentation will be checked and a walkthrough survey will be performed. Maintenance procedures will be also checked as well as energy consumption and the list of products used indoors such as cleaning products and scholar activity products (paintings, etc.). Teachers and employees of the schools, parents and homeowners will also be consulted, as sources to know as much as possible about the physics of the buildings and their histories. A checklist will collect and gather all detailed information on building environment, construction characteristics, ventilation system, past occurrences or visible problems, etc. (Table 2).

A specific form will be filled in for each classroom identifying all relevant information such as on its area, finishing materials and their conditions concerning floor, walls, and ceilings and operable exterior doors and windows. The presence of classroom furniture as well as chalkboards, copiers and plants will be also noted as well as information about environmental modifiers including air fresheners and insecticides. The same form will be used for the indoor space at home. Table 2 presents an example of the type of information collected from the checklists to the schools buildings.

Table 2 - Example of the type of information collected from checklists to schools buildings

Building description	Classroom description
Outdoor characterization (geographical location, sources of outdoor sources, ...)	Indoor characterization (floor and walls coverings, equipments, ...)
Construction characterization (nr. storeys, external wall construction, structure of roof, ...)	Visible problems
	Heating characterization
Ventilation	Ventilation
Past occurrences or visible problems	Classroom use IAQ sources
Building use IAQ sources	(...)
(...)	

2.4 Field Studies and Environmental Monitoring

To accomplish the objectives an interdisciplinary work will be undertaken to characterize the exposure supported on a diversified set of the field studies. Those field studies will be carried out only during the winter season, as the latter provides the worst case scenario of exposure for the most critical compounds. The parameters are shown in the Table 3.

The current selection of pollutants to be monitored in schools and homes has been made based on the following criteria: 1) those pollutants suspected or known as causing a health impact; 2) those pollutants for which the current knowledge suggests their presence in the air of the sites to be investigated; and, 3) the availability of methods of measurement relevant for exposure assessment and the existence of actual conditions to perform those measurements indoors in the presence of occupants.

The study involves the measurement of the concentrations of chemical compounds (e.g. volatile organic compounds, formaldehyde, carbon monoxide (CO), carbon dioxide (CO_2), ozone, particles); biological compounds (e.g. bacteria, fungi) and of physical parameters (temperature, relative humidity).

Since the chemical and physical characterisation of the indoor environment is focused mainly on substances leading to chronic health effects, the option is for long-term sampling. Therefore, the sampling in every one of the four classrooms per school will cover a 5-day sampling period (scholar week, from Monday morning to Friday afternoon), except for radon which will be deployed during 4 weeks (simulations with the biological passive sampling). The sampling at each home will cover the whole week, i.e. 7 days.

The assessment of biological contaminants will be done by collecting indoor dust by using three different, well established approaches adapted to the analyses of the different biological agents: 1) settled dust from surfaces above floor level will be vacuumed into dust sampling socks (“sock sampling”); 2) electrostatic dust fall collectors will be used for passive sampling of airborne dust onto electrostatic wipes (“EDC sampling”); and 3) floor dust and dust from other surfaces will be also collected using vacuum cleaners with ALK adaptors and filter cassettes (“ALK filter sampling”). The sampling of biological indoor contaminants will be performed simultaneously with sampling/measurement of physical and chemical pollutants.

During the monitoring of IAQ parameters, teachers filled a notebook reporting for each classroom the number of students, opened windows and doors and type of activities developed in the classroom (e .g. painting, pasting, felt-tip pen drawings and chalk use).

According to the data collected various parameters will be calculated to support the analysis. The most often used are the tendency (arithmetic and/or geometric mean), the variance and the percentiles of distribution for measured values and the frequencies for nominal variables.

Table 3 - Physical-chemical and biological compounds and respective type of measurement

Physical [Type of measurement]	Chemical [Type of measurement]	Biological [Type of measurement]
Relative humidity [CM]	Benzene [PS]	Endotoxin [PS]
Temperature [CM]	Trichloroethylene [PS]	Ergosterol [AS]
Ventilation rate [based on CO_2 measurements]	Tetrachloroethylene [PS]	Specific microbial (*Penicillium* /*Aspergillus*, *Cladosporuim sp*., *Streptomyces sp.*) [AS]
	α-pinene [PS]	Indoor relevant allergen (dog and cat allergen, house dust mites) [AS]
	d-limonene [PS]	
	Nitrogen dioxide [PS]	
	Ozone** [PS]	
	Formaldehyde [PS]	
	Naphthalene [PS]	
	Carbon monoxide [CM]	
	Carbon dioxide [CM]	
	$PM_{2.5}$; PM_{10}* [CM]	
	Radon** [CM]	

* $PM_{2.5}$ - Particulate matter with particle size <2.5 µm; PM_{10} - Particulate matter with particle size <10 µm; ** only in schools; CM - Continuous measurements; PS - Passive sampling (long duration-integrated); AS - Active sampling (short duration)

2.4.1 Indoor air sampling locations

Since the aim is to assess the exposure of children, rather than to assess the emissions of specific sources on the indoor air quality, the following guidelines, in agreement with ISO 16000-1, should be taken into account when making the selection of the proper sampling places in the room: 1) the centre of the room is generally considered the most suitable location for sampling, however in case this is not possible, the following is advised: 2) equipment to be installed not closer than 1 meter to the wall; 3) sampling to be made at a height of about 1 to 1.5 m (approximate height of the breathing zone); 4) places in the sun, nearby a heating system, with noticeable draught, and nearby ventilation channels are to be avoided.

Moreover the positioning of the samplers has to comply with any safety measure present in the classroom and do not disturb the normal activity of teachers and children's. Each school and classroom will be therefore a unique indoor environment. This environmental evaluation strategy will be considered representative of the entire building. The same approach should be taking into account during IAQ assessments in homes.

2.4.2 Outdoor air sampling

The survey will also organize measurements of pollutants outdoors, simultaneous to the indoor measurements, because children's exposure also occurs outside and because of the transfer of ambient pollutants into the indoor air.

If possible the samples are collected not closer than 1 meter to the building. Samplers and monitors should be protected as much as possible from human interaction. All passive sampling units can be mounted in a shelter protecting from direct sunlight and precipitation.

At least one outdoor air sample shall be collected for each school location and for each pollutant. The distance to traffic (and type of road) or to industrial emission sources should be recorded for each outdoor sampling site.

2.4.3 Information on activities and potential sources of emission

All factors affecting IAQ should be registered and reported. Outdoor environment including distance to a busy road, industrial sources of emissions, etc., shall also be described. The start and end time of classes stating when children are present in the classroom and, also, the time of school breaks should be recorded.

2.4.4 QA/QC procedures

In order to ensure the consistency of results, the analysis shall be performed by a laboratory that is working according to ISO 17025 quality criteria.

QA/QC procedures also include that at least 10% of the samplers are collected in duplicate. At least one field sample per building will also be collected.

2.5 Health Assessment

2.5.1 Questionnaires

The assessment of health outcomes and potential confounders will include the utilization of different standardized questionnaires derived from the ISAAC (Asher et al., 1995) which will be distributed to the children's, teachers and parents (Table 4).

1) A questionnaire for pupils, largely based on validated ISAAC questionnaire. The questionnaire also contained questions on the perceived air quality at school, on exposure to environmental tobacco smoke and on school-related symptoms;
2) A questionnaire for their parents, also based on the ISAAC questionnaire. This questionnaire also contains a series of questions regarding the pupil's and family medical history, home environment, food and lifestyle;
3) A questionnaire for teachers (one teacher for each class), containing questions about respiratory and irritative symptoms as well as about the school and classroom environment and on the policy of the school regarding air quality and on asthmatic children.
The teachers and parents questionnaire survey will be performed at least four weeks before the physical, chemical and biological measurements and will be starting after their informed consent. All the personal information from questionnaire will be stored to ensure the confidentiality of the information.

2.5.2 Clinical Tests and Biomarkers

Regarding clinical tests and biomarkers, all pupils will perform a spirometry to measure forced vital capacity (FVC); forced expiratory volume in 1 second (FEV_1) and forced expiratory flow (FEF). Additionally, a sub-sample of 5 pupils per classroom (random among participants) will also perform break-up time; exhaled nitrogen oxide (NO), nasal lavage and skin prick tests. Table 4 summarizes the health assessment included in the study.

Table 4 - Questionnaires, clinical tests and biomarkers

Questionnaires	Clinical tests (only in pupils)
Pupils/parents	Spirometry
Health status, perceived air quality	Break-up time[1)]
Home environment, food and lifestyle	Exhaled NO
Socio-economic status	Nasal lavage [2)]
	Skin prick tests[3)]
Teachers	
Respiratory and irritative symptoms	
School policies	

[1)] break-up time-time before an involuntary eye blink; [2)] collection of nasal lavage for the measurement of the following biomarkers: eosinophilic cationic protein (ECP), myeloperoxidase (MPO), lysozyme and albumin; [3)] Skin prick tests with a standardized panel of allergens: dermat pteronyssinus; dermat farinae; lepidoglyphus; cat; dog; hazel; birch; olive; maple; grasses/cereals; artemisia; quenopodium; plantago; parietaria judaica; alternaria; aspergillus F; cladosporium herbarum; horse.

3. EXPECTED RESULTS

The study is designed to address exposure in the school and the home indoor environments. It shall provide a picture of the current situation addressing the combined effect of school and home indoor air quality and enable the collection of critical information about the construction conditions of schools and homes, as well as of their maintenance and ventilation characteristics and occupants behaviour in relation to the prevalence of respiratory and allergic symptoms among children.
The relevance of the school indoor environment to the students’ and teachers’ health can be better evaluated, leading to adequate risk assessment and facilitating policy development for indoor air quality and maintenance of school buildings.
The study shall produce also data on determinants and the distribution of chemical and indoor biological agents at the home environment and their role in health effects observed in children, which may help to develop a better adequate control and protection measures.
The data will be indeed a tool for health risk assessment which shall be also shaped to help the decision-maker to manage risks since it addresses exposure determinants as well as the exposure itself. The data on the buildings and rooms shall enable to target actions, in particular, on the specific cases which present objective potential of risk in relation to a given pollutant.
This way, buildings managers and maintenance people will be able to develop a better practice towards minimizing the pollution sources adopting new materials or solutions regarding the fabrics and/or the systems (water, energy, wastes, storehouse, ...) in the building. A special contribution will be given by the survey regarding the definition of the ventilation levels and the quality of the ventilation systems from a health point of view and, also, in what regards the energy issue and its sustainable use.
The data concerning the health will make possible to support public health policies allowing to better estimate the levels of risk.

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Do Lean Methodologies include ergonomic tools?

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ABSTRACT
This paper presents some methodologies for Lean implementation, highlighting which ergonomic tools are included in these methodologies. In order to achieve this, a review on ergonomic tools used to diagnostic work conditions was necessary. Being Lean Production, a well known work organizational model, widely implemented in all sort of industries and services companies in nowadays, it is important to include ergonomic tools for diagnose, evaluate and measure the workers conditions before and after the Lean implementation. Based on literature findings concern the existing Lean methodologies, it was possible to realize that none of the searched had these ergonomic tools implicit. In spite of this conclusion it was possible to identify the synergy between Ergonomic and Lean Production, encouraging the pursuit of a development a project that includes Ergonomic tools in a Lean methodology in order to assess the factors that impacts the worker ergonomic performance, before and after Lean implementation.

Keywords: Lean Production; Lean methodologies, Ergonomic Tools.

1. INTRODUCTION

This paper presents some methodologies to implement Lean Production (LP), highlighting if these methodologies contain ergonomic tools to diagnostic, evaluate and measure worker conditions and human effort before and after Lean implementation. Evaluating these conditions is important to understand the current situation before the implementation of Lean and recognize if the current situation, is already deplorable or if it results from LP implementation, since, in the literature it is possible to find many detractors of Lean Production that see Lean as threat to workforce, imposing stressful work conditions. But, many times, this is result of misunderstandings of which Lean is and erroneous interpretations and ineffective implementations (Arezes et al., 2010).
Lean Production is a model of organization focused on the customer, seeking the elimination of waste (activities that add no value to the products) and on time quality products, materials and information deliveries. LP denomination, appeared in the book "The Machine That Changed the World", written by James P. Womack, Daniel T. Jones and Daniel Roos (Womack et al., 1990) to describe the Toyota Production System (TPS) (Monden, 1983). The TPS had its roots on the Toyota Company in the 50's, and his mentor was Ohno (1988). The LP has evolved into a philosophy of thinking, Lean Thinking (Womack & Jones, 1996), whose basic principles are: 1. Value, 2. Value Stream, 3. Continuous flow, 4. Pull System and 5. Pursuit perfection, as represented in Figure 1.

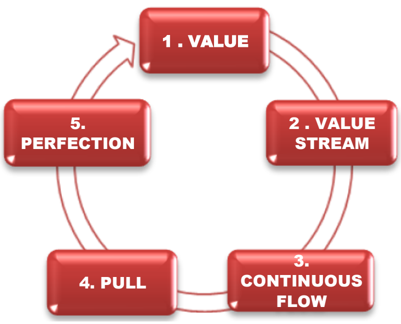

Figure 1 – Lean Thinking principles.

These principles imply the dedication of all people, being the last one - pursuit perfection (principle 5) - the principle that implies the strongest and continuously commitment of people in order to improve all the processes and activities in companies. This improvement has to do not only with the process and operations improvement as referred, but also, and more important, with the worker conditions and behaviours improvement. This is implicit on the key idea of LP: "doing more with less" and less means less space occupied, less transports, less inventories, and most important, less human effort.
Traditionally, the worker conditions have been the main concern of Ergonomics. Ergonomics is a scientific discipline concerned with the understanding of interactions among humans and other elements of a system. It is a profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance (IEA, 2011). Based on the definition stated by Karwowski (1996), Ergonomics integrates knowledge from the humanities to adapt systems, products and environments to the skills and physical and mental limitations of individuals, studying the interaction between man and technology, in a continuous work conditions improvement. So, to

achieve a good performance, the companies need to follow the technological developments but also to allow and give a good environmental work conditions.
To achieve the proposed objective of this work, it was necessary investigate Lean Production implementation methodologies and to understand if and how these methodologies consider tools to diagnostic worker conditions and measure the human effort.
The research methodology used was a literature review focused on the Ergonomic tools and Lean methodologies. The keywords used in the search were: "Ergonomic tools", "Ergonomics and Lean", "Lean Production", "Analysis Tools", and "Design".
This paper is structured in 5 sections. After the introduction of the work in section 1, it was reviewed some ergonomic tools highlighting their authors and the factor assessed by these tools. The third section presents the Lean methodologies reviewed in Maia et al. (2011), summarized and classified by the tools that are used in the methodologies. The fourth section discusses the main findings in the literature about the synergy between Lean and Ergonomics and the potential in exploring this. Finally, the fifth section presents some concluding remarks and future work.

2. ERGONOMIC TOOLS: A BRIEF INTRODUCTION AND REVIEW

Based on Wynn's[1] words "I learned about ergonomics as a way to optimize a work system, because a person is part of a work system. You have to understand that person's capabilities and design the work around their abilities. (...) Human-centred design is good industrial engineering, (...) and ergonomics has a huge impact on production efficiency at the workstation level". Hence, ergonomics ideally meets the needs of better productivity and worker health and safety all at once (Heston, 2006). So, and due to some misinterpretation, it is necessary to state that ergonomics is not a safety issue but is allied with this.
Ergonomic tools allow diagnose and evaluate worker conditions, providing the information to take decisions in order to improve them. The improvements will reduce the risk of diseases and work-related accidents. Good work conditions are essential for the workers develop their activity without being injured by this work. This will promote, at least, healthy environments that contribute positively for the productivity increase.
A wide number of factors influence the ergonomics performance. They are posture (sitting, standing, change of posture, hand and arm postures) and movement (lifting, carrying, pulling and pushing), information and operation (visual information, hearing, other senses, controls for operation, dialogues, website design, mobile interaction, virtual reality), environment factors (noise, vibration, illumination, climate and chemical substances) and work organization jobs and tasks (Dul, 2008). These factors also influence the health, safety, comfort and worker efficiency.
To evaluate the ergonomic conditions relating with these factors there are some tools, classified by some authors, for instance, Ligeiro (2010), as checklists, qualitative, quantitative and semi-quantitative criteria. Some of these tools are presented in the table 1, organized by author and by chronological order. Also, this table emphasizes the factor assessed, showing that for the same factor, different tools can be used, i.e., the posture could be assessed by the CORLETT, OWAS or REBA tool. The first one assess the posture discomfort using a map of the regions, the second assess the posture through observation of the collaborators and the last one evaluates the risk of developing musculoskeletal lesions based on an analysis of working posture. One of the reasons for using different tools to assess or evaluate the same factor is the tool reliability.
The last tool identified in the table 1 (Ergonomics checkpoints), a manual from the International Labour Organization (ILO), presents various checklists for assessing the materials storage and handling, hand tools, machine safety, workstation design, lighting, premises, hazardous substances and agents, welfare facilities and work organization. This manual, also, illustrate some useful examples of the improvements that can be achieved, at low cost.

Table 1. Ergonomic tools and factor assessed by them

Tool (Reference)	Factor assessed
CORLETT (Corlett & Bishop, 1976)	Posture Assess postural discomfort, using a map of the regions from the body
OWAS – Ovako Working Posture Analyzing System (Karhu et al., 1977)	Posture Assesses the postures assumed by workers through observation
Diagrama de Corlett (Corlett & Manenica, 1980)	Diagram of painful areas
NIOSH (Waters et al., 1993)	Load lifting Characterizes the load lifting
Checklist Michigan (Lifshitz & Armstrong, 1986)	Upper extremities Assesses the upper extremities of the workers in the workplace and list
RULA – Rapid Upper Limb Assessment (McAtamney & Corlett, 1993)	Upper arms/members Identify postures and efforts that contribute to the appearance of

[1] Mike Wynn, vice president and ergonomics engineer for Humantech (www.humantech.com), Ann Arbor, Mich.

	muscle pains and lesions in the arms
RODGERS (Rodgers, 1992)	Body segments Scans the level of effort, the duration, the time and frequency of these efforts establishing priorities
Strain Index – Distal Upper Extremity (DUE) (Moore & Garg, 1995)	Upper arms/members Establishes a rate for the biomechanics of the upper distal extremities
HAL – Hand Activity Level (Latko et al., 1997)	Manual activities Assesses the exposure in manual activities
OSHA – Occupational Safety and Health Administration risk filter (Silverstein, 1997)	Management of work Identify work environments that need to be evaluated
BORG Scale (Borg, 1998) Ratings of Perceived Exertion scale (RPE)	Effort Describes the perception of the workers for effort during the task
REBA – Rapid Entire Body Assessment (Hignett & McAtamney, 2000)	Posture Evaluates the risk of developing musculoskeletal lesions based on an analysis of working posture
HSE - Health and Safety Executive (Graves et al., 2002)	Upper arms/members Assesses gradually the risk of musculoskeletal disorders in the upper and identify risk factors
OCRA – Occupational Repetitive Actions (Occhipinti & Colombini, 2005)	Effort Characterizes task by frequency and effort required
Software TOR-TOM (Couto, 2006)	Ergonomic risk assessment, the establishment of tolerance limits and management solutions
Gilkinson (2007)	Organization of work space and the environment
International Labour Office (ILO, 2010)	All factors

3. LEAN PRODUCTION METHODOLOGIES

There are some methodologies to implement Lean Production reviewed by the authors (Maia et al., 2011) and presented in the table 2.

Table 2 – Some Lean Production methodologies and their authors.

REFERENCES METHODOLOGIES	Monden (1983)	Ohno (1988)	Ahrens (2006)	Hodge et al. (2011)	Witcher & Butterworth (2001)	Liker (2004)	Yang & Su (2007)	Womack & Jones (1996)	Jackson (2006)	Wilson (2006)	Warwick Business School (2008)	SECORA Consulting (2007)	BRIEF Consult. (2007)	Salvada (s.d.)	Caldwell (2005)
1. TPS methodology (TPS met.)	X	X													
2. Hoshin-Kanri (HC)	X				X		X		X						
3. Lean Alliance methodology (LA)			X												
4. Toyota way (TW)						X									
5. Lean Impl. model for textile (LIMT)				X											
6. Lean thinking (LT)								X							
7. Kaizen methodology										X					
8. SLIM (Secora Lean Implementation met.)												X			
9. SLIM (Strategic Lean Implementation met.)											X				
10. Brief methodology													X		
11. Methodology A3 PDCA														X	
12. Lean Six Sigma															X

In these methodologies different tools were identified, and summarized in table 3. The first seventeen are considered Lean tools that will solve a great number of problems when a company embrace a journey Lean; the others are tools from Management and Quality areas used to prepare goals and strategic plans and diagnose the current situation, the strategy and the production system of the company.

Table 3 – Lean Production tools versus Lean Production methodologies.

LP methodologies	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
LP tools:												
1. 5S's					X			X				
2. JIT	X				X							
3. Jidoka	X											
4. Heijunka	X							X				
5. Standardized work	X				X							
6. Visual management					X			X				
7. Continuous improvement/ Kaizen	X				X			X				
8. Pull system	X									X		
9. Continuous flow										X		
10. SMED	X							X				
11. PDCA		X										X
12. DMAIC												X
13. VSM		X			X							
14. SMED		X			X							
15. TPM												
16. A3					X						X	
17. Policy Development	X											
Other tools:												
18. SWOT Analysis		X										
19. Porter Analysis												
20. Porter Matrix		X										
21. PEST Analysis		X										
22. Matrix product / market		X										
23. Matrix market/technology		X										
24. Diagnosis of the president		X										
25. Analysis Report A3 (A3-RA)		X										
26. Matrix X A3 (A3-X)		X										
27. Report problem-solving		X										
28. 5W1H											X	
29. 5 Why											X	
30. Fishbone											X	
31. Pareto chart											X	
32. Histogram											X	
33. Scatter Diagram											X	
34. Check sheets											X	
35. Control charts											X	
36. Flowcharts											X	
37. Radar Charts											X	
38. Tree diagram											X	
39. Brainstorming											X	

Based on the collected information on the available LP methodologies and the correspondents' tools, and summarized on table 2 and 3, it was possible to verify that all the tools used are not ergonomic tools. However, some tools like 5S, Standardized work, SMED, Kaizen includes safety and ergonomics aspects and benefits for the worker, for example, less accidents due to adequate equipment and instructions about how to use; less confusion in the workstation; less effort, exhaustion, stress and frustration; more responsibility and moral (Bittencourt et al., 2011).

4. FINDINGS AND DISCUSSION

Nowadays, it is common to designate the 5S tool, 6S, being the 6th sense the sense of Safety (Leff, 2011). This author explains how company safety officials can use Lean initiatives to reinforce their safety programs, through the elimination of the 7 wastes: 1) overproduction (overburdening of employees); 2) unnecessary transportation (and actions of employees); 3) inventory; 4) motion; 5) defects; 6) over-processing and 7) waiting. All these forms of wastes makes the system more complex and confuse with more WIP, more idle time, more materials transports, more motion of the operators, more shadow and dark areas, after all, more opportunities to happen accidents and injuries. Applying the 5S tool, all space will be cleaner, organized, classified and normalized (without unpredictable negative "surprises" such as a cut on a hand because of a sharp tool in the wrong spot) having as a result more safety. As Wilson-Donnelly and co-authors highlighted, the organizational approach has impact on the development of a company safety culture and

influence the adoption of good practices to avoid related work-accidents (Wilson-Donnelly et al., 2005). Others tools, like Kaizen and Poka-Yoke mechanisms improve process safety leadership and field work team performance by focus in the reduction of residual risk (waste) or activities that provide no/limited risk reduction, employing team-based methods as Process Hazards Analysis (PHAs), emergency preparedness reviews, Job Hazard Analysis (JHA) and successive checking (van Scyoc, 2008).
The synergy between Lean and Ergonomics have been recognized by others authors, namely Gilkinson (2007) that show that when combined, they successfully conduce a company to reduce risk and improve the system. Heston (2006) considers ergonomics as the first step to Lean implementation, being the resistance to the change reduced when workers were involved in their work space improvement. The Lean Thinking principles aligning with the Ergonomics becomes possible the Ergonomics principle of "working smarter, not harder" (Walder & Karlin, 2007).
Material handling and the layout are two of a set of practices considered to be essential for the Lean implementation. The material handling defines the way that material is handling during the process and the layout is the arrangement of the facilities in a factory. Both could increase the manufacturing lead time and the related costs. For a good Lean Production implementation, it is necessary flexible layouts, reducing movements of both materials and people, minimize material handling losses and avoid inventories between stations (Wong et al., 2009). Ergonomics should be considered since it will help the workers to improve productivity, reduce injuries and fatigues, by reducing unnecessary gesture and handlings that directly enhance the quality of products. Above, in the section 2, the ILO manual referred some checklists relating the material handling and ergonomics. As an example, Figure 2 and Figure 3 illustrate some photos of handling material, taken by the paper´s authors in a Portuguese company. Figure 2 shows two illustrations of load lifting (roll of tissue) assuming an incorrect posture a) and assuming a correct posture b).


a)

b)

Figure 2 – Load lifting assuming a correct posture a); and an incorrect posture b)

Figure 3 shows an example of an improper trolley to the load transported, causing discomfort for workers and provoking load damage or accidents, and putting in risk the workers safety. It is possible to see in this example that the load dimension (in this case, the length of the roll of tissue) is longer than the trolley.

Figure 3 – The load transportation using an improper trolley

In order to design Lean assembly lines without wastes related with unreasonable mental or physical burden, Eswaramoorthi et al., (2010) applied the RULA method to measure a large set of operator posture parameters and assessment of ergonomic stresses. U-shaped manufacturing cells are also designed with particular care for the workers ergonomic (Payton, 2006). This concern of designing assembly lines to mitigate operator workload comes at long time in Toyota Production System (Monden, 1983) that in order to evaluate the workload or fatigue rate of each process developed the Toyota Verification of Assembly Line (TVAL). This method used equations to measure the workload or fatigue rate of each assembly line operation.

In spite of the evidences presented above about the synergy between Lean and Ergonomics, the methodologies presented in the table 2 do not include a tool that allows measuring the effort involved in the activities, before and after the application of these tools. The absence of some tools that measure this effort creates many doubts about the Lean intention in reducing the human effort and promoting a healthy work environment. In the literature it could be found many papers about the threats for workplaces ergonomics in Lean environments as demonstrated in the review work of Arezes et al. (2010).

5. FINAL REMARKS

There are various ergonomic tools to assess factors that influence worker performance. Factors like the posture or the environment factors must be assessed before any changes (e.g., a Lean implementation) take place in the shop-floor, at a cost of having disappointed and discouraged results, ensuing from unknown variables. Based on the methodologies reviewed, it was possible to witness that none of them, until now, included ergonomic tools, having the question on the title of this paper, a negative answer. However, it was possible to perceive alignments between Lean and Ergonomics and how these initiatives fit well each other. The authors will continue to review LP methodologies in order to highlight if and how these could addresses the worker conditions and human effort in companies employing Lean tools and cultivating a Lean work environment.

As a future work, the research team wants to develop a Lean methodology that will include some ergonomics tools to diagnose ergonomic current situation and measure the effort demanded before and after the Lean implementation. In this way, the workers' well-being and their satisfaction could be increased creating a good environment important to health and performance.

6. ACKNOWLEDGMENTS

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Safety and Health in Construction: Asbestos

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ABSTRACT
In the last years the safety and health in construction has been subject of concern. This is an image of a society increasingly advanced and worried about the future. Work accidents are an immediate consequence of work hazards, which gives those greater media attention and general concern. However in the last decade there began an awareness of the importance of tackling the problems of occupational health. The main cause of illness and death resulting from occupational exposures are caused by hazardous substances and in the case of asbestos in buildings the biggest threat. In recent years laws and procedures have been established for managing asbestos, being clear that with correct work practices, workers well trained and equipped, the labour related illnesses and deaths can be avoided. This paper addresses the issue by presenting: Construction works with asbestos; Risk assessment; Selection of equipment; Removal techniques; Transportation of asbestos waste; and Statistics survey data.

Keywords: Construction; Workers; Safety; Health; Asbestos.

1. INTRODUCTION

The safety and health in construction has been subjected to technical improvements and legislative changes over recent years, being this is a reflection of a society more and more evolved and worried about the future. Accidents at work have an immediate consequence, which generally gives larger media attention and concern. However, in the last decade began to exist an awareness of the importance of tackling the problems of occupational health. The main cause of illness and death resulting from occupational hazards is exposure to dangerous substances, and in case of construction, asbestos is the biggest threat.

Asbestos is responsible for 100 000 deaths annually worldwide (ILO, 2006), being occupational exposure the origin of these deaths. It is scientifically proven that asbestos is a carcinogen mineral, with deadly consequences. These deaths are tragic not only for workers but also to families and friends, having high costs to society.

The forms of asbestos exposure are: dermal, inhalation, ingestion and ocular. Although all are dangerous, inhalation is the one that presents higher risk to workers, because the diseases in which is proven the cause-effect are caused by this route. The most common and serious diseases are asbestosis, mesothelioma, lung cancer and gastrointestinal cancer. It is essential to provide medical surveillance of workers exposed to asbestos, since the disease is severe and can take many years to be revealed and may occur up to 10, 15 or 30 years after the exposure, making it critical to have continuous monitoring and medical records. Employers and workers should have as a common practice the monitoring of health, thus reducing or neutralizing the risk of contracting serious illnesses due to exposure.

In recent years laws and procedures were created to deal with asbestos. Being well known that if there are good work practices, workers well trained and equipped, diseases and deaths can be avoided. The currently existing legislation, allows reducing drastically the number of deaths due to health problems, caused by professional activity or even stopping them. However, there is the need of implementing safety culture awareness, amongst the companies and workers. Between the several pieces of legislation concerning hygiene, health and safety, Decree-Law No. 266/2007 is the most important piece of legislation on asbestos in Portugal. This document transposes into national law the Directive No. 2003/18/EC of the European Parliament, which amended Directive No. 83/477/EEC of the Council. The main objective of this law is the protection of workers from the risks of exposure to asbestos at work. Contemplates and provide rules for all activities in which there is risk of exposure to dust or materials containing asbestos and establishes a maximum exposure of 0.1 fibres per cm^3.

In Portugal, materials containing asbestos were used in buildings constructed before 2005, after this date, this use has been forbidden (Decree-Law No. 101/2005). The diversity of these materials containing asbestos is large and there are over 3 000 possible applications. There is however no inventory of the number of buildings containing such materials. It is estimated that in Portugal there are about 600 000 hectares of asbestos cement roof sheets (Vasconcelos, 2008). It is known that there are approximately 113 961 tons of asbestos in Portugal, nevertheless it is unknown what was the use and geographical distribution.

In materials containing asbestos the most important characteristic is their friability. There are two types: non-friable and friable, being the difference in the degree of propensity to release fibres. The friable materials are the ones that contain asbestos and easily break apart, disassemble, melts, dissolves or disintegrates, with a natural action or by small mechanical action, being easily reduced to powder. This type of material would represent greater risks due to easier disintegration and release of asbestos fibres. Some examples of these materials are thermal and acoustic insulations.

The non-friable materials have greater mechanical strength and the fibres do not fall apart so easily. There are two subtypes: the ones that release fibres after they are fragmented and others that do not release significant amounts of fibres. An example of non-friable material that releases fibres is roof shingles of asbestos-cement, while for instance vinyl floors do not release asbestos fibres. Although non-friable materials are less hazardous, they can become brittle, due to usage and aging.

2. WORKS WITH ASBESTOS

2.1. Risk Assessment

Working with asbestos has several specificities related with risk factors. Therefore it is very important to perform at early stage a risk analysis because it will serve to the owner in conjunction with the designers to decide what to do with the materials that contain this hazardous substance. Later, this analysis will help the contractor company, to determine the need for notification of work done to the ACT ("*Autoridade para as Condições do Trabalho*", Portuguese Authority for Working Conditions) and decide the necessary equipment and measures to be implemented. Notice that ACT is the state entity responsible for working conditions improvement in Portugal and also for the surveillance and control of legislative measures implementation.

The amount of exposure time to fibres and conservation status are crucial to the decision to keep or not asbestos-containing materials. It is considered that for short periods of exposure to low amounts of fibre and in good state of preservation, there is a reduced risk for the user health. The amount of 0.1 fibres per cm^3, imposed by the Decree-Law 266/2007, is the exposure limit for workers, calculated on a time-weighted average, for a period of 8 hours. Since there is no amount limit established for the building users, the same reference value can be used. Figure 1 presents a flowchart with the suggested procedures for the risk analysis.

The flowchart below (Figure 1) also shows the risk of exposure for workers, as required by Clause 6 of Decree-Law No. 266/2007. However, measuring the amount of released fibres cannot be performed in the same way. It should be done in a way that reflects the dispersions caused by work activities. The air sample collection for laboratory analysis should be performed in conjunction with simulations of the work to accomplish, allowing a more reliable measurement of fibres. The laboratory must be qualified, as well the personal doing the sampling, and the fibres counting method should be done preferably by phase contrast microscopy.

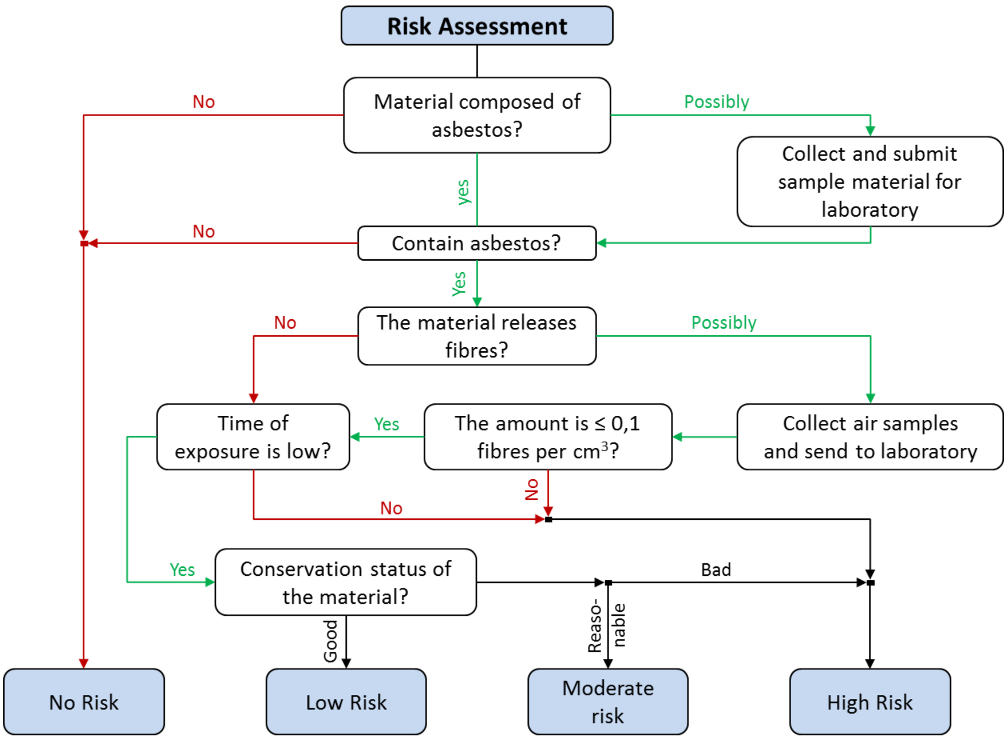

Figure 1 – Asbestos Risk Assessment (Martins, 2011).

2.2. Decision on the type of intervention to be performed

With the risk analysis for the users and workers, the designer team and the owner can make a decision on the more adequate type of intervention to be made. Usually, the hypotheses are:

- Maintain the materials containing asbestos;
- Encapsulate, enclose or cover the materials containing asbestos;
- Remove the materials containing asbestos.

It should be kept in mind that the first two assumptions imply a periodic inspection of materials, making always records of the analyses and results obtained, having a descriptive inventory of existing materials with asbestos and their locations. Figure 2 shows the flowchart that allows to determinate the type of intervention to be performed, based on the risk analysis presented in Figure 1.

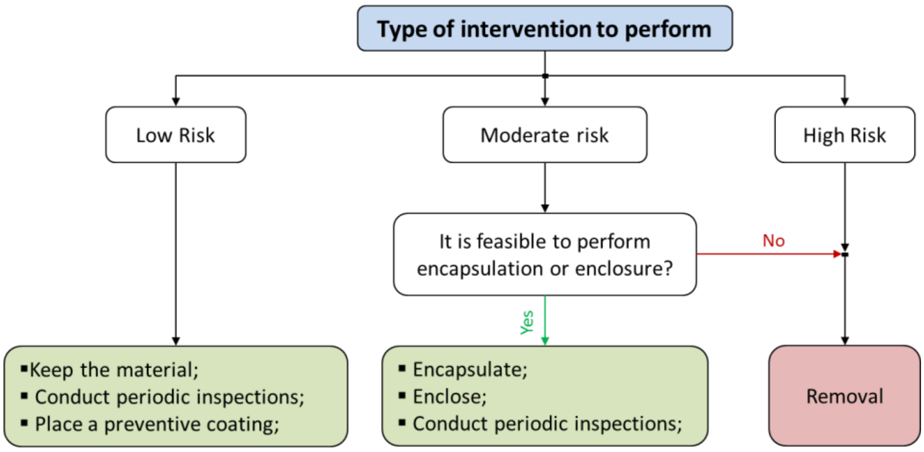

Figure 2 – Decision process on the type of intervention to be performed (Martins, 2011).

2.3. Need for notification of work with asbestos

Having a decision on the type of intervention and knowing the risk of exposure, there is the need of knowing if exists a notification obligation of the works to the ACT. In the case of moderate or high risk, the notification to the ACT is mandatory and must be done 30 days before the beginning of work. According to paragraph 1 and 2, Clause 3 of Decree-Law No. 266/2007, is available for this purpose an appropriate form on the ACT website (ACT, 2011). There is no mandatory reporting of activities with exposure to asbestos to the ACT, according to Clause 23 of Decree-Law No. 266/2007, when the works meet the necessary conditions to be classified with low risk and the requirements showed on the flowchart presented in Figure 3 are verified.

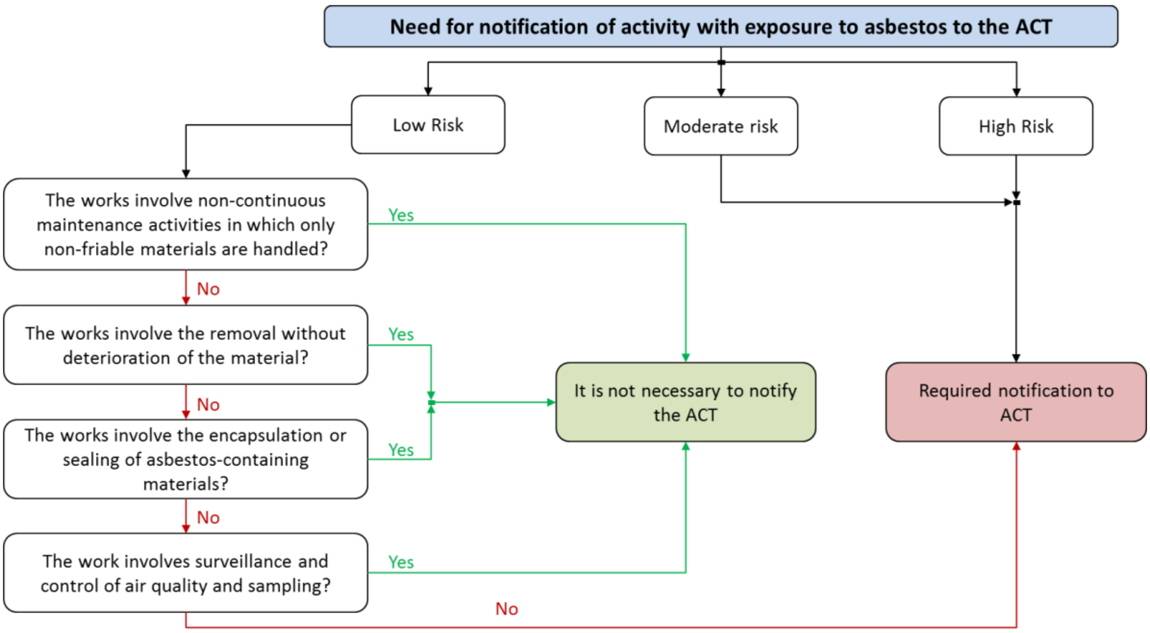

Figure 3 – Need for notification of work with asbestos (Martins, 2011).

2.4. Selection of Equipment

The risk prevention is primordial when carrying out works involving the manipulation of materials containing asbestos. Thus it is only possible through the use of adequate equipment and methods of work, demanding the use of specific safety equipment, in addition to those normally used on construction sites. The safety equipment for these works can be grouped into three categories: collective, individual and complementary protection. The main equipment's required are listed in the Annex of Decree-Law No. 266/2007. However should always be taken into account all others collective and individual protective equipment, enshrined in national legislation, since many of the asbestos removal works are performed in heights, and in this situation is essential the use of protection equipment from falls. The selection of equipment is an important factor that must take into account for safety, hygiene and health of workers and should be appropriate to the risks of exposure, which are determined according to the friability of the material. Other relevant factors to consider are maintenance, cleaning and equipment storage.

During the choice of equipment there are some fundamental principles that should be checked. They are:

- The requirement to have the conformity declaration and CE marking;
- Mandatory instructions / information in Portuguese;
- CE type-examination (in some equipments);
- CE Quality Assurance Systems (in some equipments);
- It should not disrupt the work and be comfortable;
- Take into account the opinions of users;
- Adapted to the physical characteristics of the users;
- Be appropriate to the risk.

Although all the equipment needs careful selection, Respiratory Protective Equipment is the most important, by the simple fact that asbestos exposure by inhalation is the most deadly. The choice of this kind of protective equipment should include the following factors:

- Protection factor to be achieved;
- Facial features of the individuals;
- Equipment comfort and duration;
- Conditions of the site and mobility provided by each type of equipment.

2.5. Removal Techniques

The creation of safe working practices and disclosure to employees is essential when working with asbestos. In the definition of working methods, risk analysis is essential to determine the correct method of work to be done and assess the need of confinement of working zones. Confinement depends essentially on three factors: the friability of the material, location of work and type of work.

The techniques for the removal of materials containing asbestos depend on the risk of exposure, in which the predominant factor is the friability of the material. There are essentially two main removal methods: the dry and the wet method. The first is more suitable for the removal of friable materials, because the dispersion of fibres is reduced. There are several techniques for accomplishing the wetting of materials containing asbestos: by injection, spray or submersion, using water or aqueous solutions. The dry method is not recommended in most situations, however, can be used in non-friable materials and in special situations. An example is the removal of friable materials, such as acoustic and thermal insulation, usually located in confined spaces such as air cavities between walls, cavities between floors and dividing panels. This removal should be performed by suction, using a vacuum cleaner with high efficiency particle filtering.

2.6. Transportation of Waste

Prevention should also occur during transportation of asbestos wastes resulting from works and should be performed in a way that public health is not put at risk. All materials that release asbestos fibres must be placed in sealed packages to ensure isolation and mechanical strength, and all packages must be labelled and tagged as hazardous substance. The transportation of asbestos waste must also comply with the requirements of Decree-Law No. 41-A/2010, which regulates the transportation of hazardous waste in Portugal.

The waste disposals of materials containing asbestos are at non-hazardous waste landfills. As set out in Part B of Annex IV of Decree-Law No. 183/2009, is also necessary to take precautions to prevent the dispersion of fibres.

3. STATISTICS

Statistical data allow the analysis and detection in a simple way of problems arising from the use of asbestos. These data have great importance because it allows improving preventive measures, if needed. For example, in the case of asbestos, these preventive measures will reduce illnesses and deaths. The most relevant indicators about this issue are the asbestos consumption and mortality inherent to the exposure.

The data on asbestos consumption allows estimating the amount of asbestos in buildings and other embedded applications. Figure 4 illustrates the consumption of asbestos in several continents and was obtained from United States Geological Survey (USGS, 2006 and 2009) from the values of production, exports and imports of each country. The graph shows a rapid increase in world production from 1950 to 1980. Then in 1980 production began to decline. This happened due to the fact of the appearance of studies that linked asbestos to serious illness. After 1990, the fall in production has become greater, because most European Union countries and United States decided to abolish the use of asbestos. Currently the production seems to be stabilizing. Only a few countries such as Russia, Brazil, Mexico and many industrialized countries of Asia continue to use asbestos.

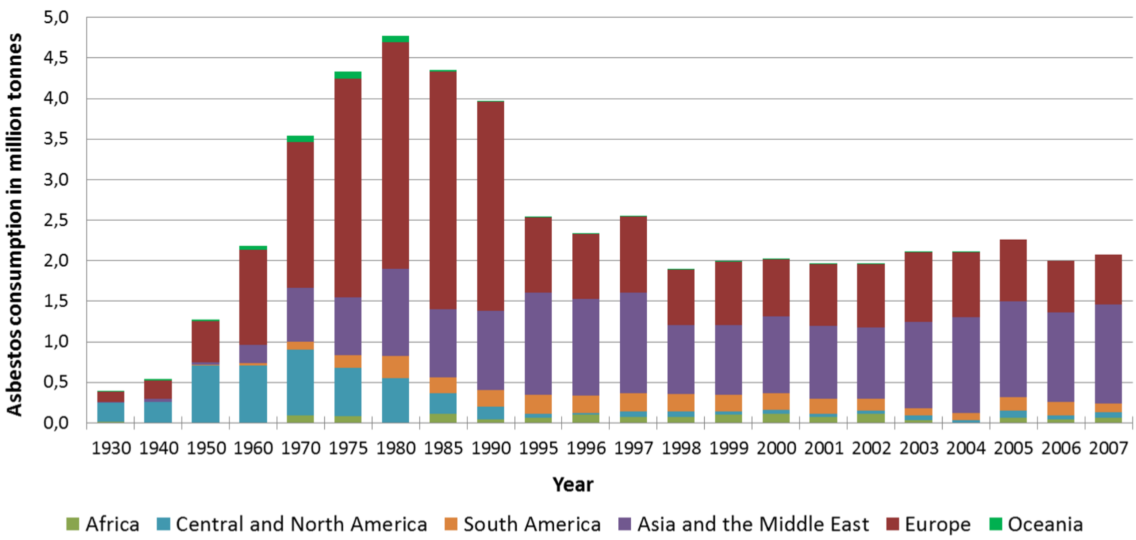

Figure 4 – World consumption of asbestos (Martins, 2011; USGS, 2006 and 2009).

Figure 5 characterizes asbestos consumption in Portugal with data obtained from the reports of United States Geological Survey (USGS, 2006 and 2009). In this figure can be seen that the peak of asbestos consumption occurred in the 80's, where 19 953 tons were consumed. After, there was a decline due to studies that have emerged about the diseases related to asbestos exposure. In 2005 asbestos consumption ended due to the entry into force/law of Directive No. 1999/77/EC, transposed by Decree-Law No. 101/2005, which prohibits the use of asbestos. Using this information can also be estimated the accumulated values of asbestos in Portugal. Accordingly with these data there are approximately 113 961 tonnes of products containing asbestos.

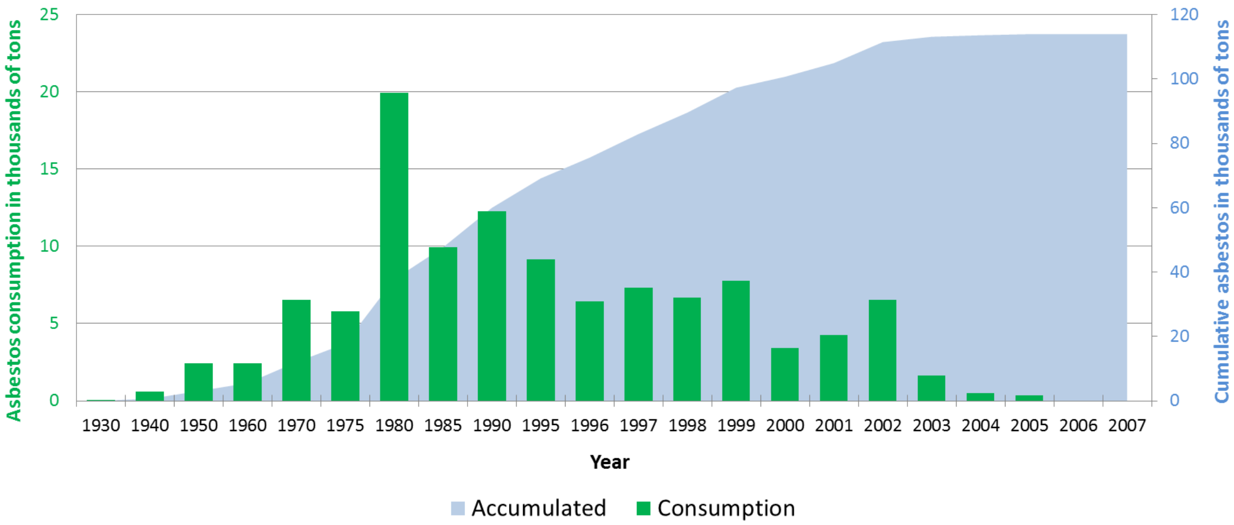

Figure 5 – Asbestos consumption in Portugal (Martins, 2011; USGS, 2006 and 2009).

Nowadays, about 125 million people worldwide are exposed to asbestos at home and in workplace (WHO, 2011). The recent estimative from World Health Organization (WHO) indicates that over 107 000 people die each year with lung cancer, mesothelioma and asbestosis, resulting from exposure to asbestos. It is estimated that one in three cancer deaths instigated by occupational origin was caused by asbestos.

The statistics of deaths from diseases associated with asbestos exposure are difficult to obtain and few countries have detailed statistics on this subject. In Portugal at National Statistics Institute (INE) it was not possible to found this type of data. Figure 6 graphically represents the data obtained in the US National Institute for Occupational Safety and Health (NIOSH, 1991 to 2008) related with asbestosis deaths in United States of America. There was a significant increase of deaths until 2000, when it has stabilized substantially as a result of reduced use of asbestos. However asbestos is not completely eliminated and remains in buildings, ships and machines. Therefore the potential for exposure remains, which means that contamination and death from asbestosis in USA will continue to occur during the next decades.

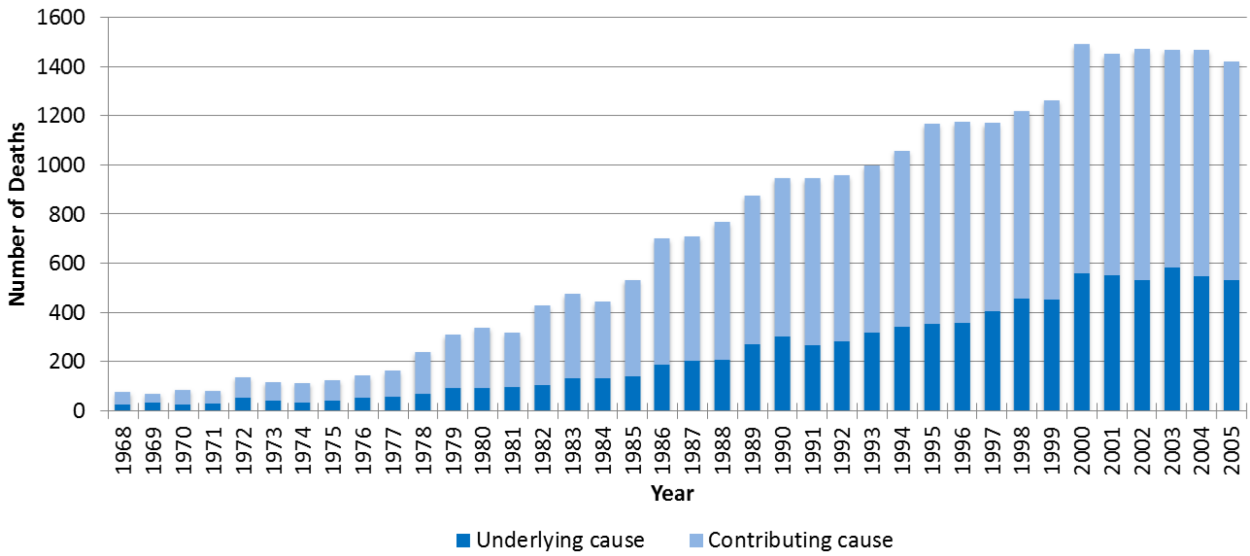

Figure 6 - Deaths from asbestosis in USA (Martins, 2011; NIOSH, 1991 to 2008).

Figure 7 shows the number of deaths due to mesothelioma in USA (NIOSH, 1991 to 2008), being these values even higher than the previous ones (Figure 6). In this case, the time scale is less expressive than the preceding, because the records were made only since 1999. However the expected outcome is identical to the presented on previous chart. Note that in 2005 there are 2 704 deaths because of mesothelioma, which makes this disease a major concern.

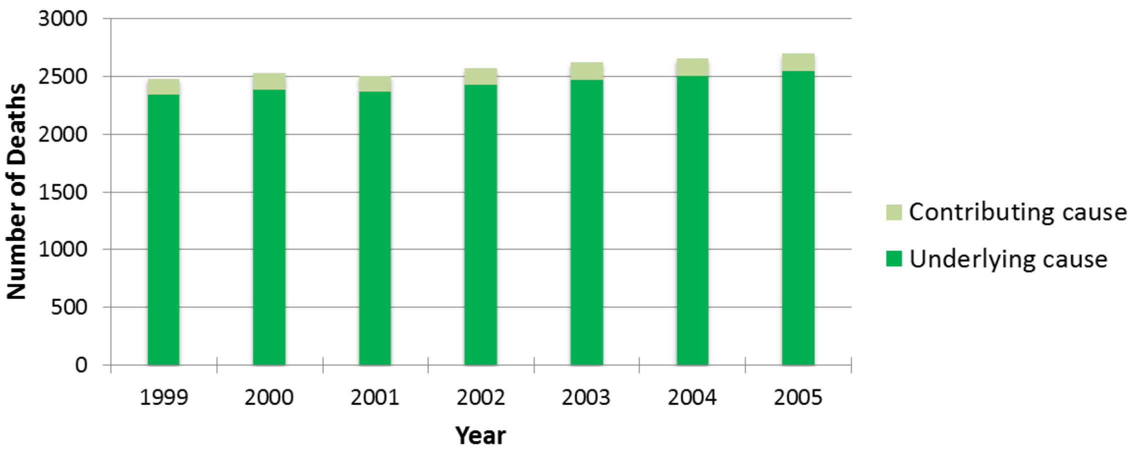

Figure 7 - Deaths from mesothelioma in USA (Martins, 2011; NIOSH, 1991 to 2008).

Figure 8 presents the relationship between deaths from asbestosis and professional area in which there was exposure to asbestos (NIOSH, 1991 to 2008). It can be seen that the construction sector accounts for 24.6% of deadly asbestos exposure, being the one that clearly stands out individually.

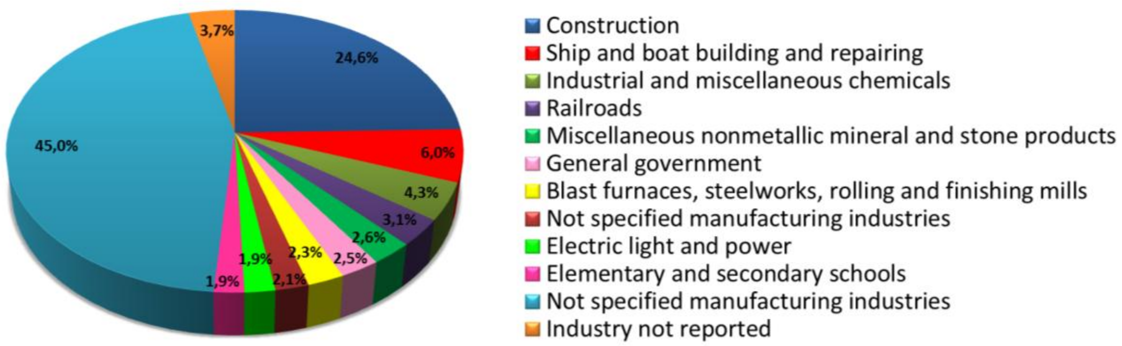

Figure 8 - Distribution of deaths from asbestosis by sector of activity in U.S. industries between 1990-1999 (Martins, 2011; NIOSH, 1991 to 2008).

The data presented in the previous figures illustrates the American situation. However, the Portuguese reality is probably closer to Britain. Therefore, the following graphs show the situation in UK accordingly with data from the Health and Safety Executive (HSE, 1968 to 2008). Figure 9 illustrates the evolution of mortality from asbestosis between 1978 and 2008. In 2008 there were 429 deaths in total, but this number has not stabilized, as happened in USA, since the prohibition of asbestos have taken place later in UK.

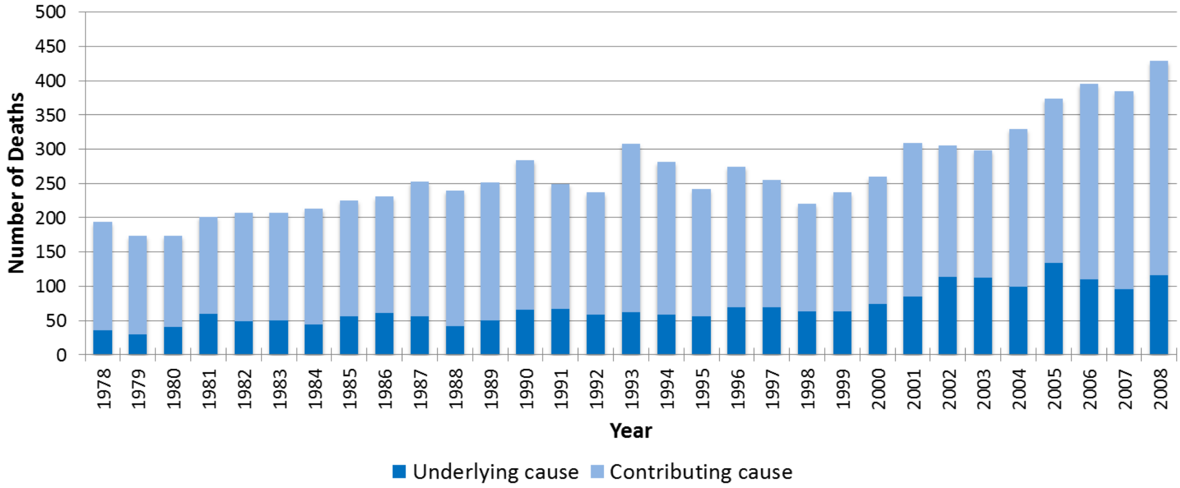

Figure 9 - Deaths from asbestosis in United Kingdom (Martins, 2011; HSE, 1968 to 2008).

Concerning the evolution of mortality from mesothelioma disease, the British data (HSE, 1968 to 2008) are more complete, having values since 1968 (Figure 10). Although asbestos is already banned, there are decades between initial exposure and death, typically between 30 and 40 years. This means that related deaths will still occur in the future, as a consequence of industrial conditions of the past. The number of mesothelioma deaths in 2008 was 2 249 (83% male and 17% female). Forecasts indicate that in 2016 will occur a maximum value, with 2 458 deaths (Mesothelioma, 2011).

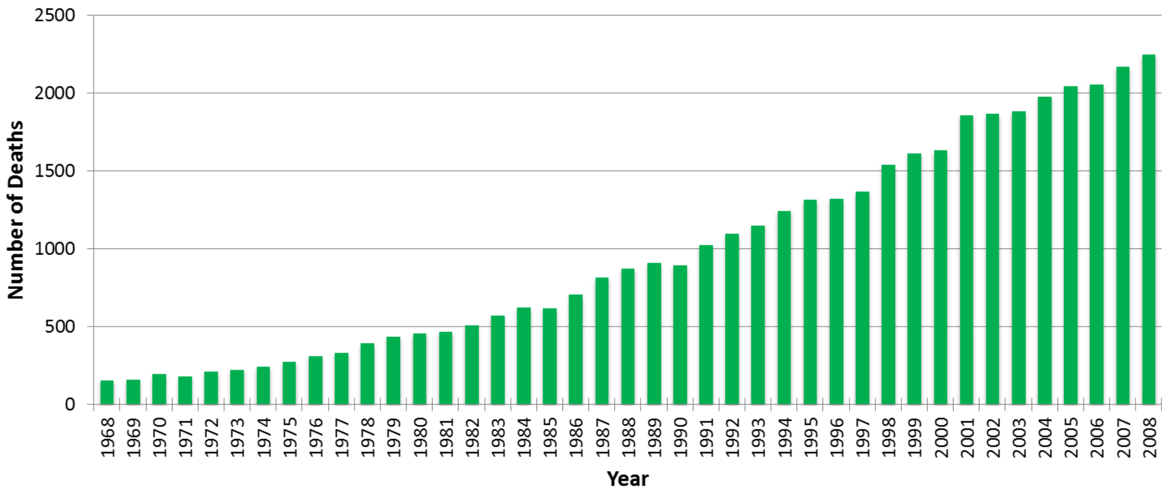

Figure 10 - Deaths from mesothelioma in United Kingdom (Martins, 2011; HSE, 1968 to 2008).

4. CONCLUSIONS

In recent years there has been a lot of pressure for the removal of asbestos cement roofs from Portuguese public buildings, especially schools. It is concluded however, that most people associate only with asbestos the roofing sheets and pipes made with asbestos cement, existing a great unfamiliarity about many others materials in which asbestos may be present. Although the society knows that asbestos is undesirable, many are unaware of the actual degree of danger and the inherent risk situations. The number of persons and companies that know how to proceed correctly in asbestos removal is reduced.

The statistics survey values clearly show that the number of deaths caused by asbestos exposure is huge internationally. Consequently there is a great need for wider dissemination of the Portuguese national reality on this issue, allowing that whole society and especially the construction workers have a real grasp of the problem scale and severity.

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The Elderly: Fall v Perception of the Environment

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ABSTRACT
A new approach to aging in its various aspects is required from the new society of the 21st century due to the increase in the elderly population. An analysis of how the theme "Falls among the Elderly v Environmental Perception" has been dealt with in the last ten years by the scientific community is addressed in this paper by conducting a review of articles published in highly-respected journals in the international academic world.
As a research tool, we used the portal of CAPES (the Brazilian body that fosters the further training and development of Higher Education staff), Google Scholar and searches on International Congresses, relating the theme to the Ergonomics of the Built Environment, Design and Aging. It was noted that the theme of "Aging" is frequently reported in scientific articles from several areas, and the subject "Fall" has been well discussed in connection with the theme of "Perception", especially when the focus is on the elderly. Thus, the findings support the need for research into the elderly´s perception when they are inserted into the built environment, since how they perceive the environment is closely related to the high number of falls recorded in this population.

Keywords: Falls by the Elderly; Perception of the Environment; Aging.

1. INTRODUCTION

This article conducts an analysis of how the theme of "Falls by the Elderly v Environmental Perception" has been dealt with in the last ten years (2000 to 2010) by the scientific community by means of conducting searches on highly respected journals in the international academic world.
The research instruments used were the portal of CAPES (the Brazilian body that fosters the further training and development of Higher Education staff), Google scholar and searches on International Congresses, relating the theme to the Ergonomics of the Built Environment, Design and Aging. It was observed that the theme of "Aging" is often tackled in scientific articles from several areas, including within the area of Ergonomics, in which the subject of "Falls" is well discussed, especially under the approach of the Ergonomics of the Built Environment, which is ahead of the theme of Perception, especially when the focus is placed in on the elderly themselves. There is discussion of how the environment is responsible for interaction; "the elderly v space," what the risks arising from the interaction are and moreover how environmental comfort can contribute to improving the quality of life of the elderly person. Thus, the results of this bibliographical search corroborate the need for more in-depth studies in the field of the perception of an elderly person who is inserted into the built environment, since environmental perception is closely related to the high rate of falls recorded in this population.
The purpose of this article consists of giving an outline overview of scientific research conducted over the last ten years, based on articles published in journals of international significance and presented at well-respected international congresses, while considering the point of intersection between two seemingly distinct areas: The High Rate of Falls, especially in residential spaces, verified among the elderly, the latter being those who are aged 60 or over, according to World Health Organization, (WHO); and Environmental Perception.
Perception is a discipline linked to sensory and cultural aspects in the sphere of interior and exterior physical spaces, while the high rate of falls among the elderly is a fact amply proven by medical records and widely explored by scientific studies. According to Okamoto (2002), aspects of interest are selected by the selective mind, given the bombardment of stimuli and it is only there that perception occurs as does awareness, resulting in a response that leads to a behavior. However, in most cases, these two issues, "Perception" and "Falls among the Elderly", are studied separately despite having an intrinsic relationship of cause and effect. Post-Occupancy Evaluation (POE) is the approach most commonly used to diagnose the positive and negative aspects of buildings and evaluates technical, functional, economic, aesthetic, and behavioral factors, taking into account the views of technicians, designers and, above all, users (Ornstein, 1995). Daré (2006) notes that for most people the environment we live in is accessible, but at different moments in our lives, we experience difficulties in the spaces we live in and with the products we use.
Given the above, the two themes merit greater in-depth study, which might consider the physiological aspects of aging and the ergonomics of the built environment, since the perception in question is about the elderly and the environment, in their homes.
Currently, the population in all countries is aging. The United Nations (UN) divides the elderly into three categories: the pre-elderly (those between 55 and 64 years old); the senior elderly (65 to 79 - or between 60 and 69 for those who live in Asia and the Pacific region) and the advanced elderly (over 75 or 80). According to the 2008 Revision of World Population Prospects, United Nations, New York, 2009, globally, it is forecast that the number of people aged 60 or older will increase almost threefold, rising from 737 million in 2009 to 2,000 million in 2050. The legions of the "baby boom"

(those born between 1945 and 1965), have lived for more than forty years. This new social situation prompts discussion about the need for new, broader public policies, with specific laws that provide protection and the due care for this phase of life. According to Arking, 2008, aging is a degenerative process that presents itself in two different ways. First, aging increases the likelihood that the individual will die with the passage of time. Secondly, aging decreases the person's ability to resist extrinsic stresses. The latter is commonly regarded as the loss of vigor or vitality.

The elderly of the 21st century are more socially and economically active than their predecessors. The fall in fertility after 1970 and the postponement of the age of entry into active life, due to longer schooling because of the ever increasing need for expertise demanded in the labor market, combined with the problems of funding pensions and the need to increase household income have contributed to the elderly playing a more significant role in society. Concern about the quality of life in the third age is universal and we are heading towards a healthier and more dignified process of aging.

However, accidents at home among the elderly is one of the major public health problems. They rank as the fifth leading cause of death in this age group and falls account for two thirds of these events (Perracini, 2010). The organic changes related to aging and linked to a physical environment and furnishings that are inadequate contribute to this index being so high.

Aging is a chronological, progressive and degenerative process that occurs in all living beings in greater and lesser proportions, although environmental factors may contribute to accelerating or retarding this process. Despite such a cruel diagnosis, the prognosis of the increase in life expectancy has begun to change the paradigm that old age is the twilight of life and that the elderly no longer have either vitality or can perform intellectually and professionally. On the contrary, in the 21st century, we are witnessing a return of this population to the labor market, social life and productivity.

From the age of 30, cells stop responding adequately to the stimuli imposed by the environment. The body is more vulnerable and begins to exhibit signs of time: the skin loses its sheen; vision becomes weaker; breathing, shallower; muscles, less powerful; and the brain, less sharp. It is important to remember that the environment in which the individual lives has a strong influence on the development and changes in his/her organism. Therefore, changes in the physical environment are extremely necessary in the sense of adapting this residential space to the new physiological and anthropometric configurations of the body, thus making it comfortable and allowing the elderly to be able to perform their household chores safely.

Perception is a complex set of activities of reception and analysis. The sense organs are the interface between the world and the individual and the sensation perceived of the environment stems from stimuli that are in the middle, even without there being full awareness of these. With aging, the body goes on losing its vitality, the sense organs (smell, hearing, touch, taste and sight), also undergo changes, except for the palate. Thus, stimuli are perceived with more difficulty, and the speed of responses varies and becomes slower with advanced age. Okamoto (2002), in his book, "Environmental Perception and Behavior," gives a description of the perception that there is no absolute reality in the mind, but only that which is perceptible by the observed facts. And these arise from attention vis-à-vis the universe of thoughts, the interpretation of facts or events that occur in the space that is considered real.

The dialogue undertaken between space with its equipment and the user is repeated throughout life, although one of the actors has changed over time. The parameters that shape the home environment do not change. The immutable format of this permanent dialogue makes the perceptive interpretation redundant and unable to diagnose the displaced aspects of the new patterns of behavior. This situation requires the user to adapt to a new situation. However, rather than the environment adapting to the elderly, what mostly occurs is that the elderly adapt to the environment, which greatly impacts their constitution in an adverse way. Rethinking residential space in the third age is to take into consideration aspects of physical security, but also affective aspects of their identity, which may interfere with the individual's emotional equilibrium, already weakened by the fact of their age.

Perception, therefore, is the fruit of previous experience which thus varies from individual to individual and is a permanent phenomenon of human cognitive activity.

The aging of perception is very varied; some sensory modalities are very little affected by age, such as smell, while others suffer severe impacts, such as hearing. Three modalities are mainly affected by senescence - balance, hearing and vision- and this leads to serious and important consequences in the psychological and social levels.

The word Ergonomics is derived from the Greek ergon (work) and nomos (rules). To summarize this in a simplified way, it is a branch of knowledge, which adapts work to the user. Therefore, its focus is on human beings. In a physical environment, several factors contribute to a state of security or insecurity for the user who inhabits it. Aspects that are harmful to the individual may be present in the environment or in the postures developed while performing the tasks. Ergonomics deals with various factors such as postures, body movements, environmental adaptations, perceptions, duties and tasks. When all these factors are conjugated, they contribute to planning the environment such that is safe, healthy and comfortable and to developing tasks that will not adversely affect the physical body such that the result is efficient and productive.

Ergonomics works in conjunction with other areas of knowledge, as it develops interdisciplinary work, such as anthropometry, biomechanics, physiology, psychology and architecture, and so forth. In accordance with ergonomic principles, equipment, systems and tasks should be designed for collective use, projects must serve 95% of the population, which leaves 5%, who must be served by specific projects. Posture and movement play a large role in Ergonomics, since they are determined by the task and by the job posts. These two factors are extremely important in old

age, for both posture and movement undergo profound changes as a person´s age advances and, therefore, will greatly influence how activities are performed.
Space needs to be pleasurable, comfortable, safe and bright so that it may contribute to the behavioral equilibrium of man, to the extent required by the user who inhabits it.
Ergonomics of the Built Environment, also known as Environmental Ergonomics is a branch of ergonomics concerned with the study of man's relationship with the environment, taking into account social, psychological, cultural and organizational aspects. Thus, three factors when assessing environments are of extreme importance. These are technical and material ones, those that are organizational and those that are psychological. Therefore, what is needed is an interdisciplinary approach that brings together the areas of ergonomics, architecture and environmental psychology when investigating the design of environments and behaviors that are in them.
Research studies on the built environment take into account the relationship between human behavior and space and have tackled the relationship of the environment to human behavior under the influence of research on urban perception and Post-Occupancy Evaluation. POE, according to Ornstein (1995), is about making behavioral and technical evaluations using equipment that measures the physical aspects of environments, such as decibel meters, thermometers and light meter, as well as observational techniques, questionnaires, interviews and mind maps.
The research studies that address environmental perception are based mainly on cognitive maps that are developed from varied investigation techniques.

2. MATERIALS AND METHOD

The research tool used was the CAPES portal, as well as the site; *http://qualis.capes.gov.br/webqualis/ConsultaPeriodicos.faces*, which lists the journals and their levels of strata, besides searches by theme in international congresses. *Qualis* is the set of procedures used by CAPES to stratify the quality of the intellectual production of post-graduate programs. This process was conceived as a means of assessment and is based on the information provided by the Data Collection application. On this site there is a list with the classification of journals and conference proceedings used by post-graduate programs to publicize their production. Stratification is based on crossing data on the movement of the vehicles of publication of scientific production (at the local, national and international levels) and their quality (A, B, C) and is placed on a scale consisting of eight strata (A1, A2, B1 to B5 and C). The C stratum has zero weight. The journals surveyed were exclusively those with an A1 evaluation.
The Impact Factor, abbreviated as IF, is a measure that reflects the average number of citations of scientific papers published in a certain journal and is used to evaluate the relevance of a journal in its field.
The criterion for choosing the journals started therefore from the level of these as seen by the international scientific community, taking into account the stratum and the impact factor linked to them, as well as to the field of activity that corresponds to the applied social sciences and the subarea of Architecture and Town Planning, Industrial Design and Ergonomics. According to Santos and Fialho (1997), Ergonomics involves the study of a concrete work, observing the performance of the task on site and with the equipment and teams involved, collecting all the data, whether these be qualitative and quantitative, uncertain, incomplete or contradictory, required for a diagnosis.

Table 1 - Journals selected for analysis.

Periodical	IF	Stratum
Applied Ergonomics	1.105	A1
Architectural Design		A1
Building and Environment	1.797	A1
International Journal of Industrial Ergonomics	0.956	A2
Design Studies	0.983	A1
Ergonomics	1.416	A1

3. RESULTS AND DISCUSSION

The articles found in Applied Ergonomics date from 2000 to 2005 and are from Europe, more specifically, Finland, Holland and Italy. These are very technical publications that deal specifically with ergonomic aspects, anthropometric measures and new routes for gerontechnology allied to design with the goal of a better quality of life in the third age. In the journal Architectural Design articles were seen that more specifically targeted falls among the elderly, but they were related to aspects of prevention (2009, New Zealand) and consequences (1998, Norway). It was found that in both Europe and the United States there is great concern with respect to hip fracture, including papers on drawing up new designs for hip protectors.
In the journal Building and Environment, recent articles, published in Holland, were found concerned with the elderly with dementia and the internal environment in order to provide an overview of the environmental parameters and their

relationship with the elderly user. In these articles we can see a marked concern with technology that targets the quality of life in the third age related to cognitive aspects of aging.
In the *International Journal of Industrial Ergonomics*, articles from 2000 to 2008 were checked, that focused on anthropometry, biomechanics, and perceptions related to security, related to physical construction aspects, such as the scaling of floors and pavements. An article of 2003 from the Department of Industrial Engineering and Manufacturing of Systems, University of Texas at Arlington, USA, addressed muscle strength in the elderly and its implications for ergonomic design. The journal *Design Studies*, published an article in 2003 of a comparative character, addressing post-occupational analysis within the philosophy of the journal of design studies.
We observed several reviews of the literature, questionnaires being used, simulations, interviews, film footage, measurements of environments. The sample of individuals ranged from 20 to 400, in the interview methodology. In the case of the review of the literature, an article was found with up to 55,000 participants.
Countries in which publications were found were: United States, England, Finland, Holland, Italy, Canada, New Zealand, Norway, Netherlands, Spain and Australia.
Of the 17 articles selected from journals that fitted the criteria chosen for the survey, all addressed the topic of aging. However, only five were related to the sub-theme of "Falls among the Elderly", more objectively, and only one article was on the issue of Perception, and even so, very specifically, with regard to perception and safety. Of the eleven international events surveyed, subjects relevant to the topic were found in only three of them. In some cases, such as when the programs of events are still in the process of being finalized, they are not available for consultation. At IFAC 2010, in France, there was an article on cognitive aspects of the elderly and the technology of design. At the Congress of the Human Factors and Ergonomics Society 2010, in the United States, one article tackles the issue of the economic aspects with regard to the low price used in the intervention for preventing falls in elderly women and concern is also seen about the urgency of rethinking design for aging. At the 9th Pan-Pacific Conference on Ergonomics Taiwan. 2010 it was noted there was technological concern about LED (light-emitting diode), about aging and residential Demands among the elderly, and also the commitment to universal design. It is noted that in 2000, there was an increase in concern for the elderly, which may be a reflection of the new questions of the 21st century. In the last three years, the number of articles published on the issue has stabilized which characterizes this as a recurring theme, and a current one.
It is noted that the methodology of experiments was the most used in the articles surveyed, there being six of such articles, followed by reviews of the literature and interviews and other methods, each of which gave rise to five articles.
According to Gunther and Pinheiro (2008, p. 378), experiment is about a method coming from the natural sciences, introduced and explained in psychology by Wundt (1906/2004). It consists of systematic observations under controlled conditions by the experimenter. In the six articles found, the research, mainly, addressed questions of the stability of the soil and its relationship with walking and falls arising.
Europe and North America were the continents with most articles. No articles were found coming from South America, Africa and Asia, in these journals, in the last decade.
Applied Ergonomics contributed to the research with six articles, the *International Journal of Industrial Ergonomics*, and the periodical *Ergonomics*, with three each. The magazines *Building Environment* and *Architectural Design*, published two articles within the theme and finally *Design Studies*, published a comparative analysis which addressed post-occupational analysis in an institution for the elderly.

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4. CONCLUSION

The survey conducted confirms the current trend towards the global concern about the elderly population. Many studies noted the relationship between technology and aging and concern about the quality of life in old age. A study in England approaches the theme from the focus of caregivers, "Running a Focus Group with Elderly and Disabled Elderly Participants", England (2000). Technology, especially targeted on the area of design and development of new products that will facilitate the performance of tasks performed by the elderly, was a recurring concern in the articles selected. Thus, the main theme of this research study, which is an analysis of how the subject of "Causes and Consequences of Falls among the Elderly and their relationship with Environmental Perception" has been debated over the last ten years in the scientific community, was dealt with, in the articles studied on the development of new design technologies for the elderly. These may minimize the risk of falls, focused on the physical and material aspects and not specifically on elderly people’s perception.
The objectives of the research revolved around the fall indices, the Information about the functional capabilities, mobility, abilities and limitations to perform certain tasks due to changes in biomechanical, physiological, psychological and mental characteristics and mainly to improve the elderly´s quality of life. This last concern is noted in all articles.
It is interesting to take note of the higher rate of experiments among the articles found, since in person-environment studies, this methodology is not widely used. One of the characteristics of environmental psychology normally pointed out is the study of human subjects in their regular life contexts.
What is observed, however, is that the articles address technical and physiological issues, but with no greater concern for the cognitive aspect of aging, which might investigate the problem of the perception of the elderly within the built environment, using ergonomic analysis. This field of science therefore deserves further study that links up the disciplines Ergonomics and Perception. Thus, this issue of perception of the elderly in relation to the built environment seems not to have been well resolved, and thus demands greater and more specific attention.

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Falls in hospital environment – risks and consequences (case study from distrital hospital in Figueira da Foz)

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ABSTRACT
Falls are the most frequently reported adverse events in health centers with the consequences of a physical nature translated into injury directly caused by trauma, blunt the psychological fear of further falls, anxiety, depression and loss of self-esteem and are socially underlying the increased costs to human and technical resources, which translate into increased hospital stay and dependence of the wearer. This study aims to know the Risk Index fall of users admitted in the pilot study HDFF, EPE; to identify associations between fall risk and age, medications used, running condition and history of decline and examine the consequences of falls for the user and the institution. To meet the targets was done, a retrospective, descriptive whose sample was not probabilistic and was composed of 135 users. In carrying out the study prior to the collection of data based on individual consultation process on general file. The interpretation of statistical tests were based on the level of significance $\alpha = 0.05$, confidence interval 95%. The results point to users who consume drugs associated with the presence of risk, this was observed in 24% of consumers. Most of the people under study is a consumer of drugs (65%) of which highlights the consumption of benzodiazepines (38%) and hypotensive (34%). The opportunity to be in the presence of risk is 7.05 times higher for consumer users The users who reported having a running condition dependent (79%) were at risk, and users that revealed a history of fall, all were classified at risk. Users with an average age of 68 were classified as risk.Com complete this study it became apparent the influence of some factors associated with the risk that maintains continuous monitoring of users classified at risk of falling.

Keywords: Falls; fall risk; falls prevention; patient safety.

1. INTRODUCTION

Patient falls are a concern of health institutions and the prevention of the fall is considered a focus sensitive to nursing care. The rate of falls in a service is an indicator of the quality of care. The falls, depending on their severity, cause: the patient and his family concerns; pain; functional disability and / or injuries; conduction of additional complementary diagnosis; additional therapeutic / surgical interventions and prolongation of the hospitalization. In the U.S. it is one indicator of quality of nursing care selected by the American Nurses Association (Directorate General of Health, 2000). Although there are few data about falls in Portugal, some health organizations have been adopting a culture of reporting such accidents that occur in hospitals (Almeida, 2010).

Falls are the rapid descent of the body, from a higher level to a lower level, by the loss of body balance or lack of ability to withstand the weight of the body in different positions (Almeida, 2010); but also "is a frequent and limiting event, being considered a marker of frailty, death, institutionalization and decline in the health of the elderly" (Nurses, 2005). The fall may occur at any age range but is particularly common in children and elderly. In the latter, the frequency of falls increases gradually over 65 years and is the leading cause of injury and a major cause of death (Chaimowicz, 2000). However, the age range of the elderly are of particular interest and concern because of the risk factors that they show, materialized in high rates of falls and of co-morbidity. Elderly who need help in the activities of daily living (the probability of falling is 14 times higher) and over two thirds of those who fell will be recurrent during the following six months (Almeida, 2010). The same source indicates that 1 out of 3 elderly suffer a fall each year, and that 50% of elderly recur in this type of accident. He also refers that the incidence is even higher in institutionalized individuals, estimating that figure to be in the order of 50%. Another source quoted by the same author has grouped these events in Occasional Falls – associated with extrinsic factors (conditions of the environment and of the situation itself); Intermittent or Intercurrent – related to some acute illness or transitory disorder of the circulatory system; Recurrent – when repeated two or more times within six months, associated with patients with weak health conditions, but without full medical explanation for the falls; and Risk Cases – include individuals with high risk of falling, although they have not yet suffered any accident. Another classification is the one that divides falls "in Accidental – associated with environmental hazards (physical obstacles and barriers); Physiologically predictable falls (in individuals with physiological changes that predispose to a high risk of falling); and Physiologically unpredictable falls although attributed to physiological factors, these are not predictable before the first fall" (Almeida, 2010).

Thus, due to the multifactorial etiology of this event, there is a range of falls risk factors, however they are commonly divided into intrinsic and extrinsic factors (Chaimowicz, 2000). The intrinsic risk factors are inventoried as: History of previous falls, age, psychotropic medication, with appropriate consequences: decreased motor function, weakness, dizziness, hypotension, confusion, drowsiness (Chaimowicz, 2000; Costa, 2010), polypharmacy (≥ 4) (Almeida, 2010; Caldevilla & Melo, 2010; Saraiva, 2008), chronic diseases, reduced mobility, sedentary behavior, fear of falling, nutritional deficiencies, cognitive impairment, impaired vision and foot problems (Chaimowicz, 2000; Costa, 2010; Marin, Bourie & Safran, 2000). As for the extrinsic risk factors, are mentioned: the environmental risk (slippery floors, uneven surfaces and poor lighting), inappropriate clothing and footwear, such as wide and long, and the use of inappropriate walking aids. Some studies (Adams, 2010; Caldevilla, 2009) refer to the works of: Hendrich 1992, that points seven risk factors – history of previous falls, depression, altered elimination, dizziness / vertigo, cancer diagnosis, confusion and altered mobility. Hendrich later gave the name to another assessment tool – Hendrich II Fall Risk Model, adopted in some national organizations, consisting of eight independent risk factors: confusion / disorientation / impulsivity, depressive symptoms, altered elimination, dizziness / vertigo, male gender, prescribed / administered antiepileptics, prescribed / administered benzodiazepines, and the performance in the "up and walk" test; Gluck 1996 suggests three risk situations – prior history of falling, confusion or disorientation, incontinence, diarrhea, or need assistance to go to the toilet; Mendelson 1996, while examining the effect of sedative medication in the falls of patients, verified that antidepressants, hypnotics, benzodiazepines and minor and major tranquilizers were associated with falls; Morse 1997, considers six risk factors – History of falls, presence of a secondary diagnosis, use of ambulatory aids, intravenous therapy or heparin lock, impaired gait and poor orientation of the patient to his own abilities; Oliver 1997, identified seven risk factors –transfer and mobility score of 3 or 4, presence of fear of falling, going to the toilet frequently, visual impairment, agitation, unsteadiness of gait, and antiarrhythmic drug (Almeida, 2010; Chaimowicz, 2000).

The first strategy of action is the inclusion in nursing care of instruments for assessing the risk of falling, instruments that allow signaling the elderly with a risk profile (Caldevilla & Melo, 2010). The instruments / protocols implemented by nursing tend to evaluate the intrinsic characteristics of the patient at the time of admission to the service, in order to classify him as high or low fall risk (Costa, 2010). In Portugal, there has not been an evident concern with the validation of falls risk assessment tools and there are few hospital institutions using instruments that did not undergo adaptation or validation for the Portuguese context. This fact may affect the process and the subsequent interventions, given that the instruments may not be sensitive to the given population and may not meet the real needs of patients (Caldevilla & Melo, 2010). Nevertheless, the use of assessment tools is a key resource for prevention, regardless of the instrument selected, and the important is for it to be specific and sensitive to the population in question and to be part of the professional practice of nurses (Almeida, 2010).

The promotion of a safe and comfortable environment for the institutionalized patients, reducing the uprooting of their natural environment and consequent depersonalization, is one of the constant concerns of nurses (Almeida, 2010). The consulted bibliography directs us to the evidence that hospitals with low allocations of nurses showed a higher rate of patients with complications, including: infections, shock, cardiac arrest, medication errors, patient falls and consequent high average delays and increased costs (Nunes, 2006). The sizing of and staff allocation refers to the adequacy of human resources to the need in health care, which "is considered a major factor in strategic management" (Parreira, 2005). The staff allocation is directly linked to quality and safety of care provided given the expressed, felt and identified needs (Nunes, 2006). People are the only living and intelligent resource of healthcare organizations and they are the ones that mobilize all other resources. Consequences are thus of different types and can be of physical, psychological and social nature, affecting the quality of life of the person (Saraiva, et al., 2008). The physical consequences are all the injuries directly caused by trauma (wounds, bruises, fractures). At the psychological level the consequences that emerge are fear of further falls, anxiety, depression, loss of self-esteem, among others. As for the social consequences, these are reflected in increased costs with human and technical resources, partly due to the increased length of hospitalization, but also due to the increased need for help to the patient given his decreased autonomy (Almeida, 2010). These related costs are the sole responsibility of the organization when the fall occurs outside the contractually specified maximum limit for the cause / disease responsible for hospitalization (Financial Services of the District Hospital of Figueira da Foz – Serviços Financeiros do Hospital Distrital da Figueira da Foz, 2011). This type of accident represents important consequences for individuals and institutions, and prevention is a priority strategy to be used by professionals and health organizations.

The objectives of the research study consisted of knowing the rate of fall risk of patients hospitalized in the pilot service; identifying the existent associations between risk of falling and age, medication, walking condition and previous history of falls; analyzing the consequences of falls for the patient and the institution in order to ensure the patient's safety and consequent gains in the quality of health; and assisting the implementation of the target 6 (patient safety) in the context of the process of accreditation of the hospital by collecting and processing the data.

2. MATERIALS AND METHOD

This was an observational study, retrospective, held in the Service of Surgical Specialties of the Hospital District of Figueira da Foz (HDFF), the sample design was of non-probabilistic type and the technique was of convenience. The sample consisted of 135 users hospitalized from June 2010 to January 2011. Data collection was based in the consultation of the individual process, in the General Archive of the HDFF, specifically the consultation of the nursing admission sheet from which were collected demographic data, type of medication, previous history of falls, walking condition and the Fall Risk assessment tool – Morse Scale, implemented in the service since June 2010. It was requested authorization to the Board of the HDFF for consulting the medical records and the anonymity of patients, the confidentiality of the collected data and the lack of commercial and financial interests was assured.

The Morse Scale was the instrument chosen by the institution for the development of the target 6 in the context of the accreditation process and "is described as an appropriate tool for assessing the risk of falling" (Costa, 2010). All

hospitalized patients were assessed for risk of falling through the Morse Scale, upon admission, by evaluating six items: 1 – History of fall; 2 – Secondary diagnosis; 3 – Aids in moving; 4 – Intravenous therapy; 5 – Gait, 6 – State of mind. According to the scores obtained, patients are considered low risk patients if the score is between 0 and 24; medium risk if the score is between 25 and 50; are high risk if score ≥ 50.
The data was processed using the statistical program SPSS version 17.0. The decision of the statistical designs (parametric or nonparametric) to use for the treatment and analysis of data were adapted according to the following criteria: the value of Symmetry, obtained by the quotient between the statistical value of the Skewness by the standard error of the measure ; the value of the Flattening, obtained by the ratio between the statistical value of the Kurtosis by the value of the standard error; Assessment of Adherence to Normal, by using the Shapiro-Wilk and Kolmogorov-Smirnov statistical tests. It was applied as descriptive measures: Frequency Statistics (Absolute and Relative), measures of location (mean and median) and measures of dispersion (variance and standard deviation). The following tests were applied: t-Student test for independent samples; one factor ANOVA for independent samples; adjustment x2 tests of independence; Fisher's exact test; as well as tests of association, namely, the Odds Ratio. The interpretation of statistical tests was based on a significance level p=0,05 and a confidence interval of 95%.

3. RESULTS AND DISCUSSION

Regarding the distribution of the sample under study, it consisted of 135 users, 34 males and 101 females, with a mean age of 64 (± 19,864) and 53 (± 14,52) respectively. With respect to the consumption of medicines, see table 1:

Table 1 – Characterization of the sample in terms of intake of medication, gait condition and falls.

		Male		**Female**		**Total**	
		n	**%**	**n**	**%**	**n**	**%**
Benzodiazepines	Not taking	27	79,4%	57	56,4%	84	62,2%
	Taking	7	20,6%	44	43,6%	51	37,8%
Antidiabetics	Not taking	28	82,4%	95	94,1%	123	91,1%
	Taking	6	17,6%	6	5,9%	12	8,9%
Antiepileptics	Not taking	34	100,0%	99	98,0%	133	98,5%
	Taking	0	0,00%	2	2,0%	2	1,5%
Hypotensives	Not taking	17	50,0%	72	71,3%	89	65,9%
	Taking	17	50,0%	29	28,7%	46	34,1%
Antidepressants	Not taking	32	94,1%	73	72,3%	105	77,8%
	Taking	2	5,9%	28	27,7%	30	22,2%
Anticoagulants	Not taking	23	67,6%	93	92,1%	116	85,9%
	Taking	11	32,4%	8	7,9%	19	14,1%
Gait condition	Independent	28	82,4%	93	92,1%	121	89,6%
	Partially dependent	4	11,8%	7	6,9%	11	8,1%
	Totally dependent	2	5,9%	1	1,0%	3	2,2%
Previous falls	Yes	8	23,5%	11	10,9%	19	14,1%
	No	26	76,5%	90	89,1%	116	85,9%

When we assessed the consumption of medication, we verified that most of the 34 men took hypotensives and anticoagulants. Of the 101 women, 44 took benzodiazepines, 29 hypotensives and 28 antidepressants. Regarding the gait condition, 82,4% had an independent status, 12% revealed having a partially dependent condition and 6% had a condition of total dependence. With regard to the previous history of falls, 8 men and 11 women reported having had previous falls. As for the attempt to control the levels of risk by age according to the Morse Scale, see table 2:

Table 2 – Mean differences in age and type of risk.

Age		Average	Standard Deviation	*p-value*
Morse Scale	Absence of Risk	53,33	16,044	0,000
	Presence of Risk	68,35	13,459	
	Total	55,89	16,585	
Morse Scale	No Risk	53,33	16,044	0,000
	Low Risk	68,71	12,139	
	High Risk	67,33	17,996	
	Total	55,89	16,585	

Mean age differences were observed for the users that were classified with presence or absence of risk. The presence of risk is higher in individuals with a mean age of 68 years (± 13,46), and was different in the group with no risk, which the

average age was around 53 ± 16,04 years (p-value <0,001). The presence of "high risk" occurred in patients with a mean age of 67 years (± 17,996) given the low or absence of risk (p-value <0,001).
We sought to evaluate the type of consumption of medication by type of risk, based on the Morse Scale. Consider table 3:

Table 3 – Relation between the consumption of medication, gait condition, previous and type of risk

		Morse Scale			
		Presence of Risk	Absence of Risk	Total (%Column)	Odds Ratio
Consumption of Medication (p-value: 0,004)	Yes	21 (23,9%)	67 (76,1%)	88 (65,2%)	
	No	2 (4,3%)	45 (95,7%)	47 (34,8%)	7,05
	Total	23 (17,0%)	112 (83,0%)	135	
Benzodiazepines (p-value: 0,003)	Yes	15 (29,4%)	36 (70,7%)	51 (37,8%)	
	No	8 (9,5%)	76 (90,5%)	84 (62,2%)	3,96
	Total	23 (17,0%)	112 (83,0%)	135	
Antidiabetics (p-value: 0,666)	Yes	2 (16,7%)	10 (83,3%)	12 (8,9%)	
	No	21 (17,1%)	102 (82,9%)	123 (91,1%)	0,98
	Total	23 (17,0%)	112 (83,0%)	135	
Antiepileptics (p-value: 0,687)	Yes	0 (0,0%)	2 (100,0%)	2 (1,5%)	
	No	23 (17,3%)	110 (82,7%)	133 (98,5%)	0,00
	Total	23 (17,0%)	112 (83,0%)	135	
Hypotensives (p-value: 0,574)	Yes	9 (19,6%)	37 (80,4%)	46 (34,1%)	
	No	14 (15,7%)	75 (84,3%)	89 (65,9%)	1,30
	Total	23 (17,0%)	112 (83,0%)	135	
Antidepressants (p-value: 0,032)	Yes	9 (30,0%)	21 (70,0%)	30 (22,2 %)	
	No	14 (13,3%)	91 (86,7%)	105 (77,8%)	2,79
	Total	23 (17,0%)	112 (83,0%)	135	
Anticoagulants (p-value: 0,005)	Yes	8 (42,1%)	11 (57,9%)	19 (14,1%)	
	No	15 (12,9%)	101 (87,1%)	116 (85,6%)	4,90
	Total	23 (17,0%)	112 (83,0%)	135	
Gait condition (p-value: 0,000	Dependent	11 (78,6%)	3 (21,4%)	14 (10,4%)	
	Independent	12 (9,9%)	109 (90,1%)	121 (89,6%)	33,30
	Total	23 (17,0%)	112 (83,0%)	135	
Previous falls (p-value: 0,000)	Yes	19 (100,0%)	0 (0,0%)	19 (14,1%)	
	No	4 (3,4%)	112 (96,6%)	116 (85,9%)	0,00
	Total	23 (17,0%)	112 (83,0%)	135	

For users who consumed drugs for compliance with therapy, the presence of risk was observed in 24% of them, of which 29% were taking benzodiazepines and likewise as for the number of users consuming hypotensives, antidepressants and anticoagulants. Most users under study consume medication (65%), of which number stands out the use of benzodiazepines (38%) and hypotensives (34%). The possibility to be at risk is 7,05 times higher for those users who consume medication, over those who do not consume, including benzodiazepines (3,96), hypotensives (1,30), antidepressants (2,79) and anticoagulants (4,90). As for the gait, the users that revealed a condition of dependency (79%) were at risk. The possibility to be in the presence of risk is 33,30 times higher for people with a dependent condition when compared with the ones that show an independent condition. Users, who revealed history of falls, were all classified with "presence of risk".

4. CONCLUSIONS

Over the years the idea was built, that the security associated with the hospital was a place of excellence for the provision of care to the populations. However, the development of these institutions and the clinical practice have shown that even in the hospital environment there are risks that may threaten the physical, psychological and sociological integrity of users, as is the case of falls. In this sense, we believe that this work contributed to a better understanding of this phenomenon in the pilot service where the study was started.
Almeida and Caldevilla conducted a systematic review on risk factors related to falls in hospital environment and reported advanced age as one of the most frequent factors. It was verified the presence of risk in users with an average age of 68 years which is in agreement with Chaimowicz when he states that "the frequency of falls increases gradually over 65 years". It was observed the presence of high risk of falling in users with a mean age of 67 years. This may be due to the hospitalization of patients of Internal Medicine, during the months of December 2009 and January 2010, that occurred because of lack of vacancies in the service of medicine and whose ages were more advanced.
When we assessed dimensions such as medication (polypharmacy), there was a relation between the consumption of drugs and the presence of risk, based in the Morse Scale assessment tool. It was verified the presence of risk in 24% of

those consumers. This phenomenon is confirmed by several authors (Almeida, 2010; Caldevilla & Melo, 2010; Saraiva, et al. 2008), when referring to polypharmacy (≥ 4 drugs) as an intrinsic factor of fall. It was found that the majority of users under study are consuming medication (65%), of which stand out benzodiazepines, considered psychotropic which effects originate decreased motor function, weakness, dizziness, hypotension, confusion and sleepiness (Costa, 2010; Chaimowicz , 2000). If we associate these effects to the fact that the user feels uprooted from his usual environment, the fall easily happens. The possibility to be in the presence of risk is also significant in users that take hypotensives, antidepressants and anti-coagulants.

In the latter, the consequences of the fall may be aggravated due to the effect of the drug, including serious bleeding, bruising which sometimes require transfusing the patient. Taking benzodiazepines and antidepressants may be related to the diagnosis of a significant portion of the female sample (unilateral or bilateral mastectomy and total hysterectomy by neoplastic process). As the drugs indicate the number of co-morbidities that the individual possesses, it is expected that people with more associated diseases take more medications (Almeida, 2010). This last statement may explain the high percentage of polypharmacy among users of the study, since the association of diseases is presented as an additional risk factor and fairly common in the studied population. The Morse Scale assigns a score of 15 points to users who have two or more secondary diagnoses.

Regarding the dependent gait condition it was found that a high percentage of users were in the presence of risk. The literature is unanimous about the use of walking aids as an important risk factor for falls. There are several studies that indicate that their use is directly associated with decreased mobility. It was also observed that all users with a history of previous falls were classified at risk, which is in agreement with the studies read: in patients who need help in daily living activities the probability of falling is 14 times higher, over two thirds of those who fell will be recurrent during the following six months (Almeida, 2010), and “1 out of 3 elderly suffer a fall each year, and that 50% of elderly recur in this type of accident and this is even more significantly among institutionalized users” (Caldevilla & Melo, 2010). According to the literature, this parameter is indicative of the associated risk, hence the importance of being assigned a score of 25 on Scale Morse, if a fall has occurred.

This study revealed and confirmed that this type of accident represents important consequences for users and institutions, and that is why prevention must be the priority strategy to be used by health professionals, especially nurses. It is important to use and develop specific falls risk assessment tools at the time of admission of the patient, which will the clinical practice of nurses, and to monitor and evaluate the preventive practices implemented. The tendency to see falls as a result of the “shortage” of nurses and not as a multifactorial indicator of quality of care, leads this to be an undervalued and underappreciated phenomenon. Understanding this phenomenon as a multifactorial event in which preventive measures aim at minimizing risk and reducing the occurrences is the starting point. It is by improving practice, adapting resources and creating new systems of excellent care that nurses are contributing to the satisfaction of staff and users. The North Carolina Nurses Association stated that “safe staff allocations reflect the maintenance of quality of patient care, professional lives of nurses and the results of the organization” (Association, 2005). The practice of safe staff allocations is considered to be the key to prevention of injuries / accidents on users, because people are the only living and intelligent resource of organizations and they are the ones that mobilize all other resources. It is essential that those responsible for the management consider important to quantitatively and qualitatively provide health services in order to respond to the needs, which means to consider important the availability that the caregiver has (or not) to dispense to each patient and be aware of their risk of falling. The development of an effective program to prevent falls thus requires the combined efforts of all in the ongoing creation and updating of good practice guidelines adapted to the specific nature of each unit (both in terms of intrinsic and extrinsic factors of their patients) and thus prevent these events to result in an increased period of hospitalization, dependence of the user and related costs, but in quality gains in health.

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Exposure to fibres in the Occupational Environment

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ABSTRACT
Occupational exposure to fibres is a risk both new and with a tendency to increase, which classifies it as an emerging risk. The fibers are used in many sectors of activity, however, knowledge of its health effects are not fully known. Based on a literature research, we intend to contribute to improving our knowledge of fibers, reporting on their classification, characteristics, hazards, uses, means of exposure and preventive measures, giving like practical examples, the asbestos fibers and the fibers of talc, among others.

Keywords: Fibres; Asbestos; Occupational Exposure; Emerging risk.

1. INTRODUCTION

The fibres are used in many sectors of activity, however, knowledge of its health effects are not yet fully known. It appears that the fibres are part of our day to day, although the proportion of chemicals classified as fibres in the Portuguese standard NP 1796:2007 (NP1796, 2007) is minimal (about 0.4%). Fibre is considered, a particle with 5 µm or more in length and a thickness with a length of 3 to 1 or more. Occupational exposure to fibres is a risk both new and with a tendency to increase, which classifies it as an emerging risk. Although the information on the exposure of the workers and their health effects is well known, must be maintained and improved the basic principles of prevention.
The fibres can be classified based on their chemical nature: organic and inorganic. Synthetic and artificial fibres are materials in constantly evolving and with a wide diversity of uses. Among the many examples presented, particular emphasis will be given to fibrous materials that appear naturally or are produced or used in some national industry activities. Talc is a hydrated magnesium silicate, which may contain asbestos fibres and because of its lubricating properties is used as filler in many industrial sectors, such as in ceramic industry, textiles, pharmaceuticals, cosmetics and paper and rubber industry (Dias & Canzian, 2011). Can be found in its pure form or associated with other minerals (Gibbs, Pooley, & Griffiths, 1992), causing different forms of pulmonary disease (Feigin, 1986). It's called asbestos, one group of six fibrous minerals belonging to the group of silicates that are found in natural rock formations. The six different types of mineral fibres have different structure and commercial interests. The carcinogenic effect appears to result from their physical properties and not their chemical structure.

2. OBJECTIVE

The purpose of this article, based on literature research, is contribute to the improvement of knowledge about occupational exposure to fibres, their ways of classification and characteristics, types of use, type of industry, means of exposure in the workplace, exposure risks methodologies, collection and analysis, preventive measures by giving practical examples, among others, the fibres of asbestos and talc. It is also the intention of the authors, throughout this article, alert to this emerging risk, which you can find a variety of activities and for which the Technician of Safety at Work and other professionals should be aware. The assessment and analysis of emerging occupational risks play a crucial role in early identification of effective prevention measures. In order to enable a quick analysis of the researched information is presented at the end of the article, a table that collects this information.

3. METHODOLOGY

3.1. Classification and characteristics

The fibres can be classified based on their chemical nature: organic (carbon and hydrogen) and inorganic (INRS, 2008). These in turn can be of natural, artificial or synthetic origin. Thus, a natural fibre is drawn directly from nature, the artificial fibre is a fibre produced by humans using as raw material products of nature, such as cellulose, the most common is viscose and cellulose acetate, lastly, fibre is a synthetic fibre produced by humans using chemicals (eg polyester, polyamide, polypropylene).
For example, are summarized in Table 1 some activities or uses of fibres.

Table 1 – Classification of fibres, based on their chemical nature and origin.

Fibres organics			Fibres inorganics	
Natural Fibres	**Synthetics Fibres**	**Artificial Fibres**	**Natural Fibres**	**Synthetics Fibres**
Examples: - Cellulose - Cotton - Wool - etc…	Examples: polyester - polypropylene - Polyethylene - aramids polyamide - etc…	Examples: - viscose - Cellulose acetate - etc…	Examples: - asbestos - etc…	Examples: - glass fibre - mineral wool fibres -Refractory ceramic fibres - etc….

As can be seen by the elements shown in Table 1, the inorganic fibres can be of natural origin, which is the case with the asbestos or synthetic origin, such as fibre glass wool or refractory ceramic fibre. The synthetic inorganic fibres can be grouped into a family called FMA - Artificial Mineral Fibres (INRS, 2008). The FMA can be classified according to their chemical composition, fibres siliceous or not siliceous. The FMA siliceous best known are: refractory ceramic fibres, mineral wool, fibreglass, special use and continuous filament fibres. It should also be noted, even though they are outside the scope of research for the present work, the nanofibres that nanofibres are elongated nano-objects, understood in a section and tens of nm and lengths between 500 and 10 000.

3.2. Routes of Exposure

Exposure to asbestos fibres, talc containing asbestos fibres or synthetic fibres can occur in two perspectives:

• Occupational exposure, which occurs mainly through inhalation of fibres, which can damage the lungs and other organs and digestive tract;

• Environmental exposure through contact with the family clothes and workers contaminated by the fibre, the fact that live near factories, exploitation, or in contaminated areas (soil and air) fibre, because of frequent environments where products fibres and also degraded due to the presence of fibres free in nature or points of deposition of products containing fibre.

3.3. Sectors of activity / uses of fibres

The fibres are used in many sectors of activity. For example are summarized in Table 2 some activities or uses of fibre, (FT145,2009), (FT268, 2007), (FT282,2011).

Table 2 – Activities or uses of fibres

Fibre	**Activities/uses**
Asbestos	Construction and protection of buildings Heating systems Protection of ships against fire or heat, Slabs, tiles and tiles Strengthening of road surfacing and plastic Brake linings Protective clothing against heat.
Talc (containing asbestos fibers or not)	Ceramic industry Textile industry Pharmaceuticals Cosmetics Paper Industry Manufacture of rubber Paints and coatings
Glass fibres for special use	Tablecloths, carpets, felts and fabrics Material and thermal insulation in the aerospace industry Filters for filtration systems with high efficiency Solar Panels Reinforcement for temporary denture resins
Cotton	Textile industry Fabrics for decoration
Refractory ceramic fibres	Tablecloths, sheets, panels Isolation of high temperature furnaces, castings and tubing Cables Manufacture of seals

	Automotive, aerospace Fire Protection
Mineral Wool: Fibre glass wool, mineral wool fibre and fibre slag	Thermal isolation Sound isolation Fire Protection HVAC - Air conditioning heating and cooling systems (insulation of pipes) Isolation of boilers, furnaces, appliances
Cellulose	Paper Folder Chemical and plastic manufacturing Manufacture of textile fibres
Carbon fibres	Sport and leisure (golf clubs, tennis rackets, fishing rods, etc.) Rolls of printing machine Components for textile machines Wind turbine blades Reservoirs of gas under pressure Aircraft industry
Aramids	Clothing fire-proof and bullet Aircraft industry Sport and leisure (tennis rackets) Personal Protective Equipment Sewing

4. RESULTS

4.1 Health Risks

Exposure to fibres is related to the occurrence of various diseases, malignant and benign. On contact, the fibres with a diameter greater than 4 microns can, based on its chemical composition or due to the presence of additives, cause skin or respiratory allergies (eg fragments of carbon fibres cause skin irritation by physical action, and due to feeling "itchy" rub the skin, they penetrate more deeply and can cause secondary inflammation). Another example is the small glass fibres that penetrate and become embedded in the outer layers of the skin, starting fracturing and releasing one of its constituents, the binder of formaldehyde on the skin. Recently, there's Disease or Morgellons "fibre disease" that is the inclusion of multi-colored fibres in skin texture, attributed to exposure to nanofibres produced by industry 2. For the analysis of safety data sheets it can be seen that most fibres presents the risk phrase R 38 - irritating to the skin, making it by this fact, need a special attention to this risk, present in the workplace and to which the workers are subject, and that is often underestimated. Inhalation of fibres can cause inflammatory reactions in the bronchi (bronchitis) and alveoli (alveolitis). Due to prolonged exposure, pulmonary fibrosis may occur, which is presented as a transformation of lung tissue which eventually leads to respiratory failure. This effect is irreversible and, in the case of certain fibres may still be rolling after the exposure. In the long term, some fibres may cause cancer, especially lung and pleura. cancer. The nomenclature used in the NP 1796:2007 (NP1796, 2007) to apply to asbestos fibres, for inorganic synthetic vitreous fibres and talc when it contains asbestos fibres, corresponding to a rating based on the degree of carcinogenicity that goes from A1 to A4.
Among the major diseases related to asbestos fibre, we find:

- Asbestosis, a disease caused by the deposition of asbestos fibres in lung alveoli, causing an inflammatory reaction of these, followed by fibrosis and therefore causes stiffness, reducing the ability to perform gas exchange, promoting the loss of lung elasticity and respiratory capacity with serious limitations to airflow, which may have the result of an inability to work. In the later stages of the disease this inability can be extended up to perform simple tasks and vital for human survival.
- Lung cancer, which may be associated with other morbid manifestations, such as asbestosis, with or without pleural plaques. The risk of this type of cancer can increase by 90 times if the worker exposed to asbestos is also smoking, because smoking enhances the synergistic effect between the two agents recognized as promoters of lung cancer. It is estimated that 50% of workers who have asbestosis will develop lung cancer.
- Larynx cancer, digestive tract and ovaries cancer.
- Mesothelioma is a rare form of malignant tumor that usually affects the pleura. Do not establish any relationship of smoking with mesothelioma, or dose of exposure. Malignant mesothelioma can metastasize via the lymphatic system in approximately 25% of cases.

4.2. Collection Methodology and Analysis

To determine the concentration of fibres, one can resort to sampling methods for use of personal sampling pumps with filters placed in the breathing zone of the worker, or the placement of static samplers in work areas. Personal methods are more representative of personal exposure of workers, while the remaining methods are most useful in the development of improvements in working practices and prevention measures.

For the sampling and measurement of asbestos and other fibres, can be used NIOSH method 7400 (7400NIOSH, 1994), whose analytical technique is the manual counting of fibres using a phase contrast microscope. Regarding asbestos, you can also apply the NIOSH 7402 method (7402NIOSH, 1994), whose determination is made using the electronic transmission microscope.
According to the Act n.º 266/2007, the counting of asbestos fibres is carried out preferably by the method of phase contrast microscopy (membrane filter method), recommended by the World Health Organization, or other method that assures equivalent results in qualified laboratories. For sampling fibres in contact with the skin are being studied methods that use tape or exposed stickers surfaces in the epidermis, as well as methods of aspiration of the skin to a filter and subsequent counting under a microscope.
Each technique has limitations and may give different answers. Therefore, it is necessary to understand the techniques and how they can be used. Table 3 provides a guide for the main classes of fibres encountered. Even when populations of fibres exhibit certain characteristics, these may not be shown by all individual fibres: thus, unless further information is available at least two characteristic properties of each fibre should be examined to permit discrimination. The analyst should choose the most appropriate technique for the strategy selected. However, if the types of fibre are not known, a decision hierarchy may be adopted. The results and their implications should be evaluated after each analysis.

Table 3 – Guidance in selection of the appropriate method (MDHS87, 1998)

	Methods			
	PCM/PLM	PCM/UV Fluorescence	SEM-EDXA	TEM-EDXA-SAED
Primary fibre analysed	**Strategies**			
Asbestos	Exclude other fibres > 1 µm diameter (limited use if some types of other mineral fibres are present)	Not recommended	Include asbestos fibres > 0,2 µm diameter	Include all fibres
MMMF	Include MMMF fibres > 1 µm diameter which are isotropic	Not recommended	Include MMMF fibres > 0,2 µm diameter, can be useful if source of fibre is known	Can be useful for fibres from known source
Other mineral fibres	Exclude other fibres > 1 µm diameter, eg rutile needles (cannot always be used to discriminate between different types of mineral fibres	Not recommended	Include fibres > 0,2 µm diameter, if source is known: can be used to discriminate between some types of mineral fibres	Include all fibres; can identify or discriminate between fibre types
Synthetic organic fibres	Not recommended, except for a known source which may have a characteristic property	Include certain types of organic fibre from a known source which fluoresce of specific wavelengths	Exclude inorganic fibres > 0,2 µm diameter	Exclude other inorganic fibres of all widths of all widths give in EDX spectrum

MMMF – Man-made mineral fibres; PCM - Phase contrast light microscopy ; PLM - Polarised Light Microscopy;
TEM - Transmission Electron Microscopy; SAED - Selected Area Electron Diffraction; SEM - Scanning Electron Microscopy; EDXA - Energy Dispersive X-ray Analysis;

This table helps the analyst to select the appropriate method and strategies for different fibre types based on the capabilities and limitations of the methods.

4.3. Prevention Measures

After that some prevention measures are indicated:
- Replacement of toxic products for less toxic products such as asbestos for fibre glass or ceramic material;
- Isolate higher risk processes;
- When handling or applying hazardous materials, use clothing, gloves and protection goggles;
- After handling these products, wash skin with soap and warm water;
- Wash work clothes separately from the rest;

• Adequate general and localized ventilation with conservation and maintenance plan;
• Wet cleaning work surfaces;
• Information and training of workers; Use of standards of hygiene and safety;
• Medical examination to diagnose signs and symptoms that allow early detection of disease;
• Systematic monitoring of the concentration of fibres in the air;
• Protection masks;
Note that, the employer must provide adequate masks and in good condition, and should only be used temporarily as a complementary measure to the collective protection.

5. CONCLUSIONS

It follows, for all these reasons, there is still a long way to go for a perfect and proper knowledge of possible effects and especially in the development of mechanisms that can prevent the occurrence of damage. It is not possible at this stage of knowledge (or ignorance) to evaluate the impact of emerging risk at the society level, productivity and sustainability of the industries themselves responsible for the production of fibres, or whose production process involves the release of fibres.
However, factors such as:
- Risk assessment;
- The adoption of measures to prevent or control risks;
- Information, training and consultation of workers;
- Regular monitoring of the risks and control measures;
- Appropriate monitoring of health;
- The examination for admission before the start of exposure, are very important in preventing the risks of exposure.

To implement the proposed objectives, is in Table 4, a small practical example for refractory ceramic fibres, which allows a quick analysis of researched information.

Table 4 – Definition/Characterization and Health Hazards of Refractory ceramic fibres.

Fibre Type	Definition / Characterization	Diameter	Main health hazards	TLE -TWA
Refractory ceramic fibres	• Artificial fibres glassy silicates, with random orientation, where the percentage of alkaline oxides and alkaline earth oxides is less than 18%. • Aluminum silicate fibers used for applications above 1000 ° C. • Above 1000 ° C recrystallize gradually and form the cristobalite (crystalline silica is classified as carcinogenic to humans). • It does not form fibers with smaller diameter, but have transverse orientation. • Classified as a category 2.	1 -3 µm	• Irritating to skin ; • Appearance of pleural plaques and alterations in respiratory function • Slightly soluble in biological fluids – biopersistent; • Fibroses • Carcinogenicity comparable to asbestos	0,1 fibre/cm^3

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Occupational Exposure to Dust in Open Pit Mining. A Short Review.

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ABSTRACT
A literature review concerning the scientific knowledge of all the key factors related to respirable crystalline silica dust exposure was conducted and a chronological evolution of the state-of-the-art knowledge that can respond to questions raised by the development of the work done in quarries and opencast mines is presented, based on bibliographic research. Findings assert that exposure to silica dust is the most frequent and dangerous hazard in open pit mining. Some aspects meet consensus amid authors: tasks and work equipment, areas surrounding the quarry, methods of sampling, relationship between the amount collected and the legal limits set (TLV) in each country. “Good practice” preventive strategies towards the protection of the exposed workers comprehend early knowledgeable recognition of the danger followed by application of technical means of exposure control. A review evidence concerns the link between exposure, by inhalation of dust containing crystalline silica, and its harmful effect to human health, often deadly (silicosis). Authors noted that other work-related factors associated to exposure to silica dust may potentiate other occupational diseases. Silicosis is a preventable occupational disease, but not curable, accounting for new cases of death even among young workers. Thus an effective mandatory control of exposure to crystalline silica in the workplace is therefore crucial.

Keywords: Silica dust; open-pit mining; occupational prevention.

1. INTRODUCTION
Occupational exposure to dust is one of, if not the main health risk originating from quarries and mines. It’s closely associated with almost all the phases of the production process. From the general concept of risk, defined as the probability of an event being held in conjunction with the consequences of exposure to a substance, arise a number of other factors that must be analyzed in detail. Thus, in addition to the hazardous substance - respirable crystalline silica dust, the target must be considered - the exposed worker, an entry point into the human body, the place of exposure - work place (post or work equipment), time or duration of exposure, as well as the frequency of exposure, so that the hazardous substance may or may not exercise its adverse effects. Dust is generated at all stages of production and the smallest dust particles, therefore invisible in size, are the most dangerous due to their ability to reach the lower part of lung (the alveolus) (Orme, 1998).

2. OBJECTIVES
In order to consolidate the knowledge of all the key factors related to respirable crystalline silica dust exposure a bibliographic research was conducted. The general purpose was to present the state of the art for each of the crucial factors and the relationships established. This paper aims to present a chronological evolution of scientific knowledge that can respond to questions raised by the development of the work done in quarries and opencast mines. The research main objective involved the dust hazardous substance(s) and their effect on the target under analysis: i) the exposed worker, knowledge of the route of entry into the body of the exposed worker; ii) the airways, the site of exposure; iii) different equipment and work places, time or duration of exposure and the frequency of exposure.

3. METHODOLOGY
The present review is based on bibliographic research, Metasearch variant, using the search engines available at the Faculty of Engineering, of the University of Porto, which is conducted in Databases and Scientific Journals. The research was initially done for all the Databases and Scientific Magazines available and gradually restricted to the resources effectively relevant and articles of interest. Thus, the resources that have been proved to be more productive, from the Database, were the following: Compendex, Current Contents, Web of Science and from the Scientific Journals, the ACS Journals, Highwire Press and Wiley Online Library. PubMed was another database searched and proved of great interest in connection to the subject matters of Occupational Health. The research has been developed by combining a set of keywords that were predefined; the search was made in all available fields, excepting when the number of results of each research was too long for analysis, and then it was restricted to one field only. The logical operator between keywords used was "And." The research fields that returned better results with interest were "Subject" and "All fields", being the most comprehensive, when used alternately and respectively as 1st and 2nd keywords. During this process and when the number of articles was in very large numbers, about 1899 articles, refining the search, combining it with another expression, limiting the results to the logical "and" a 3rd keyword or, alternatively, refining the search of the years between the publishing options "dates (2000-2005)", "dates prior to 2000" and "Dates after 2005" or by searching for "Year" to year. The logical operator between keywords used was the option to "And." The fields of research that showed better results were - "Subject" and "All fields". They have interest, because they are the most comprehensive, when used interchangeably and respectively in the 1st and 2nd keywords.

From the results, 45 articles were selected that appeared relevant to the topic and are presented by valid evidence of its scientific rigor and whose data / observations to show sustained or properly validated. Subsequently, the screening process of scientific articles arising from various searches was made and in most of the situations, based on the summary information provided. And in some situations when an article reveals more importance, through access to the full article, more detailed and complete information can be obtained. The group formed between the permanent term "Occupational Dusts" as the first keyword and as 2nd keyword "Extractive Industry", were assessed in all fields of research available. In order to refine the search, different keywords were introduced: "*Opencast mining industry", "Open pit mining industry", "Quarry", "Equipment quarry rock", "Drilling equipment" and "Transportation equipment in extractive industry"*. In order to continue to restrict the search in any one of these searches was also used another strategy, which allowed the search of articles published within the ranges of "dates". Thus, after refining and suitable for evaluation set out above, a database was constructed, with the articles grouped in areas of interest based on the study objectives.

4. RELEVANCE OF RESULTS

4.1. Characteristics of potentially dangerous substance - respirable crystalline silica dust

Considering the research main target, occupational dust, all articles have a common data, revealing that exposure to silica dust is the most frequent and dangerous hazard in open pit mining. Because of the references made throughout the review, formulated in a more or less general way to silica dust, it should be noted as referring to crystalline silica dust in the respirable particle size, which is present in its basic form quartz α, being the most abundant toxic silica.

The component most widely recognized as dangerous, are the particles of crystalline silica that in excessive exposure can cause serious respiratory problems or silicosis (Orme, 1998) and considered as class 1 - carcinogen, confirmed in a study by Peretz & Checkoway (2006) and in an earlier studied by the working group led by Donaldson (Donaldson & Borm, 1998). However, this author noted that the carcinogenicity to humans was not detected in all industrial circumstances, verifying that this may depend this may depend on inherent characteristics on inherent characteristics of the crystalline silica or external factors affecting its biological activity.

Demircil and Scarselli in their studies (Demircigil, 2010), (Scarselli & Binazzi, 2011), in Turkey and Italy respectively, concluded that the activities of rock blasting, crushing and grinding, are classified at high risk of exposure, especially in developing countries, where awareness to this problem is smaller. Mikolajczyk, in its study in coal open pit mines in Poland (Mikolajczyk, 2010), concludes that exposure to silica dust remains the biggest problem in industrial hygiene and occupational medicine in that country. When dealing with crystalline silica, the focus is particularly on quartz, because it is the most abundant mineral on the surface, with an approximate value of 20 percent in the earth's crust (Madsen et al., 1995).

4.2. Place of Exposure - jobs and work equipment. Definition of TLV - Threshold Limit Values.

Another field of research, object of consensus amid several authors is the place of exposure - tasks and work equipment, areas surrounding the quarry, methods of sampling, relationship between the amount collected and the legal limits set in each country.

For example, Golbabaei (2004), conducted a research in a stone quarry of marble located in the northeast of Iran. Time weighted average of total dust, respirable dust, and crystalline silica (α-quartz) concentration in the workers' breathing zone were monitored by using both gravimetric and XRD methods. The results showed that the employees working in hammer drill process had the highest exposure to the total and respirable dust: 107.9 ± 8.0 mg/m^3, 11.2 ± 0.77 mg/m^3 respectively, while the cutting machine workers had the lowest exposure (9.3 ± 3.0 mg/m^3, 1.8 ± 0.82 mg/m^3). The maximum concentration of α-quartz in total and respirable dust were detected equal to $0.670 \pm 8.49\times 10–2$ and $5.7 \times 10–2 \pm 1.6 \times 10–2$ mg/m^3 respectively, which belonged to the exposure of the workers of hammer drill process. The prevalence of skin and respiratory symptoms were higher in hammer drill workers, however, respiratory symptoms showed no significant prevalence. Regarding the average age of workers (31.6 ± 1.9 yr) and average of their work history (3.8 ± 1.0 yr), these results were predictable.

Bahrami also reports the sampling methodologies and analytical studies of quartz quarries and find values of exposure exceeding the TLV (Threshold Limit Values), (Bahrami, Golbabai, Mahjub, Qorban, Aliabadi, & Barq, 2008).

One of the mandatory requirements specified in laws or standards of most countries including the United States of America and Europe and inherently Portugal, in the area of occupational health and safety, is the evaluation of occupational exposure of workers to chemicals in the workplace.

The assessment of occupational exposure of workers to these agents consists in determining the concentration of these agents in the air of workplaces through methodologies and equipment specified in standards and their subsequent comparison with reference values, which represent acceptable levels of exposure.

These values are studied and proposed by U.S. government agencies such as NIOSH-National Institute for Occupational Safety and Health (NIOSH) and the ACGIH-American Conference of Governmental Industrial Hygienists and introduced into European standardization through ISO standards, which are incorporated in the standardization system of each member country.

Scarselli, in his paper "Occupational exposure to crystalline silica: estimating the number of Workers Potentially at high risk in Italy" (Scarselli, Binazzi, Marinaccio & 2008), estimate the need of approximately 10 to 15 years of occupational

exposure are required to cause silicosis, and a 5–10% likelihood to develop the disease is estimated in workers exposed during 20 years to silica concentrations of about 0.1 mg/m^3.
This level is the TLV (Threshold Limit Values) allowed for 8 hours of exposure defined by OSHA for respirable crystalline silica in the United States. Recently, the ACGIH reduced the TLV allowed for eight hours of work exposure to 0.025 mg/m^3. Following the most recent values defined by the ACGIH, in Portugal, it is recommended that for reference values are used TLV defined in the Portuguese Standard 1796:2007 (NP1796, 2007). Measuring the concentration of chemical agents and compare with the exposure limit values (TLV's) is a set of ways to undertake the evaluation (Matos, Santos, & Barbosa, 2010). This standard specifies the TLV and defines them as the concentration of chemicals to which it is considered that nearly all workers may be exposed, day after day without adverse health effects. These TLV are designed to use in practice of the Health and Safety at Work and are only guidelines or recommendations for control of potential health risks in the workplace, taking into account that the levels of contamination should always be the lowest possible. The parameter typically used as a comparison with the values obtained from collections made is the exposure limit value weighted average (TWA), which is by definition a weighted average concentration for a day's work of 8 hours and 40 hours a week.
The value stipulated in the Standard referred to crystalline silica is TLV-TWA = 0.025 mg/m$^{3(R)}$ where (R) is the Respirable fraction, with a notation A2, which considers crystalline silica as a suspect carcinogen in humans. This notation is used especially in cases where there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals with relevance to humans.
In a study conducted by Vinzents, collected samples of total dust and respirable dust (Vinzents, 1995), in view of the results can be used as tentative of establishing occupational exposure limits, concluding that these concentrations vary by type of industry and the results depend on the industry type and the content of the dust. There are also authors expressing some concern, not only by the exposure of workers in their jobs, but also related to people living in the surrounding areas of this type of industries.
In this sense, the work presented by Mukhopadhyay (Mukhopadhyay & Ramalingam, 2011), refers to a sampling, analysis and evaluation of particles in the workplace, $PM_{2,5}$, PM_4 and environmental dust / total – PM_{10}, conducted over 2 years, in order to test a system for control of dust in suspension by wet process.

4.3. Preventive measures.
In order to try reducing concentrations to below the TLV, in addition to early recognition of the danger and use of technical means of control, some measures should be taken. The knowledge of the situation of exposure to this type of dust, i.e., recognition of danger, is the first step towards the protection of exposed workers. The application of technical means of control can be considered as a "good practice" measure by the sole fact that prevents exposure. A large part of the work developed in the industry generates dust and consequently over-exposure of workers to respirable crystalline silica dust, which contributes significantly to mortality and occupational morbidity. Meeker (2009) evaluated the performance of portable personal control systems that were commercially available. With these systems, reductions of up to 96% in the concentration of respirable quartz exposure between workers with and without control have been achieved. However it can be concluded that there is a need to establish strategies to improve the performance of this type of equipment (Meeker, Cooper, Lefkowitz, & Susi, 2009). Other preventive measures, such as, regular medical examinations, respiratory protection and training, should be taken. The training given to workers at the beginning of their professional activity is important, but recycling programs are also important. Personal Protective Equipment (PPE) should be used as a last resort given the fact that its use is usually sporadic, unless, the supervising authorities intervene with a tight periodicity. Respiratory masks do not reveal effective protection for very high dust concentrations (Thomas, 2010).
Most operations of extraction and processing of rocks result in the release of significant amounts of dust. These dusts are released not only to the workplace but also for the atmosphere of the surrounding areas of the quarries. We have always been used dust suppression systems and direct exhaust systems from dust, so they were totally or at least partially removed from the workplace.
The need for maximizing the effectiveness of available dust suppression systems in conjunction with other effective controls, such as water sprays and personal dust collectors, continues to be critical to the long-term health of mine and open pit mines workers (Colinet, 2005). For these dust control systems to be monetized to its full potential, it is essential that their maintenance becomes part of routine practices. Management should encourage employees to regularly review the systems installed. An effective reduction of respirable dust exposure of workers should also contain a component of education and training. Workers should be aware of potential risks to health associated with exposure to respirable dust in excess.
Taken the fact that drilling operators in general have one of the highest exposure levels to respirable dust and the operator of the drill bits, being an employee who is at the top of the list of functions that have the highest exposure to respirable silica dust, (Randolph (2004), was one of the researchers studying dust generation from blasthole drills and developed a simple, quick fix system that reduces respirable dust concentrations by more than 63% at the dump point. This device, which requires almost no maintenance, is small and inexpensive, and it will help operators maintain compliance to the dust standard. The thought process was that a reduction of respirable dust at any of the multiple sources points on the drill, in this case the dust collector dump point, should reduce the total respirable dust generated by the drill. The drilling

machine generates high concentrations of respirable dust from several sources: drill table shroud leakage, dust leakage through the table bushing, dust discharge from the dust collector exhaust due to impaired filters, and dust entrained from the dust collector fines dumped onto the bench. Advantages to this method of respirable dust reduction are that the material is inexpensive and requires almost no maintenance. If the shroud becomes damaged, it can easily be replaced in 10-15 minutes requiring little, if any, downtime for the drill. To reduce the respirable dust concentrations at the collector dump point, the purpose of Randolph, was a piece of brattice cloth attached to the dust collector dump point using a large hose clamp. This dust shroud is installed over the existing rubber boot attached to the dust collector dump point. The length of brattice cloth (or similar material) should be sufficient to allow it to extend from the dust collector dump point to the ground. It should be cut so that it is only long enough to just touch the ground when the drill is lowered.

4.4. Health Effects

Throughout the literature review there is an evident link between exposure to crystalline silica dust and the its effect, in general harmful. Silicosis, the main illness resulting from exposure to this type of contaminant, can be defined as an occupational disease that results from prolonged exposure to crystalline silica dust. The inhalation of dust containing crystalline silica can be very harmful to human health, and may often be deadly if safety precautions are not used. It has plagued industry around the world since mankind began digging into the earth (Thomas, 2010).

According to Smith (Smith & Leggat, 2006), silicosis, asbestosis and coal workers' pneumoconiosis, represent the three of the most important occupational-related dust diseases in Australia.

To gain a clear picture of pneumoconiosis trends over time, a 24 year’s retrospective analysis of national mortality data was performed for the period 1979 to 2002. Over 1.000 pneumoconiosis-related fatalities occurred during this time, 56% of which were caused by asbestosis, 38% by silicosis and 6% by pneumoconiosis. Between 1979 and 1981, silicosis accounted for 60% of all pneumoconiosis-related fatalities in Australia, followed by asbestosis (31%). By 2002 however, asbestosis was causing 78% of all fatalities, while silicosis accounted for only 19%. Asbestos-related mortality increased three-fold between 1979 and 2002, with a clear excess risk demonstration among male workers. On the other hand, mortality rates for mortality rates for silicosis and coal worker’s pneumoconiosis declined significantly during the same time period. Overall, this study suggests that pneumoconiosis, particularly asbestosis, continues to be an important occupational disease in Australia.

To identify whether there is evidence of pneumoconiosis and other respiratory health effects associated with exposure to respirable mixed dust and quartz in United Kingdom opencast coalmines, Love (Love, et al., 1997), with a cross sectional study of current 1249 workers (1224 men, 25 women) was carried out at nine large and medium sized opencast sites in England, Scotland, and Wales. To characterize a range of occupational groups within the industry, full shift measurements of personal exposures to respirable dust and quartz were taken. Up to three surveys were carried out at each site, covering all four seasons. For the purpose of comparisons with health indices these groups were further condensed into five broad combined occupational groups. Full sized chest radiographs, respiratory symptoms, occupational history questionnaires, and simple spirometry were used to characterize the respiratory health of the workforce. The highest concentrations of quartz were found in groups of rock drilling and bulldozers drivers (used to move earth and stone of the coal seams). As their exposure is principally to dust from overburden that contains silica rather than coal, and as the exposures to respirable dust are far lower than the exposure to coalmine dust associated with coal workers' pneumoconiosis, it is likely that the pneumoconiosis represents silicosis. It can, therefore be concluded that exposure to airborne mixed respirable dust, particularly in the dustiest preproduction parts of the industry, can give rise to a small risk of radiological abnormalities, consistent with the characteristics of pneumoconiosis, probably silicosis. The dust conditions are not sufficient to cause notably reduced lung function or increased frequency of chronic bronchitis, nor are they positively associated with symptoms of asthma. However, the results point to a need for continuing vigilance to keep dust exposures low, particularly in those occupations of highest occupational risk.

Silicosis typically presents as a chronic disease after 10 or more years of exposure to crystalline silica dust (Checkoway, 1995). The existence of a quantitative relationship between exposure to quartz-α and silicosis risk, is well established (McDonald, 1995) (Donaldson et al., 1998).

Regarding the average age of workers (31.6 ±1,9 yr) and job seniority (3.8 ±1,0 yr), the author (Golbabaei, et al., 2004) concluded that workers are too young to have severe silicosis symptoms and therefore the likelihood of cough, phlegm, allergies and skin disorders are very low (Sanderson et al., 2000). As other research has shown, the symptoms appear after 10 years of professional experience, while workers analyzed in this study have a short history of seniority at work which leads to the conclusion that it is too early to find any relationship between concentration of quartz and respiratory symptoms and skin (Calvert et al., 1997). Exposure to crystalline silica dust may be responsible for the increased risk of developing tuberculosis and other respiratory diseases, contribute to kidney disease (Thomas, 2010) and other systemic autoimmune diseases, including scleroderma, rheumatoid arthritis, lupus erythematosus, and some sclerosis of small vessels with renal impairment. Studies on specific groups of professionals with high level of exposure to silica, as is the case of miners working underground or in open pit mines, showed increased rates of autoimmune diseases compared with the expected rates in the general population. The specific manifestation of this effect may depend on underlying differences in genetic susceptibility or other environmental exposures (Parks, Conrad, & Cooper, 1999).

The author (Hnizdo, 2003), in a review article on chronic obstructive pulmonary disease caused by occupational exposure to silica dust, explores the epidemiological and pathological evidence, considering this type of dust one of the most important occupational respiratory toxins. Epidemiological and pathological studies suggest that silica dust exposure can lead the worker to chronic obstructive pulmonary disease, even in the absence of radiological signs of silicosis, and that the association between cumulative silica dust exposure and airflow obstruction is independent of silicosis.

4.5. External factors enhancer's diseases linked to exposure to respirable crystalline silica dust.

Some authors point to some other factors that associated with exposure to silica may potentiate other diseases. According to Solt, the increased risk of developing rheumatoid arthritis is associated with workers' exposure to silica. However, the history of this disease reflects genetic and environmental factors such as the habit of smoking, but little is known about the influence of other factors. Actually it is known that factors such as age, residential area, and socioeconomic class as smoking habits were considered as potential confounders in the analysis of the association between silica exposure and rheumatoid arthritis (Stolt & Källberg, 2004).

Other authors (Jones, 2003), (Akbar-Khanzadeh & Brillhart, 2002) consider as confounding factors, the following parameters: speed and wind direction, relative humidity and ambient temperature, which are determined during dust sampling period. It appears that with increasing wind speed was a significant reduction in the concentration of silica dust. The fact that we are working against the wind, also contributes to the reduction of exposure to silica dust compared to wind in a favorable direction, however, the difference was not statistically significant.

In the study of Akbar-Khanzadeh (2002), the weighted average concentration of silica dust in 69% of the samples exceeded the recommended exposure limit (0.05 mg/m3 recommended by the American Conference of Governmental Industrial Hygienists - ACGIH, 2001) , showing a strong need to developed methods to control workers exposure to crystalline silica dust.

Most of the authors surveyed, talk about the dust generated by machinery and equipment during the production process. Jones (Jones, 2003) makes the physical and chemical characteristics of the cloud of dust generated by the detonation of explosives in the dismantling of the massive, in a quarry in the North of Cardiff, Wales. From the study, it is confirmed the existence of three distinct clouds of dust, not only in terms of color of the projected cloud but also designed the cloud constituents and respective particle sizes, were examined within the quarry and the nearest village. So, the cloud that expanded even greater distance would be consisted mainly of mineral particles and should take the color of the stone quarry, was followed by a cloud of gray dust, mainly constituted of particles arising from the combustion of explosives, followed by a cloud of lighter color and located essentially in the detonation area. The samples were analyzed by high-resolution electron microscopy that found different sizes as the cloud of dust analyzed and the location of the sample. Thus, any consideration made in terms of adverse health effects of these dust clouds, it has to take account of these three components, wherever they locate sampling. The size distribution of dust corresponding to particles arising from the combustion of explosives, is below 2 µm and mineral dust transported by the first cloud have grain sizes above 2 µm, when analyzed in their travel outside the quarry, in the nearest village, dust sampled have a close size distribution. With this study it can be concluded that sampled dust in the nearest village, does not correspond entirely to dust generated at the quarry, but are caused by other industrial sources and aren't caused by the quarry, such as work on the surrounding roads, and others.

In that way, the literature research conducted until now, allows us to conclude that the substance of concern in evaluation - dust, crystalline silica is the one that has, for the type of industry under review, more papers with scientific interest evidenced, not only because the effects it would have on workers' health, but also because, together with other agents, become potential of various autoimmune diseases. As a consensual aspect, silicosis is an occupational disease that is preventable, but that has no cure. New cases of death from silicosis continue to occur, even in young workers. Currently, there is no effective treatment available (Thomas, 2010) (CDC, 2005), so the effective control of exposure to crystalline silica in the workplace is therefore crucial.

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Ethics and Social Responsibility: healthy labor environment and management of the waste generated in the constructive process

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ABSTRACT
This paper shows through a study in a Civil Construction Company that the good practices of safety and healthy associated to the correct management of wastes generated in the productive process of companies in any activity sector, brings with it measures that aims to reduce the negative impact of industrialization, whether protecting the physical and mental health of employees through prevention and control of environmental and operational risks, or protecting the environment with properly handle measures of wastes generated by their productive processes. These measures extend to the three areas: company personnel, products and costumers and the general public. In this way, the conditions are gathered so the employer ensures a healthy workplace and contributes to improving the quality of life for all involved in the production process, providing the welfare in a manner consistent with the environmental balance and social justice and essential to the principles of ethics and social responsibility. As a technique of data collection it was used, in the first moment, the interview technique. The script used in the interview addressed issues that allowed the knowledge of the policies of hygiene and safety at work and waste management of construction and demolition, committed by the surveyed company. In the second moment, it was used the simple observation when visiting the construction site of surveyed company, in order to verify in loco the conditions of hygiene and safety at work, including the disposing of construction or demolition waste. Based on the information obtained in this research and the reflections presented in the paper, it can be concluded that the good practices of health and safety at work and the management of the waste generated during the productive process of companies from various sectors of activity are indicators of an ethical business activity and socially responsible.

Keywords: Health and safety at work; Waste; Ethics; Social responsibility.

1. INTRODUCTION

The working environments, where people spend a third of each of their days, are considered potentially more harmful to health than the social environment or the community. Actually, the industrial environment presents, in most cases, highly artificial, since in this environment operations are accomplished with dangerous machinery, potentially toxic chemical agents, excessive noises, extreme temperatures radiation sources, etc. And many of these risks have reached the community where the company is inserted, through the pollution of the air, the water and the soil, being also the cause of public health problems.

The civil construction stands out in today's economic landscape as being responsible for the production of durable goods and employment generation. Its productive process is very complex, with predominance of human factors, hard working conditions and greater exposure to risks than most of other industrial sectors. According to Dias (2009), it can be affirmed that this industry stands out as one of the most unfavourable in matters of health and safety at work, presenting a dire picture of high rates of accidents and occupational diseases and of environmental impact due to waste generated in the constructive process.

Such wastes are those from buildings, reforms, repairs and demolitions of works in civil construction, and those resulting from preparation of the excavation of lands and they are classified, as the resolution CONAMA (National Council on the Environment – BRAZIL) number 307 (05/07/2002) in classes A, B, C and D. Class A wastes are the reusable ones or the recyclable as aggregates. Class B wastes are those recyclables to other destinations, such as plastics, paper/cardboard, metals, glasses, woods and others. In class C are the wastes for which were not developed technology and applications economically viable that enable their recycling / recovery, such as product made from gypsum. The class D is composed by dangerous wastes from demolitions, reforms and repairs of radiology clinics, industrial installations and others. The abandonment of these materials in inappropriate places is a problem that affects worldwide and cause environmental impact that interfere in the quality of life and in the welfare of the society, in both present and future.

Several studies have been made in order to determine the quantity of Construction and Demolition Wastes (CDW) generated in Brazil. John and Agopyan (2001) estimated that, in Brazil, the mass of CDW generate in big cities is the same or bigger than the mass of household wastes, and Pinto (1999) estimated that in Brazilian cities of medium and large port, the mass of waste generated by Civil Construction varies between 41% to 70% of total mass of urban solid wastes, corresponding to a generation that varies between 0,23 to 0,76 tons per inhabitant per year. According to data of the Brazilian Association of Special Waste and Public Cleansing Companies, in 2008 were collected, in the Northeast/Brazil, 4.887.000 tons of CDW, in other words, 17% of the total of construction and demolition wastes collected in the Country at the same period.

2. CONCEPTUAL ASPECTS

The constant search for improvements happens nowadays in several companies of the Construction Industry, centred in an external perspective and they do not necessarily follow an actual improvement of working conditions at construction sites. Unlike, it is frequently noticed some degradation in safety and health at these environments that still present an undesirable reality of predictable accidents and diseases, where people get sick or die from open gears, poorly installed scaffolding, poor electrical installations and hazardous productive processes.

By health at work should not be understood simply the domain of medical surveillance, in other words, medical individual health assessment, but the control of physical and mental elements in workplaces. It is noticed that health at work must not be seen as a simple state of absence of disease, but as the promotion of a welfare environment, generating factors that motivate the company employees. But, in the conception of the most responsible for the productive processes, the health problems are due to the carelessness of workers regarding to safety standards. Such conception is based on holding the weakest link, forgetting the structural aspects of the working process and its effects on the human beings, the collectivity and the environment.

To a company operates in its social environment, there are limitations established by society such as laws, standards of behaviour, payment of taxes, etc. If the company uses badly the natural resources that it takes from the environment, this company is undertaking a predatory action; the company will also be predatory and pollutant if it is taking creative and healthy people from the social environment and returning to this environment sick, disabled, unhappy and unable people, due to inadequate working conditions. But, it is known that the Brazilian worker is still getting sick, being mutilated and dying because of the bad conditions of many different work environments.

It is common to consider that a program based on safety and health at work is something very complex and, sometimes, even impossible to be implanted. But this reasoning is rather simplistic and utterly wrong, since a large part of what causes accidents, illness and death, stems from technical and organization problems for which solutions have been found. They do not require scientific challenges, it is just a matter of decision making to deploy and develop, in companies, programs of Safety and Health at Work that aimed the prevention of risks of work accidents and occupational diseases, as well as the respect for the environment, and they are based on the following general principles:

- Evidencing risks.
- Fighting the risks in their origin.
- Controlling the risks that cannot be avoided.
- Adapting the work to the man, especially with regard to the conception of jobs, as well as to the choice of equipments and methods of work and production, in order to alleviate the monotonous work and reduce their effects on health.
- Having regarded the evolutionary stage.
- Replacing the hazardous by what is exempt from danger or less dangerous.
- Delineating the prevention with a coherent system that integrates the technique, the organization and the working conditions, social relations and the correct placement of waste generated in appropriate places so as not to pollute the environment.
- Providing adequate training to employees.

The main focus of these principles is proactive, once it proposes the incorporation of actions related to safety, health and environment protection in the planning of the productive process so that, according to Dias (1998), these aspects can be part of the production instead of requiring complementary and isolated actions, disconnected from other parts of the act of produce.

In order that prevention becomes an integrant and daily part of productive processes and business goals, there must be the will and the commitment to adopt a Management System of Safety and Health at work, perceiving it as a promising approach to improve working conditions and positive impacts on overall business performance and a reconciliation of the produce with the well-being.

A company can be compared with a live organism, affirm Melo (2001), and the occurrence of illness will interfere in business health which in turn will affect the sustainability of this company. The deaths, the mutilations and the occupational diseases resulting from unhealthy working environment, besides bringing harm to workers representing losses for the companies, they cross the limits of these internal environments, causing a negative impact on the external environment (social environment) represented by social security spending for the government, environmental pollution and marginalization of the injured worker or patient, or at least changes in their family and their quality of life.

According to Ribeiro (2004), is not pleasant to live or to work in a place with a heavy traffic, bad odors, excessive noise, breathing an air combined with several chemicals elements, which most of them are the cause of serious diseases to humans. It is common knowledge that the dysfunctions under the conception, organization and management of workplaces often reverberate in the external environment (social environment).

The dynamism of a globalized world caused innovations in the economic, political, social, cultural scenario and changes in patterns of relationships between companies, markets and society, resulting in multiple efforts to accomplish shared goals. Estigara et al (2009) consider company as all human action that aims to satisfy a need, i.e., company is not limited exclusively to capital and profit, because it is embedded in a social environment and without natural resources and people it does not generate wealth, does not satisfy human needs, does not provide progress, does not improve quality of life and does not survive.

Every organization is an extension of society and, as such, it cannot survive alone, impacting and being impacted by the social context in which it operates. It should therefore identify and address different requirements of stakeholders in business and not only the economic interests of its shareholders. Actually, all human activities implies the creation of some aspect that can impact the society positively or adversely and can be identified and expressed in environmental, ethical, social, political and economic levels. Somehow, these aspects always represent an increase or a loss of social welfare, as its consequence is positive or adverse.
Based on this assumption, the intervention of several social actors requires from the organization a new attitude, called Social Responsibility, grounded in ethical values that promote the sustainable development of society as a whole.
Oded Grajew, president of the Ethos Institute, considers social responsibility as an ethical attitude of the company in all its activities. It refers to the company's interactions with employees, suppliers, customers, shareholders, government, competitors, environment and community. The issue of social responsibility goes, therefore, beyond the company's legal stance, the practice of philanthropy or the community support; it means a change of attitude, in a business management perspective with a focus on the quality of relationships. Social Responsibility is a set of concepts and actions that contribute to a better world with the participation of all.
In December of 2010, it was published the ABNT NBR ISO 26000 – Guidelines on social responsibility, becoming a landmark. This norm defines Social Responsibility as the responsibility of an organization by the impacts of its decisions and activities (products, services and processes) on the society and the environment, through a transparent and ethical behaviour that:

• Contributes to the sustainable development, health and the welfare of society;
• Takes into account the expectations of the stakeholders;
• Is in conform with the applicable Law and is consistent with international norms of behaviour;
• Is integrated throughout the organization and its relationships (activities of an organization within its spheres of influence).

Ethics is a fundamental part of social responsibility and aims to provide directions to the organizations and consistency to its programs. By ethics it is understood a set of moral values and principles that guide human conduct in society and is present in our everyday all the time, whether in family decisions, policies or at work. Ethics serves to allow for a balance and a good social functioning, enabling nobody to get hurt. In this way, although it cannot be confused with the laws, ethics is related with the sense of social justice. So, ethics and social responsibility are related to the company's interactions with employees, suppliers, customers, shareholders, government, competitors, environment and community, which should beacon all business political activity.
The maintenance of a healthy workplace through the implementation of good practices of Safety and Healthy in construction sites, as well as the correct management of wastes generated in the constructive process, are collaborator factors of the social responsibility of an organization. According to the book "Promoting an European Framework for corporate social responsibility", dated from 18th of July of 2001, social responsibility is a concept whereby companies decide, voluntarily, contribute to a fairer society and to a cleaner environment.
This means that business management should not aim for just the satisfaction of owners and shareholders of the companies, but also others stakeholders such as, for example, workers, local communities, customers, suppliers, public authorities, competitors and society in general.
Table 1 illustrates the principles of ethics and social responsibility.

Table 1 – Principles of ethics and social responsibility

Principles of ethics	**Principles of social responibility**
• Consideration of Others that is expressed by the integrity of personal conduct, by the non-discrimination of people, by the mutual respect and by the fair treatment between the employees and other stakeholders; • Commitment to Transparency that makes visible the criteria that guide decisions and actions, in order to ensure the fairness in the agreements and the compliance with it terms; • Observance of Laws and of the regulations that keep the proper alignment with the Country's Law, as well as the line with the internal rules, and preserve the suitability of operations and statements of account; • Social Responsibility that guides strategies and policies through the strengthening of financial sector entities and by adding value to stakeholders.	• Good governance practices; • Fair practices of competition; • Worker's right, including that of freedom association, and negotiation of a fair remuneration; • Commitment to Professional development; • Promotion of safety and healthy; • Promotion of sustainable patterns of development, production, distribution and consumption; • Protection to the environment and to the rights of future generations; • Social actions of public interest.

This paper shows through a study in a Civil Construction Company, that works in João Pessoa/Paraíba/Brazil, that the good practices of safety and healthy associated to the correct management of wastes generated in the productive process of companies in any activity sector, brings with it measures that aims to reduce the negative impact of industrialization, whether protecting the physical and mental health of employees through prevention and control of environmental and operational risks, or protecting the environment with properly handle measures of wastes generated by their productive processes. These measures extend to the three areas: company personnel, products and costumers and the general public. In this way, the conditions are gathered so the employer ensures, in his/her company, a healthy workplace and contributes to improving the quality of life for all involved in the production process, providing the welfare in a manner consistent with the environmental balance and social justice and essential to the principles of ethics and social responsibility.

3. METHOD

The research that is presented in this article was accomplished in a medium-sized company (companies with the number of workers ranging between 100 and 500, according to the criterion of the Brazilian Institute of Geography and Statistic – IBGE) of civil construction industrial sector, working in the city of João Pessoa (capital of Paraíba state, Brazil), in distinct moments. As a technique of data collection it was used, in the first moment, the interview technique, which is an individualized procedure, the contact is direct between the interviewer and the interviewee, and it aims to collect qualitative information. Being a deeper approach, it enables to understand some of the behaviours that cannot be explained through the observations, as well as obtain information about beliefs, feelings, desires, people expectations or about their explanations or reasons about the things above. The script used in the interview addressed issues that allowed the knowledge of the policies of hygiene and safety at work and waste management of construction and demolition, committed by the surveyed company. In the second moment, it was used the simple observation (based on the Regulatory Norm number 18, resolution number 307 of 05.07.2002 of the National Council on the Environment – CONAMA and the law number 11176 of 10.10.2007, of the Prefecture of João Pessoa, that establishes the system of sustainable management of waste from construction and demolition) when visiting the construction site of surveyed company, in order to verify in loco the conditions of hygiene and safety at work, including the disposing of construction or demolition waste. Thus it was proved how (or whether) was being implemented the policy of safety and health at work and the management of waste generated in the constructive process, declared by the company's director when he was interviewed.

Table 2 shows the variables considered and the respective indicators of good practices of safety and healthy at work and of the correct management of wastes generated in the constructive process.

Table 2. Variables and Indicators

Variables and Indicators	Indicators
Company Size	Number of Employees
Management System For Safety and Health at Work: existence of an OSH policy and a guide of procedures to a safe accomplishment of the constructive process.	Documents that prove the existence of: • OSH policy • OSH planning • Implementation and operation • Verification and corrective action
Waste Management of Construction and Demolition	Document that prove the existence of a management policy to the produced waste Destination given to the generated wastes
Terms of Safety and Health at Work at the construction sites	• Existence of the Program of Conditions and Work Environment required by NR 18 (Brazilian regulatory norm). • Presence of environmental risks and appropriate control measures. • Collective protections • The correct use of Personal Protection • Capacity building and training of the workers.

After the data collection, it was proceeded the comparison of the situation found at the company with the Regulatory Norm number 18, resolution number 307 of 05.07.2002 of the National Council on the Environment – CONAMA and the law number 11176 of 10.10.2007, of the Prefecture of João Pessoa, that establishes the system of sustainable management of waste from construction and demolition and with the indicators of Table 2. After this comparison, it was sought, in Table 1, the proof that the company, object of this study, works according to the principles of ethics and social responsibility.

4. RESULTS AND DISCUSSION

The surveyed company performs works of hydro infrastructure, dams, drilling of wells, water supply, and sanitation, contracted by the Federal, State and Municipal Government. At the moment of the survey, the company had 280 employees working in the office and at the workplace. The construction of dams is the main service performed. In this process, the workers are exposed to solar radiation, silica dust, noise caused by several machines as well as other risks arising from the complexity of the construction process, that, if were not properly controlled, they will certainly cause disorders (diseases and work accidents) in the lives of workers and the company.

To obtain information, it was interviewed an engineer who belongs to the Administrative Council. According to the interviewee, the Company is aware of the current legislation (CONAMA and Municipal) and operates within the established rules, since, due to the type of work that is performed, it must prove to SUDEMA (Superintendency for the Development of Environment) the existence of management with appropriate disposal of the CDW, in each beginning work. It was also noted the existence of the documents cited in Table 2 as indicators of implementation of the OHSMS.

As the conditions of health and safety at work in the construction sites, it was verified the implementation of a "Health and Safety Plan" that supports the policy of prevention and safety at work. This is an open document, likely to be added as the execution project is developed, with the following goals:

• To comply with all legislation under the health and safety at work and the management of waste generated by its constructive process;

• To plan, for all activities with associated risks, the measures of prevention and protection necessary to the control of occupational hazards;

• To address the risks control according to the general principles of prevention;

• To keep an updated Record able that is able to enhance the measures and responsibilities of construction tasks;

• To involve the objectives stated, all the stakeholders in the enterprise, in a way to ensure concerted and consistent performances;

• To promote the necessary actions so all the employees can understand the implementation of measures;

• To allocate all human and material resources required to implement planned actions to ensure the safety at work and the respect for the environment.

In relation to the management system of safety and health at work and of the wastes generated in the constructive process, it can be affirmed that this company had a formalized and properly implemented system integrated to the productivity, the reducing costs and the respect for the environment, not only by setting rules, but including them in the whole planning of the company to the job site.

In the end of the study at the company, it was realized that the proper management of issues related to the wastes generated in the constructive process and the safety and healthy at work, is consistent to the principles indicators of social responsibility and ethics, listed in Table 1:

- Considerations of Others, verified through the organizational environment that emerges the mutual respect and fair treatment among employees and other stakeholders.
- Commitment to Transparency, identified at the policy of the company that allows visibility of the criteria that guide decisions and actions, contributing to the fairness and compliance with the signed agreements.
- Observance of Laws and Worker's rights, proven for compliance with labor laws, that keeps the proper alignment with the laws of the country
- Good governance practices, perceived in the fulfillment of what is planned and satisfaction from the different levels of the company.
- Promotion of safety and healthy, protection to the environment and to the rights of future generations, proven for compliance with Regulatory Standards on Health and Safety at work and the official recommendations on proper management of waste generated in the construction process.

5. CONCLUSION

It can be stated that the management system of safety and health at work and of the wastes generated in the constructive process, is a professional way to do the job without loss of life, physical and mental injures, damage to the property and the environment, and the adoption, by companies, of this System means a qualitative leap of organizational innovation, impacting on all levels, motivating the management and the employees around the prevention of occupational risks, with positive effects on people's quality of life and on the overall company performance, contributing, in this way, to the sustainable development.

The Safety and Health at Work and the respect to the environment are truly established in several companies, although others the most elementary rules are not accomplished. The results of that appear on statistics about accident and diseases at work that reflect the negative aspects related with the problematic of inadequate work conditions and show the pain and suffering for the victims and their families and the impact on quality of life of those people and the ecological environment. This situation is in the opposite way of world's expectations of sustainability, once that currently, maintainable is considered as the development that assists the needs of the present without compromising the possibilities of future generations assist their own needs and is based on principles of the environmental balance an social justice.

The environmental impact caused by the waste generated during the construction process and the impact on working conditions are consequences of the disengagement of some constructors with the legislation related to the subject and with good management practices. It is also worrying the poor oversight by public agents related to the presented problem, allowing these attitudes of ignorance and indifference to the law.
Nowadays, the society expects that the performance of the organizations exceeds the concern with economic aspects of the business, that they develop their activities in order to contribute to the improvement of social conditions as a whole. In other words, the expectation of the society is not only for the quality of the product purchased, but also that the process which produced it had been conducted in a health work environment for employees, creating the smallest environmental impacts.
It can be concluded that the good practices of health and safety at work and the management of the waste generated during the productive process of companies from various sectors of activity, as demonstrated in this study, are indicators of an ethical business activity and socially responsible.

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Ergonomics Aspects and Mental Workload of Operators of Electric Power Control Centers: Case Studies in Northeast Brazil

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ABSTRACT
Electrical systems can be categorized as critical systems where failure can result in significant financial loss, injury or threats to human life. The operators of the electric power control centers perform an activity in a specialized environment and have to carry it out by mobilizing knowledge and reasoning to which they have adequate training under the terms of the existing rules. To reach this there is a common mental request of personnel involved in these centers due the need to maintain attention, memory and reasoning request. In this sense, this study aims to evaluate the Mental Workload of technical workers of the Control Centers of Electrical Energy. It was undertaken a research on operators control centers of the electricity sector in Northeast Brazil. It was used for systematic observations, followed by interview and application of the instrument National Aeronautics and Space Administration Task Load Index known as NASA-TLX. As a result there will be subsidies for an assessment of mental workload of operators, and a contribution to improving the processes of managing the operation of electric utilities and the quality of workers.

Keywords: Ergonomics, Electric Control Centers, Fatigue, Mental Workload.

1. INTRODUCTION

Institutional changes currently underway in the Brazilian electric sector are intended to establish a free market in energy, increasing the efficiency of the sector by enabling competition and raising funds for expansion. In this market, as elsewhere, participants and staff strive to improve their strategic position by achieving a competitive advantage relative to competitors, to ensure their survival and growth in the system of free competition. The technical sector is at the center of this process, where levied efficiency and productivity exist. Being at the center, as a component critical to the success of any company, one of the biggest challenges that organizations increasingly face is related to the health and welfare of workers, particularly those linked directly to the operation of the system. When observing the activity of operators of the electric power control centers, one can note that they perform intense activities in a specialized and dangerous environment. Operators have the responsibility of, as a principle, prevention of incidents that disrupt the operation of the electrical system, or when it is not possible, they try to make the process return to its normal state, the so-called recovery. They have to do so by mobilizing knowledge and reasoning for which they have been trained, which, under the terms of the existing rules, are considered to be adequate. However, there are some factors that need to be improved, and there are still incidents and accidents caused mainly by fatigue, lack of concentration, or inadequate operator, screen, machine, and computer.

This research aims to evaluate the ergonomics aspects and mental workload of operators of electric power control centers and to contribute to develop a working methodology that is better adapted to these activities in the electricity sector,

The impacts that may arise due to problems in electrical power substations can cause severe damage resulting from faults in electrical power, which may also affect the electric power company. Thus, it really is necessary for the electricity companies to have adequate human resources capable of making decisions quickly and effectively to attend to the events, both emergency and contingency (Neves, 2007). In the electricity sector, technicians who work at centers of operation and control have the basic activity of monitoring the operation of the substation, which is essential to make decisions and process information continuously. This is a common mental burden due to the need of maintaining attention, memory request, and reasoning. Among the factors involved in making capacity decisions, the following can be cited: the postural requirements, depending on factors, such as the existing equipment, lighting, and state of continuous attention that the task requires, may lead to worker fatigue and affect the health of the worker and the company's productivity; the difficulty in interpreting the information, which may occur due to environmental conditions, such as inappropriate noise, lighting, and temperature, as well as the qualitative and the quantitative aspects of the presentation of information (Santos; Zamberlan, 1992).

The current automated equipments conduct more mechanical and repetitive activities, while humans perform activities in dynamic environments requiring rapid adaptation and flexibility to the occurrence of an actual performance. This adaptation to circumstances that are constantly changing due to the variability of processes and supervisory function of the employees requires complex skills and cognitive abilities. In this scenario, the incorporation of cognitive component analysis of the work has become a necessity to be able to address satisfactorily the complex skills involved in the operation of modern work systems (Oliveira, 2009).

2. MENTAL WORKLOAD AND FATIGUE IN OPERATORS OF THE CONTROL CENTERS

The mental burden is placed as a hypothetical construct, induced by performance of a task and causing a decrease in the mental activity of other tasks. The aspects of fatigue were analyzed by Ilda (2005), who noted that a balance between the demands at work and the ability of workers is needed. This balance can be supported by ergonomics research conducted in the workplace, because ergonomics aims to study the interactions of people and technology, as well as organization and environment to cooperate in an integrated way for the safety, comfort, welfare, and efficiency of human activities. Grandjean (1998) classified the main determinants of fatigue in internal and external variables. The following external variables are those that act more explicitly on the subject: Availability of time, equipment, instruments, and securities, for the physical environment (temperature, noise, vibration, and air quality); technical pressures; management; strategies; and organizational policies. On the other hand, internal variables are those intrinsic to human nature, such as the biological aspects of the constitution of the individual worker; psychological aspects characterized by personality style, emotional, and social aspects demonstrated by the level of commitment to issues of work and the service needs of food, shelter, safety, and comfort. According to Ilda (2005), fatigue and stresses are considered to be due to a complex set of factors of cumulative effects (Curt *et al.*, 2000).

First, there are physiological factors related to the intensity and the duration of physical and mental work; psychological factors, such as boredom, lack of motivation; and finally, the environmental and social factors, such as the lighting, noise, temperature, and personal relationships on site. Fatigue is very common in the workplace and must be understood as a set of signs and symptoms of physical and mental attributes (Murata *et al.*, 2005; Meijman, 1997), and that, if not properly observed and reversed, it may pass on to several systems of the body, causing changes in the functions and leading to reduced performance at work as well as psychological, family, and social disorders (Limongi, Rodrigues,, 2002).

Due to the complexity of events, fatigue may occur due to the failure of one or all physiological systems and may be from the participation of the central nervous system (CNS) to the contractile machinery. However, most of the researches have not considered the possible interrelations between the systems, presenting a possible physiological system responsible for the fatigue, e.g., the cardiovascular system or the CNS (Sahlin, 1992).

As the body is made up of parts that are connected and work in synergy, and therefore cannot be isolated, it is thus a unit and what happens in one part affects the whole. Excessive fatigue can cause overload, and it is interesting that it also marks an underload; thus, factors such as boredom and monotonous work are sources of fatigue. It is highlighted that a monotonous and boring job causes more fatigue than an interesting one, and has detrimental implications and impact in the viewpoint of quality of work or the health of the performer. A study conducted by Noriega et al. (2004) demonstrated that fatigue had a 5.8 times higher risk in workers who had little creative work than in those who had a higher content of work.

2.1. Cognitive Ergonomics

The introduction of new technologies requires operators to solve tasks that rely more on reasoning than physical engagement. Salles (2008) presented and analyzed the various aspects on this technical electricity sector, such as the aspects of cognitive ergonomics and its contribution in the areas of reasoning, comprehension, and memory, among others. The task of the operators is to the prevention of incidents that disturb the normal course of the process or production stage where they work, or when it is no longer possible, try to make the process return to normal, i.e., the so-called recovery. They have to do this by mobilizing knowledge and reasoning for which they have received training, which, under the terms of the existing rules, are adequate; however, there are some factors that need to be improved as there are still accidents and incidents mainly caused by fatigue or concentration.

With regard to the reasoning used by operators to solve the problems of operation and control, it has been studied primarily through verbalizations resulting in a situation of simulation and much rarer cases, making the operators narrate their activity.

Figure 1 shows a typical room of an electric power control center, where there are individual monitors in the background as well as monitors, boards, and general monitors system. There is a complex information system where the operator is at the heart of the decisions between multiple monitors and tables and diagrams that take up the entire field of vision.

Figure 1. The Typical Room of the Electric Power Control Center

According to Vidal (2008), the role of regulation is the property that a system must remain operational in a given period of time. Regular, therefore, means adapting the operation of a system to its internal and external environment. They occur as a response of the systems to environmental changes that conflict with their goals of selecting the tasks and ordering them in time to fix the malfunctioning. The application of ergonomic analysis of mental activity aims at bringing the requirements of the cognitive task of the user. Cognitive ergonomics to reduce the effort requires understanding and development of the task, facilitating the mental process for decision making, and execution of certain action (Salles, 2008). In the analysis of cognitive activity, the cognitive demands will be identified and expressed by the worker to perform a work activity. Usually, the operator relies on methods that are not prescribed as well as on the variability of the working conditions, which require the operator to design and adapt various strategies and mental processes for the implementation of the action (Santos, 1991 apud Salles, 2008). Studies on the interrelation of work and cognitive analysis are the subject of several research technical papers (Hollnagel, 1997; Marmaras, 1999 and 2001; Hutchins, 1995; Weill-Fassinal., 1990).

2.1. Mental Workload

The concept of workload originally derived from studies of occupational psychology, but was later taken up and developed by ergonomics. It covers the physical effort, the cognitive and psychoaffective (emotional) to meet the demands of the task and is divided into physical and psychic pressure. On the other hand, the physical workload is mainly due to the technical requirements for processing the work object and can be present both in the workplace and outside it, where it is cited as an example, noise, temperature and lighting. On the other hand, the mental burden is related in a general way to the stress or psychological unbalance in the organization. The concepts of mental workload are related to cognitive ergonomics, since this branch deals with the cognitive aspects related to the task through the cognitive architecture that involves the description of the different elements that constitute the cognitive system and their relationships. Mental workload refers to the workload related to psychological and cognitive aspects of the task (Meijman *et al*. 1997, Murata *et al*., 2005). The association between mental workload and cognitive architecture was proposed by Richard (1990) and can be seen in Figure 2.

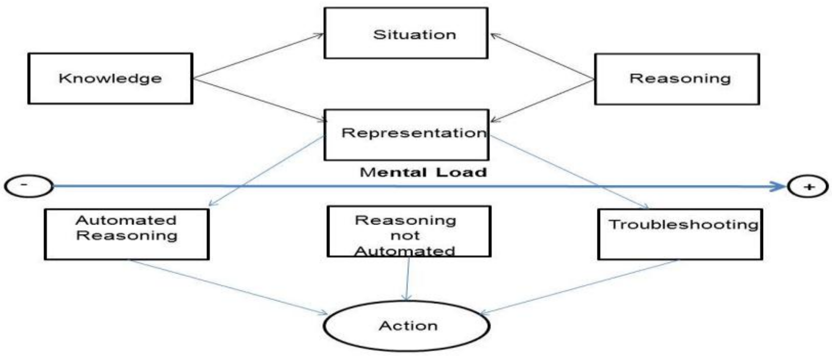

Figure 2 - Cognitive architecture associated to mental workload concept.

In the model presented, the consideration that automated reasoning has a mental burden lower than those associated with resolving problems. This initial guess can be confirmed or not in a particular work situation.
In the Electric Power Control Centers there is a basic activity functioning surveillance system, where it is essential to make decisions and process information continuously. For this, there is a common mental request of personnel involved in these operation centers because of the need to maintain attention, memory and reasoning request (Ku et al., 2010). They have to do it by mobilizing knowledge and reasoning for which they received training, which under the terms of the current standards are adequate, however, there are some factors that need to be improved, there are still incidents and accidents, caused mainly caused by fatigue, lack of concentration or due to inadequate operator and computer screen (Carvalho et al., 2005).

3. MATERIALS AND METHOD

This research was a descriptive study, and its results were analyzed quantitatively comprising 27 operators. It was analyzed in four Electric Power Control centers in Northeast Brazil in the cities Recife; Joao Pessoa, Campina Grande and Natal.
The instrument used was the National Aeronautics and Space Administration Task Load Index known as the NASA-TLX (NASA, 2008), developed by the NASA Ames Research Center in 1986, after 3 years of studies involving over 40 laboratories research and flight simulations. The NASA-TLX method works with physiological indicators associated with subjective methods in situations simulated in the laboratory or in real situations and operational work, taking great advantage of being applicable to various operators and activities without the need of change in its structure. The NASA-TLX was developed from the concept of mental workload of standard DIN 33405:1987-02s predecessor, in accordance with standard ISO 10075.

It is a multidimensional assessment procedure that gives an overall score of the workload based on a weighted average of the scores obtained in the six factors of NASA-TLX scale. These six factors are as follows: levels of achievement, effort and frustration, which have strong influence from the characteristics of individual operators, and the requirements of mental, physical, and time factors that are determined by the work situation (NASA, 2008).
With regard to satisfaction with the performance of the staff, the level of effort with respect to how much one has to work physically and mentally to achieve a good performance, as well as the level of frustration, there are factors that inhibit the performance of work, such as insecurity, irritation, lack of stimulation, and setbacks are important. On the other hand, the mental requirement involves mental activity needed to complete the work, and the physical requirement corresponds to physical activity required for the performance of work requirement and time on the level of pressure needed to achieve the same as shown in the Table 1.

Table 1 - Factors considered in the NASA-TLX Instrument

Factors considered	Low Limit	High Limit
Mental Demand	Tasks considered easy, simple, goals achieved without difficulties	Tasks difficult, complex, requiring much mental effort to achieve the goal
Physical Requirement	Light, slow, easily accomplished tasks	Heavy, quick, strong, and lively tasks
Temporal Requirement	Slow and relaxed pace, with low pressure to the termination of activities	Fast and furious pace, with lots of pressure for completing the activities
Level of Effort	You feel very happy and are praised when it reaches the goals	You become no satisfied and almost no one notices your work
Level of Achievement	For the task to be performed successfully, surface concentration, muscle strength light weight, and simple reasoning are required (lack of skills)	Deep concentration, muscle strength, intense, complex reasoning, and great skill are needed
Level of Frustration	You feel safe, happy, and relaxed when you run the task	You feel insecure, discouraged, angry, and bothered with the task

4. RESULTS AND DISCUSSION

The overall weighted average ranged from 8.81 to 17.77 (MV= 14.24, SD = 4.40). In order to obtain an overview of the overall scores given by the weighted sample, descriptive analysis was performed, as mean, standard deviation and quartiles according to Table 2.

Table 2 - Score of the Results

Weighted Overall Rate (WOR) Areas	Applied Range (AR)	N	Mean Value(MV)	Distribution points that divide the quadrants			Standard Deviation (SD)
				25%	50%	75%	
Mental Demand	1–20	27	17,77	17,00	19,00	20,00	3,77
Physical Requirement	1–20	27	10,25	7,00	11,00	13,00	5,36
Temporal Requirement	1–20	27	17,00	17,00	19,00	20,00	4,39
Level of Effort	1–20	27	15,88	14,00	16,00	19,00	4,04
Level of Achievement	1–20	27	15,74	15,00	16,00	19,00	4,46
Level of Frustration	1–20	27	8,81	5,00	10,00	14,00	5,21
WOR	1–20	27	14,24	12,5	16,20	18,00	4,40

The higher the average Mental Requirement (MR), the more the individual feels that demand in the workplace. The average was 17.77 MR. The distributions of scores by percentile shows that 75% of the sample has a score of 20.00. Taking into account that the scale of the domains varies from 10 to 20, the mid-point (which represents a point of indifference or neutrality) is 19.00, scoring 19.00 indicates that 75% of the sample has high scores in MR.
With regard to the Physical Demands (PD), we found that 25% of the sample has to score 7.00. Thus, one quarter of the sample has low scores. Half of the sample (50%) had scores of up to 11.00, which equates to a low score on a scale ranging from 1 to 20. The average PD is 10.25. It is observed that the demand for physical effort is indeed very small, since most of the time the operators are sitting, they stand only in certain situations to monitor the machines or when directed into the courtyard to perform inspections on equipment.
With regard to the Temporal Requirement (TR), it is in general the average of 17.00 which shows high levels of mental demands. This is confirmed by the distribution by quartile, while 25% of the sample has to score 17.00 in the scores of temporal requirement. Half of the distribution has to score 19.00. Thus, the sample of operators has high time requirements. The Level of Effort (LE) brings together the physical and mental demands and the study has an average of 15.88. It is observed that 25% of the sample has scores up to 17.00, thus, one quarter of the sample has moderate score,

50% of the sample have scores to 19.00. As mental demands present high values, while the physical demands, low values, there is a level of effort to moderate score.
The distribution of scores by quartile shows that, with respect to Level of Achievement (LA), 25% of the sample has a score of 15.00, while 75% has a high score of 19.00. The average of 15.74 shows a high score. We conclude that the operators are happy when they successfully perform the activities they are intended.
Level of Frustration in the field (LF), 50% of the sample has a low score of 10.00 and scores of 75% of the sample is 14.00. As a result, operators have low values in relation to the level of frustration in this way; they feel safe when they realize their work. This security may be a consequence of routine training that the company does, thus giving subsidies to employees to perform their activities.
In this light, it appears that among the analyzed categories that make up the overall rate the highest weighted average corresponds to Mental Requirement ($\overline{X}$ = 17.77), followed by Temporal Requirement ($\overline{X}$ = 17.00). The lowest averages relate to Physical Requirements ($\overline{X}$ =10.25) and the frustration level ($\overline{X}$ = 8.81).

5. CONCLUSIONS

- The measurement of the mental requirements average level was high EM=17.77 (range 1.00 to 20.00). The distribution of scores by percentile shows that 75% of the sample has maximum score to EM=20.00;
-With this method there will be subsidies for an assessment of mental workload and ergonomic aspects of the operators at the Electric Power Control Centers;.
- One way of mitigation should be done through counseling by an occupational medicine management;
- With these data, there will be a contribution to the operation management of the electric utility company, a better work quality and consequently a lower probability of operator error.

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Ergonomic Problem Analysis: Applying the Rapid Upper Limb Assessment Method in a Hospital of the Paulo Afonso/BA/Brazil

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ABSTRACT

Nowadays the ergonomic studies have contributed to the physical and mental well-being workers in different sectors of the economy with the development of experiments and practical applications through the progress of the various areas which came to contribute with the ergonomics. Therefore, this paper aims to carry out some important considerations about the action and the ergonomic implications of the workloads in order to emphasize the ergonomic problems in the financial department of a hospital in the city of Paulo Afonso/BA/Brazil analysing possible inadequacies of the environment and suggesting some recommendations. To analyse the situations that cause injury or work-related absences, we used the technique ergonomic Rapid Upper Limb Assessment (RULA). The results show the importance and need for ergonomic intervention in the hospital in order to minimize possible causes of worker absenteeism due to occupational accidents, increasing productivity and welfare in the organizational environment.

Keywords: ergonomic; Rapid Upper Limb Assessment; occupational accidents.

1. INTRODUCTION

The socioeconomic and technological changes which are developing themselves in the world, including in the field of labor, sets a scene of several transformations. The concern of the companies in increasing productivity makes the working conditions in second plan and while these changes occur, it will carry a burden to workers. Today's ergonomic studies have contributed to the physical and mental well-being of workers in various sectors of the economy.

As defined by the International Ergonomics Association (IEA), 2000, ergonomics is "the scientific discipline which studies the interactions between humans and other elements of the system and the profession that applies theory, principles, data and methods in order to optimize human welfare and the overall performance of systems. Ergonomics can be subdivided into the following specialized areas: physical ergonomics, studying the adaptation of working to physical activities, the cognitive ergonomics, which studies the relationships between people and other elements of a system and the organizational ergonomics, studies the relationship between workers and the organizational structure in which they live. The work has an ergonomic feature interdisciplinary and multidisciplinary because it is based on several areas of human knowledge applied in the adaptation of the workplace and the organizational environment.

According to Falzon (2007), ergonomics aims to meet two main objectives: a people-centered (safety, health, comfort, ease of use, satisfaction and interest in working) and another focused on organizations and their performance (efficiency, productivity, quality, reliability). Cordeiro (2006) presents an analysis in which ergonomics is targeting the improvement of specific working conditions of men whatever their line of action, strategy and methods used.

Thus, his basic proposal is to establish a pattern of interaction between man and his work in a healthy way without the detriment of his health. As a result, the search for quality of working life has been driven by several factors such as physical and mental fatigue, excessive working hours, which ends in influencing high rates of accidents.

Therefore, this paper aims to make some important considerations about ergonomics and the implications for the loads of working in order to emphasize ergonomic problems in the financial department of a hospital in the city of Paulo Afonso/BA/Brazil, analysing possible inadequacies of the environment and suggesting some recommendations, through the identification and analysis of the situations which cause injury or work-related absences, using the technique ergonomic Rapid Upper Limb Assessment (RULA).

2. MATERIALS AND METHOD

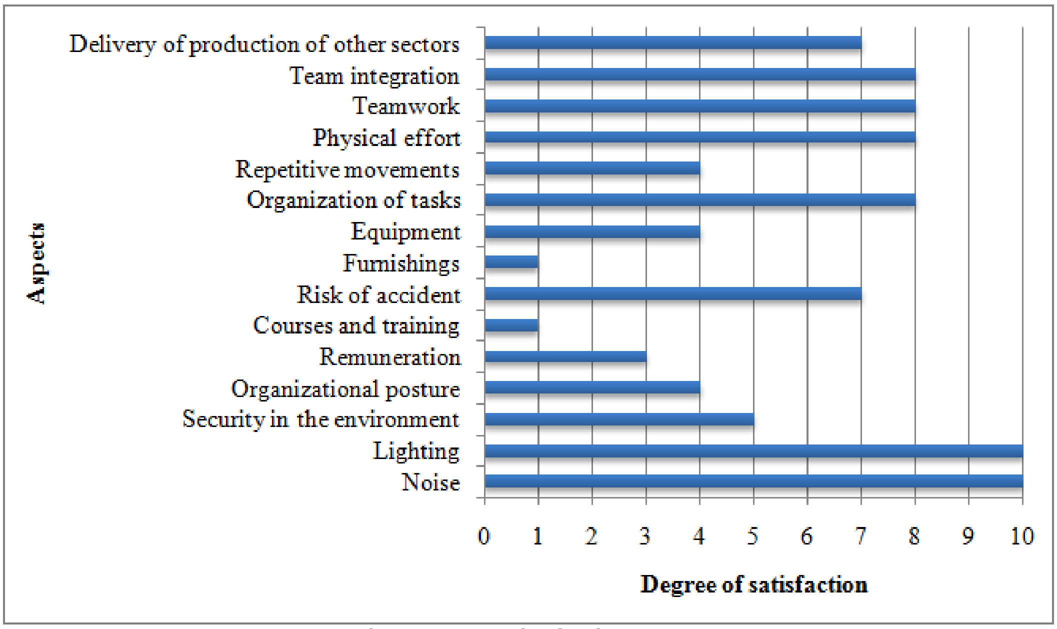
This study was conducted at the Hospital Nair Alves de Souza (HNAS), a mixed economy company, located in the city of Paulo Afonso/BA/Brazil, which is subsidized by the São Francisco Hydroelectric Company (CHESF). The hospital carries out public services, such as treatment of the Unified Health System (SUS). It currently has about 400 employees spread throughout the hospital. Among many existing departments, the option is to work with the financial department of the institution which has an excessive load of activities because it is the sector where all procedures are received from all areas and that are transformed into medical bills based on table pre-established by the SUS, detailing their values and professional. All these processes happen in short periods, since their presentation is given monthly and with deadlines set forth in the official calendar which ends up generating a tiring routine for the team. The survey was conducted during the months of September, October and November 2010, and to get the data it was performed some interviews with team coordinator and application of questionnaires to other employees, monitoring the execution of activities and analysis of the physical environment, all this in order to identify musculoskeletal risks arising from operations.

For data analysis was adopted the ergonomic method known as RULA. According Hembecker (2006), this method was developed by Mc Atamney and Corlett, in 1993, aiming to be used in ergonomic assessments general of workplaces where there are possibilities of developing musculoskeletal disorders of the upper limbs. According to Pavani (2007), this assertion is evidenced by the fact that the main result of the method is to identify the need for a deeper analysis of specific risk factors with other methods of higher sensitivity, being a research tool generic as other checklists. The method has three distinct phases: the first is identification of working postures, the second is the implementation of scoring system, and the third is the application of a scale of levels of performance. The application of this methodology is through the analysis and record of the different postures of the work, being sorted by a scoring system, using posture diagrams of the body and tables that assess the risk for exposure to factors of the external loads.

The materials used for this work were: balance for verifying the body mass of the employees and weight materials which are carried by them; stopwatch for checking the number of repetitions per minute; camera for photographic records. The RULA method, mentioned previously, provides a classification system based on pre-established parameters, which enables expose some critical points arising from the number of movements, static posture, strength, posture, among other factors that contribute to occupational diseases (MC ATAMNEY and CORLETT, 1993).

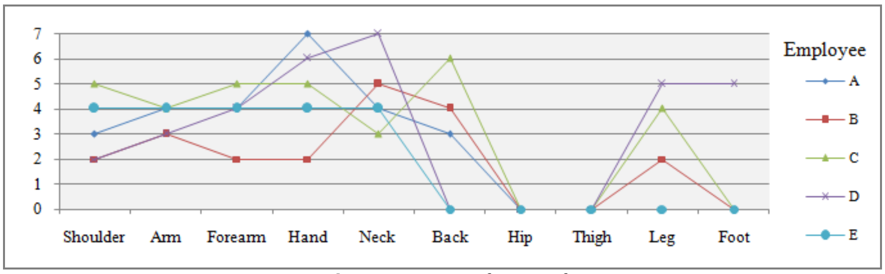
3. RESULTS AND DISCUSSION

The financial sector, target of the study, runs from Monday to Friday in 8 hour shifts and is composed of five employees, later identified as A, B, C, D and E, distributed in the following roles: coordinator, administrative assistants and typists. In interview with the coordinator, some aspects were analysed in relation to the environment, based on the group's overall satisfaction, scoring on a scale from 0 (dissatisfied) to 10 (satisfied). According to the results obtained, it was found that the company should invest more in the following aspects: furnishings, courses and training, remuneration, organizational posture, equipment and the repetitive movements, as shown in Graphic 1.



Graphic 1 – Aspects related to the organization.
Source: Prepared by the authors.

Analysing the graphic, it is observed that some factors obtained scores below 5, indicating a probable dissatisfaction of workers in the environment in relation of these aspects, which in the opinion of employees, are points that need improvement to increase overall satisfaction. In order to determine those regions where employees feel more discomfort, a survey was developed with employees to identify these issues, where for this purpose we used a scale from 0 (comfortable) to 7 (totally uncomfortable), as shown in Graphic 2.



Graphic 2 – Regions of Discomfort.
Source: Prepared by the authors.

The results showed that the regions in which employees feel more discomfort are the upper limbs. To assess the level of nuisance was used the RULA method. The tasks performed were evaluated according to criteria based on Table 1.

Table 1 – Indicators with their perception and punctuation of the RULA method.

Indicator	Perception	Scale	Punctuation
Muscle strength	Light Moderate Serious	Less than 2 kg From 2 to 10 kg Above 10 kg	1 2 3
Static contraction	Ligth Moderate Serious	Under 10s 10s to 1 min Over 1 min	1 2 3
Number of Movements	Light Moderate Serious	Less than 4 breaths/min 4 breaths/min More than 4 breaths/min	1 2 3

Source: Mc Atamney and Corlett (1993).

The critical points identify the most suitable indicator during execution of work and what level of perception of the employee, being assigned punctuation from 1 to 3. The evaluation was obtained according to the results of the sum of points for each task. It is worth mentioning that the higher the number, the greater the risk of injury. The activities performed in the sector are detailed in each step to their execution, were then tabulated according to the information set out in Table 1. Next, it was analysed the activities performed by employees. The employee A performs the tasks to collect and give low in the medical records, and the withdrawal of synthesis reports and daily record of hospital admissions.

Table 2 – Evaluation of the activities performed by the employee A.

Task	Development	Indicator	Points	Total
Collect medical records	a) Collecting in the clinics.	1 2	2 **3**	5
Giving low in the medical records	a) Removing the staple of medical records b) Organizing the medical records c) Withdrawing the synthesis d) Removing the reports e) Stapling the medical records f) Filling the medical records g) Sending to the sector of the file	1 2 3	2 2 **3**	7
Withdraw Synthesis	a) Filling in the patient data b) Making notes relating to internment c) Sending to the employee B of the sector	1 3	1 2	3

Source: Prepared by the authors.

Table 2 – Evaluation of the activities performed by the employee A (continuation).

Task	Development	Indicator	Points	Total
Withdrawal of Report	a) Filling in the required fields b) Putting the codes of practice c) Stamping the reports d) Sending to the health secretariat of the municipality	3	**3**	3
Daily Record of hospital admissions	a) Recording the entry of patients	3	**3**	3

Source: Prepared by the authors.

Analysing Table 2, it is realized that all tasks showed scores three, indicating a serious perception. The risk is quite high, which explains the discomfort illustrated in Graphic 2. The employee B performs the task of archive the synthesis, forward reports to the Municipal Health Secretariat, attaching summaries, check the reports and prepare letters.

Table 3 – Evaluation of the activities performed by the employee B.

Task	Development	Indicator	Points	Total
Archiving the synthesis	a) Separating alphabetical order b) Sorting in date order c) Storing the synthesis	2 3	1 **3**	4
Send to Department of Health of the Municipality	a) Forward reports to the authorization of the hospital admission - AIH b) Finding the IAI Authorized in Secretary of Health	1	1	1
Attach the synthesis	a) Separating the AIH in alphabetical order b) Attaching the corresponding syntheses c) Separating reports by specialty d) Distributing reports to employees D and E	2 3	1 **3**	4
Conference of the Reports	a) Checking the information b) Checking the values c) Performing the necessary adjustments	3	1	1
Elaborate the Letters	a) Typing the documents b) Checking the documents c) Forward to management	2 3	2 **3**	5

Source: Prepared by the authors.

In this case, only the task "send reports to the Municipal Health Secretariat" presented the punctuation 1, the others presented punctuation 3. Although not all tasks present the incidence of the indicators with scores 3, this does not indicate that the employee is immune from injury. The employee C performs the tasks of receiving and conference records Ambulatory Emergency Care (EAP), typing of the EAP and preparation of the monthly summary of the procedures performed.

Table 4 – Evaluation of the activities performed by the employee C.

Task	Development	Indicator	Points	Total
Receive EAP	a) Confers the control	3	**3**	3
Typing the EAP	a) Taking the mouse b) Typing the Nº. PAA c) Typing the age d) Typing the date of hospital attendance e) Typing all procedures f) Typing the physician g) Typing the Municipality of the patient	1 2 3	1 2 **3**	6
Monthly Summary	a) Separating procedures by category b) Putting the values of each procedure c) Putting the total value d) Identifying the professionals e) Doing the productivity of the physician f) Submitting the report to the employee E	1 3	1 2	3

Source: Prepared by the authors.

The amount of PAA billed each month is 7,443, which equates to an average of about 250 chips per day, so it is clear that the employee performs repetitive movements for several minutes daily. The employee D performs the tasks of separation of the authorization of the hospital admission (AIH), preparation of the mirror (which is to write the number of medical records, transcribe patient data, write down the codes of procedure, fill in the details of the professionals involved and codes of the exams realized), typing the reports, prepare and submit the simulated (summary of each AIH) and answer the phone.

Table 5 – Evaluation of the activities performed by the employee D.

Task	Development	Indicator	Points	Total
Separation of the AIH	a) Separation of the procedures	3	3	3
Preparation of the mirror	a) Writing the number of medical record b) Transcribing patient data c) Writing down the codes of practice d) Completing the CPF of the professionals involved e) Writing down the codes of the examinations	2 3	2 3	5
Typing the reports	a) The type AIH b) Checking the errors c) Fixing the errors d) Listing of the reports e) Generating the archive f) Submitting to the employee E g) Carrying out the prediction of workers' productivity h) Delivering to the employee E	2 3	2 3	5
Prepare and submit the simulated	a) Attaching simulated in the AIH b) Forward to the medical file	1 3	1 3	4
Answer the phone	a) Answering the phone	2	2	2

Source: Prepared by the authors.

It was noted that almost all the tasks had punctuation 3. In relation to the employee E, it performs the tasks of separation of AIH, preparation of the mirror, typing of reports, generation of report production (GAP), preparation the report and refer the simulated.

Table 6 – Evaluation of the activities performed by the employee E.

Task	Development	Indicator	Points	Total
Separation of AIH	a) Separating of the procedures	3	**3**	3
Preparation of the mirror	a) Writing the number of records b) Transcribing patient data c) Writing the codes of the procedures d) Filling in the CPF of the professionals involved e) Writing down the codes of the examinations	2 3	2 **3**	5
Typing of reports	a) Typing the AIH b) Checking errors c) Fixing the errors d) Listing the reports e) Creating the file f) Referral to the health secretary g) Carrying out the prediction of productivity	2 3	2 **3**	5
Generation of report production (GAP)	a) Receiving reports from the other sectors b) Receiving the report of the employee C c) Typing the GAP d) Generating the file e) Referral to the health secretary	3	**3**	3
Preparation the report	a) Receiving the productivity of Employee C and D b) Adding of the productivity of employee C and D c) Delivering to the employee B	2 3	2 **3**	5
Refer the simulated	a) Attaching simulated in the AIH b) Forward to the medical file	1 3	1 **3**	4
Answer the phone	a) Answering the phone	2	2	2

Source: Prepared by the authors.

Almost all tasks present punctuation 3. By applying the method RULA was possible to identify critical activities, where in the moment that employees perform these activities can have a great chance to generate injuries or disorders. Besides these factors, the employees of the HNAS cite as ergonomic problems the temperature of the working environment and the workload of 8 hours, being considered much excessive for those who develop the typing. The suggestion is that this workload is reduced to six hours and the furniture is appropriate anthropometric height of each employee, improving the temperature of the workplace, through the implantation of fans and air conditioners.

4. CONCLUSIONS

The RULA method has contributed significantly to the identification of critical activities, evaluating the exposure of individuals to risk factors related to diseases of the upper limbs.

During the analysis of the activities, it became clear that most of the tasks performed presented degree three at least in one of the indicators, which explains the discomfort in the upper limbs, increasing the risk of occupational diseases. In relation the tasks performed by the finance sector, the majority it is done manually, seen that many information regarding the patients are made by various sectors, including the sector in question, i.e., the data related to the patient are filled in the reception, books of occurrences of the clinic that the patient was admitted and in the register of the Medical Staff, beyond the book of the sector of finance, this redundancy could be reduced with an integrated system would that reduce the number of repetitive strain and the volume of paper used for this purpose.

Another important factor is related to incompatible furnishings, both directly to the employee, as to the activity attributed to him by the company. It is concluded that using the method adopted was possible to identify the most critical activities related to muscle strength, static contraction and the number of moves, being identified as serious the administrative activities in general of the sector analysed.

It is worth mentioning that the data is early, but through them we could see how ergonomic studies are of fundamental importance for the improvement of working conditions, contributing to the increased operational efficiencies.

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Work-related Musculoskeletal Disorders among Portuguese Physiotherapists

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ABSTRACT
Work-related musculoskeletal disorders are a common and increasing problem. Physiotherapists perform physically challenging and risky tasks for acute or cumulative injuries. A cross-sectional design was used for this study to identify the prevalence of work-related musculoskeletal disorders in Portuguese physiotherapists and to identify possible causes for the onset of disorders, the activities behind their origin, the implications to physiotherapist's work, the prevention strategies used by these professionals and to find possible associations between work-related complaints, gender and clinical placement. A two-part self administered instrument was used in this study, a demographic questionnaire and a standardized Nordic questionnaire. Information such as age, gender, clinical experience, number of patients treated daily, daily working hours, clinical placement, prevention strategies used, implications of symptoms in working experience and possible causes and activities for injuries and the occurrence of musculoskeletal complaints in the last 12 months was gathered. Reported 12 month prevalence was 89,4%, younger and less experienced Physiotherapists were the most affected. Probable causes were the use of force when performing tasks, fatigue and working in awkward postures. The most reported patient-care activities related to the injuries were the use of manual therapy techniques and lifting and transferring patients. The presence of musculoskeletal disorders affected the work capacity of physiotherapists. The most affected anatomical regions were the neck and the lower back, female physiotherapists have higher prevalence of neck disorders, physiotherapists working in musculoskeletal placement have higher prevalence of upper back disorders and physiotherapists working in neurology placement have higher prevalence of disorders in the lower back ($p \leq 0{,}05$). Prevalence of musculoskeletal disorders is high among the studied subjects and affects mainly younger, with less professional experience and female physiotherapists. Patient lifting and transferring and the use of manual therapy techniques are the most commonly pointed causes of injury.

Keywords: Musculoskeletal disorders; Prevalence; Occupational Health; Physiotherapy.

1. INTRODUCTION

The term "Musculoskeletal Disorder" is a generic term used in literature to identify several injuries that might affect muscles, ligaments, tendons, nerves, joints and blood vessels related to movement. Musculoskeletal disorders refer to a large spectre of injuries that might have sudden or insidious onset of symptoms and might affect an individual for a short period of time or for the whole life (Bernard, 1997; Sanders & Dillon, 2006; Sanders & Stricoff, 2006; Woolf & Pfleger, 2003). This group of disorders is extremely common, affects strongly both individuals and society, are one of the major causes of diseaase burden around the world and have been a significant reason for the development of the Bone and Joint Decade, an iniciative of the World Health Organization (Brooks, 2006) prolonged to 2020 as it is yet to fulfill the goals that were proposed initialy (Atik, 2010).

Although largely studyed and discussed among several investigators work-related musculoskeletal disorders (WRMSD) are still very common and increasing (Franco, 2010, World Health Organization, 2003).

Acording to Bork et al. (1996) physiotherapists perform activities like transferring patients, assiting patients in gait, provideng manual resistance, assisting with mat activities and lifting heavy equipment. These are activities that put professionals at risk for acute or cumulative WRMSD.

Past studies have used different measures of prevalence. Lifetime prevalence, 12-month prevalence and one-week prevalence have been used to acesss the magnitude of WRMSD among physiotherapists (Adegoke, Akodu, & Oyeyemi, 2008; Bork et al., 1996; Cromie, Robertson, & Best, 2000). The prevalence of WRMSD in physiotherapists reported in the literature is dependant of the method chosen for the different studies but regardeless of the methodology adopted, the prevalence has been found to be high, varying between 48% and 91% (Adegoke, Akodu, & Oyeyemi, 2008; Alrowayeh et al., 2010; Cromie, Robertson, & Best, 2000; Glover, McGregor, Sullivan, & Hague, 2005; Holder et al., 1999; Nordin, Leonard, & Thye, 2011).

Age, gender and clinical placement were pointed to influence the prevalence of WRMSD among physiotherapists (Glover, et al., 2005; Nordin, et al., 2011) but Alrowayeh, et al. (2010) states that the frequancy of disorders was only influenced by these factores in specific pain sites.

Job tasks in physiotherapy are physically challenging and further research is needed to determine and address the effects of work-related physical demands on physiotherapists. Therefore, the objective of this study is to identify the prevalence of WRMSD among Portuguese physiotherapists since data related to several countries was found but no study, to our knowledge, addressed this problem in Portugal. The study aims to identify the possible causes involved in these disorders, the activities behind their origin, the implications to physiotherapist's work, the prevention strategies used by these professionals and to find possible associations between work-related complaints, gender and clinical placement.

2. MATERIALS AND METHOD

2.1. Participants

Physiotherapists working in several clinical placements (e.g. neurology, musculoskeletal, cardiopulmonary) were recruited using convenience sampling method from private institutions in the northern region of Portugal. Sixty questionnaires were delivered and all participants read and signed the informed consent for this study.

2.2. Research Design

A cross-sectional design was used for this study.

2.3. Instrumentation

A two-part self administered instrument was used in this study. One part was a demographic questionnaire, used to obtain information such as age, gender, clinical experience, number of patients treated daily, daily working hours, clinical placement, prevention strategies used, implications of symptoms in working experience and possible causes and activities for WRMSD. The second part was a standardized Nordic questionnaire used to access the occurrence of musculoskeletal complaints. The questionnaire divides the human body into nine anatomical regions (neck, shoulder, elbow, hand/wrist, upper back, lower back, hip/thigh, knee and ankle/foot) and includes a diagram with the anatomical regions clearly marked (Kuorinka et al., 1987). The Nordic questionnaire was used in simmilar studies (Alrowayeh et al., 2010; Nordin, Leonard, & Thye, 2011) and a Portuguese version, adapted and published by Serranheira et al. (2003).

2.3. Procedures

After institutional consent was provided, sixty copies of the instrument were distributed among the participants who were recruited by convenience sampling. Answers were provided to all questions the subjects thought necessary and the completed copies of the instrument were collected by the same person that distributed them.

2.4. Data Analysis

Statistical analysis was made using the software Statistical package for the Social Sciences, version 18 for Windows. Descriptive statistics were used to estimate the prevalence of WRMSD and demographic characteristics. Frequencies and cross-tabulations were used to compare WRMSD between demographics and work setting. Chi-square tests were used to assess the relationship between gender and clinical placement on affected anatomical regions defined by the Nordic questionnaire. Statistical significance was set at α=0,05.

3. RESULTS AND DISCUSSION

Out of a total of 60 questionnaires distributed, 13 (21,7%) were not returned, thus giving a percentage of response of 78,3%. The 47 respondents comprising 70,2% (n=33) females and 29,8% (n=14) males had a mean age of 31,1 years, with ages varying between 22 and 57 years. Physiotherapists reported an average of 8,6 years of practice (ranging from 6 months to 34 years), an average of 7,9 working hours per day (ranging from 2,5 to 12 hours) and an average of 28,7 patients treated daily (ranging from 6 to 64 patients). Socio-demographic characteristics of participants are presented in table 1.

Table 1 – Socio-demographic characteristics of participants

Characteristics	
Gender (n=47)	
male	14
female	33
Age (years) (n=47)	
mean±sd	31,1±7,4
range	22-57
Years of experience (years) (n=47)	
mean±sd	8,6±7,7
range	0,6-34
Daily working hours (hours) (n=47)	
mean±sd	7,9±2,2
range	2,5-12
Patients treated daily	
mean±sd	28,7±13,5
range	6-64

Physiotherapists in this study reported working in more than one clinical placement and musculoskeletal was the most reported, followed by neurology and cardiopulmonary as seen in table 2.

Table 2 – Current clinical placement of respondents

Clinical Placement	N(%)
Musculoskeletal	44 (93,6)
Neurology	33 (70,2)
Cardiopulmonary	27 (57,4)
Pediatrics	20 (42,6)
Obstetrics and Gynecology	2 (4,3)
Other	11 (23,4)

Out of the 47 respondents, 44 (93,6%) have reported WRMSD at some point of their careers. When inquired about the last 12 months, although 42 (89,4%) reported WRMSD only 7 (14,9%) had to be absent from work. Higher lifetime prevalence of WRMSD was observed in physiotherapists younger than 40 years and with less professional experience as seen in table 3.

Table 3 – Lifetime prevalence of WRMDs according to demographic characteristics

		Lifetime Prevalence	
Variables		**Yes N (%)**	**No N (%)**
Overall respondents		44 (93,6)	3 (6,4)
Gender	Male	12 (85,7)	2 (14,3)
	Female	32 (97,0)	1 (3,0)
Age	<40	40 (95,2)	2 (4,8)
	≥40	4 (80)	1 (20)
Work experience	≤5	21 (95,5)	1 (4,5)
	5<12	11 (91,7)	1 (8,3)
	≥12	12 (92,3)	1 (7,7)

Although the usefulness of lifetime prevalence of WRMSD is not being questioned, an accurate appreciation of the severity of the injury using a retrospective study is difficult so we focused on the impact of WRMSD within the last year. The respondents' recall of injury is likely to be fresh, increasing the accuracy of the results. Table 4 shows the results obtained in our study for the 12 month prevalence of injuries in each anatomical region.
The most affected anatomical region is the neck (83,3%), followed by the lower back (64,3%) and the shoulders (61,9%) and the least affected anatomical regions were the ankles/feet (11,9%) and the hips/thighs (9,5%).

Table 4 – 12 month prevalence of WRMSD in the studied anatomical regions

Anatomical region	N(%)
Neck	35 (83,3)
Shoulders	26 (61,9)
Elbows	11 (26,2)
Wrists/hands	20 (47,6)
Upper Back	17 (40,5)
Lower Back	27 (64,3)
Hips/thighs	4 (9,5)
Knees	12 (28,6)
Ankles/feet	5 (11,9)

Physiotherapists in this study reported working in more than one clinical placement. The most reported clinical speciality was musculoskeletal (93,6%), followed by neurology (70,2%). Looking at the relationship between the clinical placement and anatomical regions, musculoskeletal and neurology were found to be related with higher prevalence of WRMSD in the upper back and lower back, respectively (table 5).

Table 5 – Clinical placement influence in anatomical regions affected by WRMSD

p values (Chi-square) related to anatomical regions and clinical placement analysis			
Anatomical Regions	**Musculoskeletal**	**Neurology**	**Cardiopulmonary**
Neck	0,295	0,674	0,943
Shoulders	0,429	0,078	0,069
Elbows	0,675	0,586	0,824
Wrists/hands	0,383	0,978	0,770
Upper Back	0,017(*)	0,171	0,170
Lower Back	0,739	0,050(*)	0,770
Hips/thighs	0,111	0,827	0,753
Knees	0,749	0,060	0,154
Ankles/feet	0,188	0,613	0,903

(*) Significant at 95%, $p \leq 0,05$

Gender was found to influence the prevalence of WRMSD (figure 1). Females were more affected than males in all anatomical regions, except in the upper back. Differences were significant in the neck, as seen in table 6.

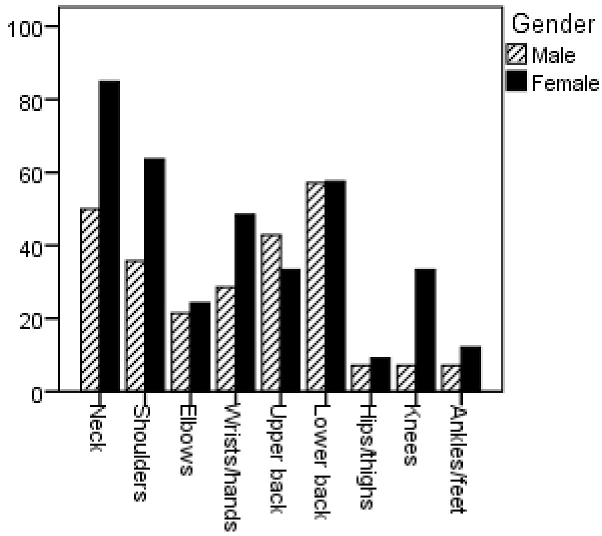

Figure 1 – Gender influence in 12 month prevalence of WRMSD

The most reported perceived causes to WRMSD were the use of force when performing tasks (56,8%), fatigue (50%), working in awkward postures (47,7%) and performing the same task over and over (43,2%) and the most reported patient-care activities related to the injuries were the use of manual therapy techniques (72,7%) and lifting and transferring patients (63,6%).

Table 6 - Gender influence in anatomical regions affected by WRMSD

Anatomical Regions	p value (Chi-square)
Neck	0,012 (*)
Shoulders	0,078
Elbows	0,835
Wrists/hands	0,207
Upper Back	0,534
Lower Back	0,978
Hips/thighs	0,827
Knees	0,060
Ankles/feet	0,613

(*) Significant at 95%

The three most commonly adopted copping strategies among physiotherapists in this study were stop performing the tasks or using the techniques that aggravate or provoke the discomfort (63,6%), increase the use of mechanical aids (45,5%) and asking for the help of colleagues (31,8%).
The adoption of preventive strategies was reported by 35 physiotherapists (74,5%) and the most common strategies adopted were the improvement in body mechanics, the practice of regular physical activity and the use of stretching exercises.
This study found that the prevalence of WRMSD among Portuguese physiotherapists was very high, considering lifetime prevalence (93,6%) and 12 month prevalence (89,4%). The prevalence of disorders previously reported by several studies was lower (Bork et al., 1996; Cromie et al., 2000; Glover et al., 2005; Nordin, et al., 2011). There are however reports similar to ours, like the study of Adegoke et al. (2008). Acording to Bork et al. (1996) the knowledge of this professionals about musculoskeletal health does not protect them from WRMSD.
The neck was the anatomical region with the highest prevalence of disorders (83,3%), followed by the lower back (64,3%). Previous studies report the same regions as the most affected but point to the lumbar spine as having the highest prevalence of WRMSD (Adegoke, et al., 2008; Alrowayeh, et al., 2010; Glover, et al., 2005; Nordin, et al., 2011), except for Cromie et al. (2000) that poin the neck as the most affected region.
Evidence of a high prevalence of WRMSD among physiotherapists working in the musculoskeletal placement is well documented. Cromie, et al. (2000) found that physiotherapists that performed manual therapy techniques on a regular basis were more likely to have had musculoskeletal injuries than those who did not perform manual therapies. Glover et al. (2005) found in their study that clinical setting was significantly related to respondents' most serious injury, which was reported while working with general musculoskeletal outpatients, neurological rehabilitation and elderly care.
In the studies of Bork et al. (1996), Cromie et al. (2000) and Glover et al. (2005), younger physiotherapists, with ages between 20 and 30 years, were pointed as being more prone to develop WRMSD. In our study a descriptive analysis was made and our results are in line with previously reported data.
Professional experience seems to be a factor that deserves attention since physiotherapists with less professional (≤ 5 years) experience had higher prevalence of WRMSD in our study. Similar results were found in the studies of Adegoke et al. (2008) and Glover et al. (2005). Lack of clinical experience and skills might be responsible for these results.
Nordin et al. (2011) stated that lifting and transferring patients and the use of manual therapies were the main causes reported by the subjects to justify the higher prevalence of WRMSD. In our study those were also the most reported patient-care activities that might have cause the musculoskeletal disorders. Adegoke et al. (2008) and Glover et al. (2005) reported other patient-care activities like treating a high number of patients, performing the same task over and over and working in the same position for long periods of time.
As a consequence of WRMSD Cromie et al. (2000) found that 16,7% of the physiotherapists in their study changed clinical placement but in our study only 6,4% had to work in a different clinical setting due to their complaints. Stop performing the tasks that were painful or stop using the techniques that aggravate or provoke the discomfort was the most reported change in clinical practice, followed by an increase in mechanical aids. Adegoke et al. (2008) had also found that physiotherapists changed their clinical practice but Alrowayeh et al (2010 published different results since the majority of respondents have not changed their clinical interventions.
Females were more affected by WRMSD in our study and the results are in line with those of Adegoke et al. (2008) and Nordin et al. (2011).
Only 1 physiotherapist had to take sick leave as a consequence of WRMSD but 25 (53,2%) were treated by other physiotherapists informally. Glover et al. (2005) and Alrowayeh et al. (2010) had also reported similar results. The fact that physiotherapists choose physical therapy as their preferred treatment might explain the lower number of physiotherapists that took sick leave. Physiotherapists tend not to report their injuries to their superiors and to seek informal treatment among peers, keeping the problematic of WRMSD less evident than it actually is and should be encouraged to report their injuries in order to clarify the real impact of WRMSD.
Our results might be related to the daily activity of the physiotherapist, mainly in awkward positions, stressing the spine due to prolonged standing while performing several tasks (Nordin et al., 2011).

4. CONCLUSIONS

This study allowed us to conclude that lifetime and 12 month prevalence among our subjects are high. The neck and lower back are the most affected anatomical regions and the most reported causes were the use of force when performing tasks, fatigue and working in awkward postures. The most reported patient-care activities related to the injuries were the use of manual therapy techniques and lifting and transferring patients. The most commonly adopted copping strategies among physiotherapists in this study were stop performing the tasks or using the techniques that aggravate or provoke the discomfort, increase the use of mechanical aids and asking for the help of colleagues.
Younger physiotherapists, with less professional experience are more prone to be affected by WRMSD, as females and those working in musculoskeletal and neurology clinical placements.
More satisfactory preventive and treatment measures are recommended to minimize the prevalence of WRMSD among Portuguese physiotherapists.

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The management systems and the performance indicators - the integration way

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ABSTRACT
The last decade has seen the worldwide proliferation of management systems standards, preceded by a period of nearly twenty years where the quality assurance systems, which evolved later to quality management systems, were the only ones.
This diversity of standards accompanied the organizations changing needs in the optimization of its subsystems and systematization of management promoted by market imperatives, customer, statutory regulations, the dictates of regulators of the sector, as well as by concerns of efficiency improvements and operational control.
This implied a systematic orientation towards integration of the different management systems. However, in Portugal, after a decade of coexistence of various subsystems, the effective integration is not a current reality. In addition, overlapping and partial integration continues to prevail, either through lack of knowledge or incapacity of those who run the systems, either by structural difficulties of the organizations or even top management options.
However, stakeholders learning process - leaders of organizations, consulting, certification or normalization entities - although with rhythms and different approaches, led to a significant development, both in the aspect of regulatory harmonization and consolidation of intra-organizational practices, as well as use of monitoring tools and performance indicators from the perspective of systems optimization in the service of an appropriate response to the increasing demands of the dynamics of current management.
The data collection methodology used in this study was supported by a set of semi-structured interviews. The results obtained constitute the scope of the analyses and the conclusions of this publication, with crossing findings to other published studies in this domain.
Important findings of this study are that there is not a unique methodology for integration and that there is still an inefficient use of KPI systems for decision support, mainly within the integrated systems.
The critical success factors towards the integration of management systems are essentially inner motivation for the integration and top management commitment as well as competent and professional organization governance, regardless the sectors involved.

Keywords: Integrated management system (IMS); Key performance indicator (KPI)

1. INTRODUCTION

Through the last decade, the expected development of the various systems/subsystems in an organization points to their integration, what was recognized as a positive balance, between the advantages and disadvantages, in adopting this approach.
Given this trend it could be expected orientation of the International Standardization Organization on the development of regulatory frameworks oriented to the integration of management systems. However, the option was to evolve the various standards on its responsibility - determining that the other normalization bodies to do the same - towards the harmonization and alignment in terms of structure and requirements.
It is evidenced by the results of several studies published in this context – Karapetrovic, Willborn (1998), Jorgensen, *et al* (2006), Bernado, *et al* (2008), Sampaio, *et al* (2008), Wilkinson; Dale (2001), Wilkinson, Dale (1999), Zeng, Lou (2007), Zutshi; Sohal (2005), Karapetrovic (2002), Matthias, Coelho (2002) and Seghezzi (2000) – that one of the difficulties of organizations in integrate their management systems results from the understanding of the standards and a harmonized use between them. This explains the initiatives taken by national standards bodies of the United Kingdom, Denmark and Spain towards the development of guidelines for management systems integration (BSI, 2006; DS 8001:2005, AENOR, 2005).
Given this reality, it was identified to be relevant the development of this research project whose aim is to create knowledge in the integration of management systems, oriented to provide to the enterprises, self-assessment tools to evaluate their IMS maturity level and best practice's guide to implement and maintaining an integrated management system - quality, environment and safety (QES) - as well as the definition of guidelines for the establishment of systems performance indicators that support and drive their organizations towards the effectiveness and efficiency of its integrated management systems.

2. MATERIALS AND METHODS

The data collection methodology used was supported by a set of semi-structured interviews, was carried out in two distinct phases.

The first phase was oriented to professionals and entities that have an active and relevant role in QES's Integration Management Systems - third-party auditors, technical committees responsible of national and international standardization bodies for quality, environment and safety management systems, as well certification entities managers and academics with work developed and published in these domains.
The results of the first phase contributed to the selection of the companies with QES`s integrated management systems. This selection constituted the second phase of data collection in this study.
As support tools for the mentioned interviews, have been developed checklists with open and oriented answer questions, related to the development of the systems as well as to the approaches to their implementation, including the use of key performance indicators and its support in decision-making.
The results obtained in the first phase constitute the scope of the analyses and the conclusions of this publication, with crossing findings to other published studies in this domain.

3. RESULTS AND DISCUSSION

The present study results and this discussion focus on twenty third-party auditor's interviews.
This first phase interviews survey covered the following aspects:

- Motivations for management system integration;
- Management system integration difficulties;
- Management systems integration strategy;
- Integrated Management System (IMS) responsibility structure
- Approaches to integration.
- Integrated elements
- Assessment tools;
- IMS maturity analysis;
- Levels of integration;
- Integration evolution;
- Obstacles to a better integration;
- Strategy to integration level improvement.

Data analysis focuses on open questions contents and descriptive statistics for closed ones.

3.1. Motivations for Management Systems Integration

The motivations identified, for integration, were of external nature but mostly of them have internal purposes.

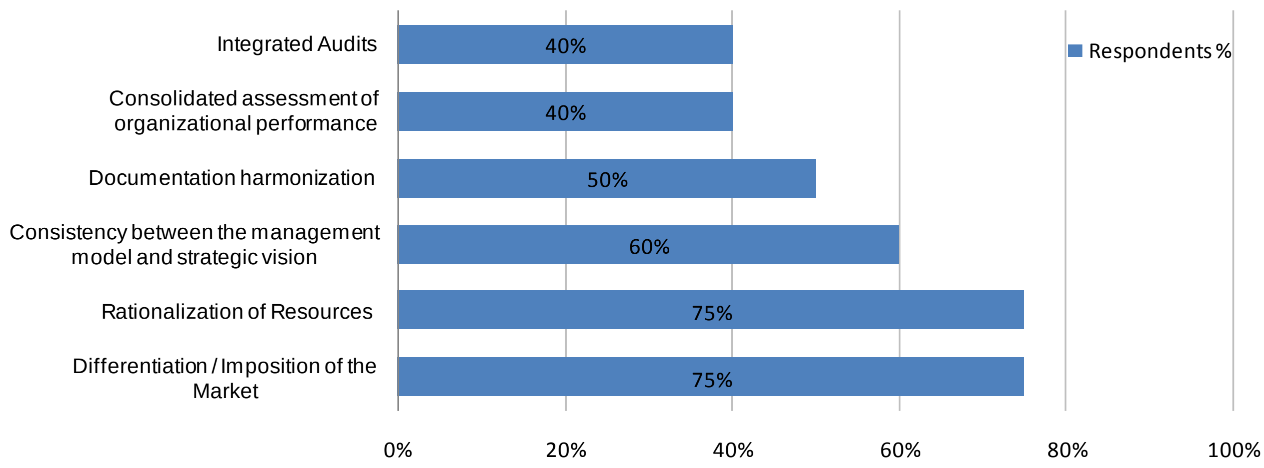

Figure 1 - Motivations for Management Systems Integration

Through the results represented above, can be concluded that the most important motivation of external nature was "Differentiation / Imposition of the Market") and the one of internal nature was "Rationalization of Resources". This fact is consistent with the study published by the authors Sampaio; *et al*(2009**).**

3.2. Management system integration difficulties

The most important factors related to this issue were: "Difficulty in obtaining multidisciplinary expertise to the various systems" and "Threat of loss of hierarchical power or loss of job".

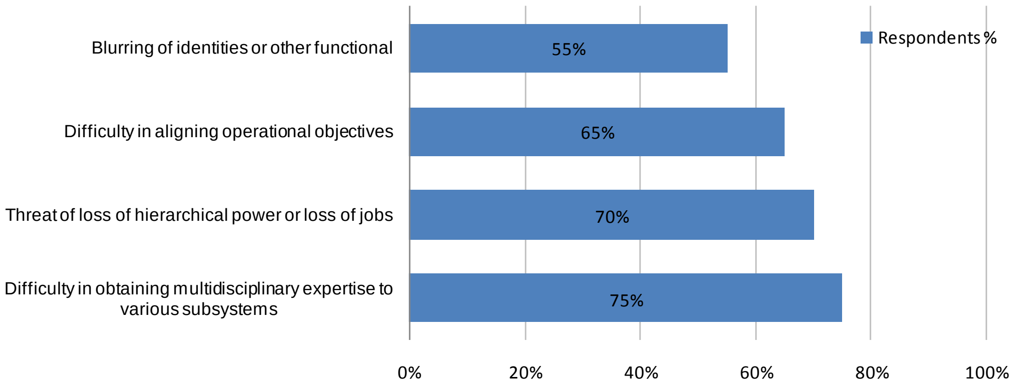

Figure 2 - Management system integration difficulties

The results presented here about the difficulties in integrating systems are converging with those published by Karapetrovic; Willborn (1998), Jorgensen, Remmen, Mellado (2006), Bernado, *et al* (2008), Sampaio, *et al* (2008), Wilkinson, Dale (2001), Wilkinson, Dale (1999), Zeng, Lou (2007), Zutshi; Sohal (2005), Karapetrovic (2002), Matthias, Coelho (2002) and Seghezzi (2000).

3.3. Management systems integration strategy

The reason for the integration to be phased or not, is due to multiple sources of constraints or priorities of the business and of the organization. The literature presents several studies on the sequence of systems integration, mainly Karapetrovic; Willborn (1998) and Labodova (2004) that confirm the diversity of approaches concerning this aspect.

3.4. IMS responsibility structure

Concerning IMS structure responsibility the results show a greater predominance to a single manager, allowing the structure to unfold in the management of each subsystem.

3.5. Approaches to integration

The majority of the respondents pointed out that the best path to integration is based on the process approach together with the PDCA methodology. This conclusion was also reached by Karapetrovic (2002), Karapetrovic; Jonker (2003), Karapetrovic (2003), Jorgensen, *et al* (2006), Zeng, *et al*(2006), Jorgensen (2008), Fresnes, Engelhard (2004), Matthias; Rabbit (2002), McDonald, *et al* (2003), Karapetrovic; Willborn (1998) and Holdworth (2003).

3.6. Integrated elements

The general opinion of respondents points to the possible integration of all IMS components, based on two major trends:

- Audits, Management Review, Policies, Documentation and Resources are considered with the greatest potential for integration,
- Processes and Indicators appear to be least integrated elements.

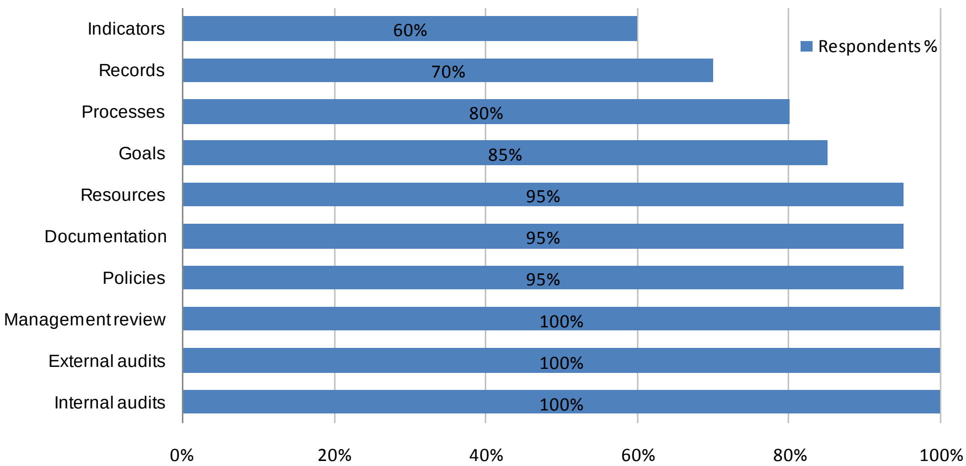

Figure 3 - Integrated elements

The references in the literature in the context of integration elements have very different studies that advocate, either the full integration of the system components, either the integration of a more or less restricted set of elements that the authors consider to be integrated. ISO Guide 72:2001 is a global regulatory framework for the development of management systems standards, which promotes the alignment of requirements and inter-systems elements. Studies published by Karapetrovic (2002), Karapetrovic (2003) and Karapetrovic; Willborn (1998) also highlight the need for such alignment and harmonization.

3.7. Assessment tools

The general opinion of the respondents indicates as assessment tools the key performance indicators, mostly applied in each subsystem for processes evaluation. Generally, they point to incipient integration practices in relation to key performance indicators. Even, some of them, put into question the feasibility and added value for organizations of such systematization.

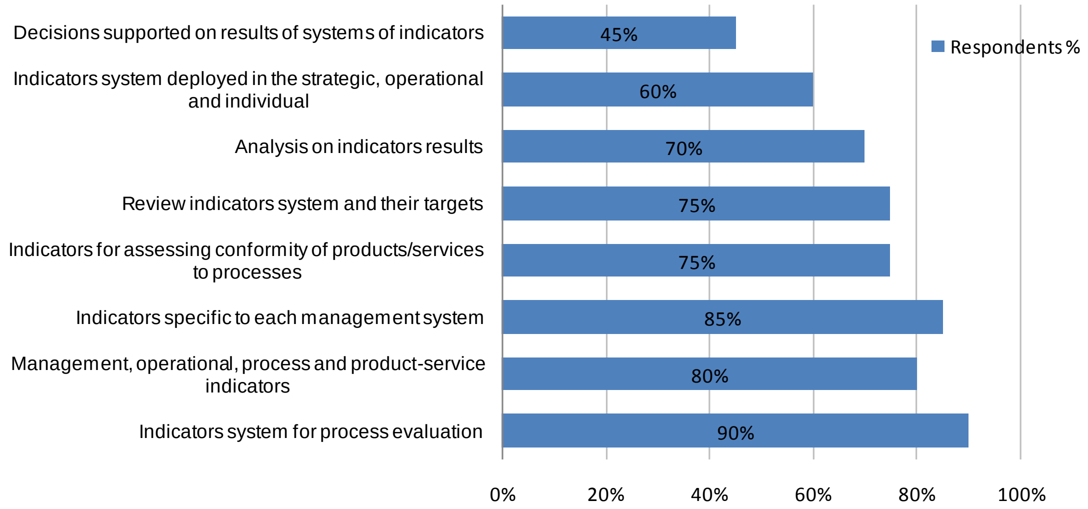

Figure 4 - Assessment tools

References in the literature about integration practices in relation to key performance indicators (KPI) are scarce. There are some normative guidance - AENOR (2003) and EN (2009) - whose are not on organizations knowledge and do not constitute a basis for their guidance. There are also studies that established methodologies for KPI's systems design and implementation: Sousa *et al* (1994), Macarthur (1996), Neely *et al* (1996), Gonçalves (2002), Zinber *et al* (2002), Rodrigues *et al* (2009), Searcy *et al* (2008 and 2009), Carluci (2010) and still Neves *et al* (2011) which refers to the state of the art in this domain.

3.8. IMS maturity analysis

The evaluation on IMS's maturity level based on these elements showed great diversity of opinions.

3.9. Levels of integration

Concerning integration levels, the following options were proposed to the companies:

- "Management systems individualized" - considered as level zero.
- "Understanding / identification of common elements" - considered as level 1.
- "Partial integration of these same elements" - considered as level 2.
- "Full integration of all common elements, including KPI's systems" - considered as level 3.
- "Organization culture learning" - considered as level 4 (holistic view of management systems integration).

Respondents agreed with the proposed levels for integration, and some of them, merged levels 1 and 2. Regarding level 3, some of them accepted it with a short characterization review. Regarding level 4, some consider it, not as a level, but as a goal of integration. Studies published in the literature about integration levels, present several models with different approaches. References are: Karapetrovic (2002), Wilkinson, Dale (1999), Jorgensen, *et al* (2005), Sampaio, Saraiva (2010) and Zeng, *et al* (2007).

3.10. Integration evolution

Most opinions were towards a positive evolution of integration, although with different perspectives. Some respondents believe that evolution was intra-organizational, during each management system review cycle, while others consider it in an extra-organizational perspective. Results are in line with recommendations in several literature references, mainly Karapetrovic (2002), Zeng, *et al* (2007) and Wilkinson, Dale (1999).

3.11. Obstacles to a better integration

The main reasons pointed as obstacles to a better integration were: "Lack of knowledge/skills in respect to standards, concepts and management practices", "cultural and organizational aspects of company's management".

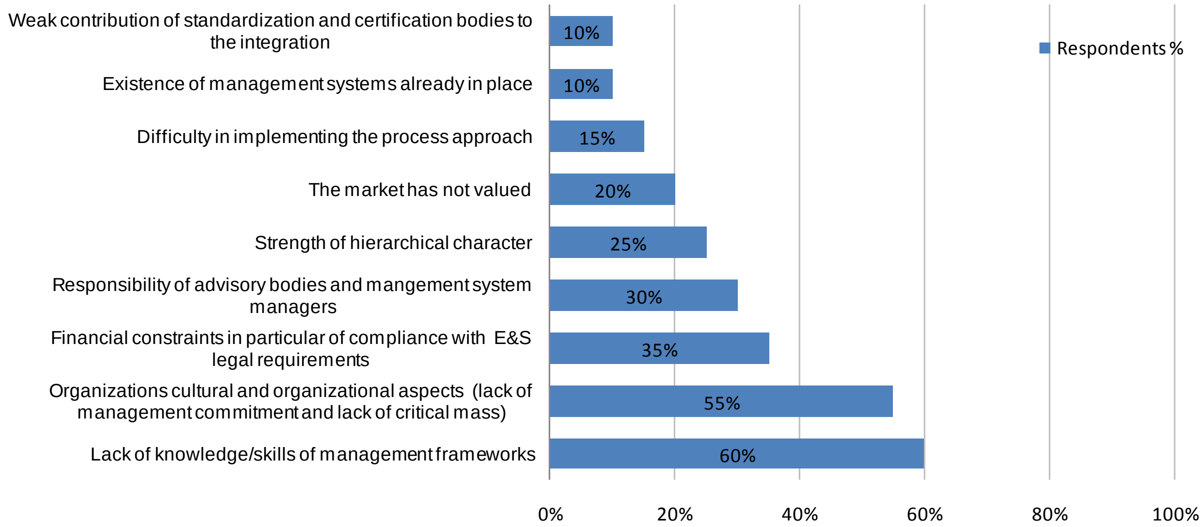

Figure 5 - Obstacles to a better integration

Those reasons determine the "lack of management commitment", constrained "internal critical mass" and emphasise "financial constraints, associated to the compliance with requirements for environmental and safety management systems standards".

3.12. Strategy to integration level improvement

The measures that were considered more relevant were: "More academic and professional training ", "Changing organization culture", "Management commitment" and "Professional management and innovation".

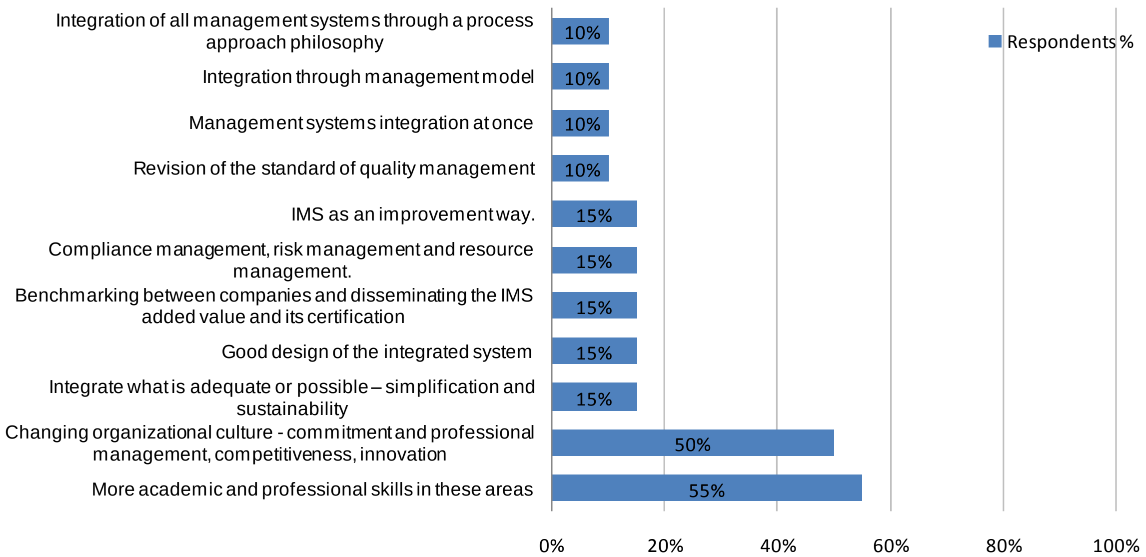

Figure 6 - Strategy to integration level improvement

The literature presents studies converging with these results, in particular, Zeng, *et al* (2007), Zutshi; Sohal (2005), Jorgensen, *et al* (2006), Wilkinson, Dale (1999), McDonald *et al* (2003), Rahim (1995), Zeng, *et al* (2007), Matthias, Coelho (2002), Zutshi; Sohal (2005) and Karapetrovic (2002), Pettigrew, Whipp (1991), Matthias, Coelho (2002) Crowe (1992), Fresno, Engelhard (2004), Holdworth (2003), Karapetrovic; Jonker (2003), Matthias, Coelho (2002), McDonald, *et al* (2003), Asif; *et al* (2008).

4. CONCLUSIONS

The results of this study at the level of motivations, difficulties, integration strategies and approaches to greater and better management systems integration are in line with the findings of several research works on this domain published in international reference journals and conference proceedings.

An important finding of this study is that there is not a unique methodology for integration. The IMS should be tailored to each organization, based on the model of the process approach together with the PDCA methodology. Top management commitment and involvement in IMS definition and implementation, as well as a competent and participated management trough the various hierarchical and functional levels of the organization, are critical factors and/or facilitators to the success and added value towards an IMS.

The results of this study point to an inefficient use of KPI systems for decision support, either in each subsystem or within the integrated system. In addition, the results point to incipient integration practices in relation to key performance indicators, putting right into the question of the feasibility and the added value to companies with such systematization.

The great acceptance of respondents to the proposed empirical model levels of integration provides the necessary support for its use as one of the basis for the implementation of a self-assessment tool in organizations towards the IMS maturity.

The critical success factors towards the integration of management systems, as evidenced in this study, are essentially inner motivation for the integration and top management commitment - an integration motor - as well as a competent and professional organization governance, regardless the sectors involved.

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Comparative Study of Methods of Analysis Work Accidents in Hospital Context

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ABSTRACT
The hospital environment has many occupational health risks due to the variety of clinical and non-clinical tasks performed by professionals. Exposure to chemical, physical, mechanical and biological risks predisposes professionals to various kinds of work accidents. Since most of the studies and tools of analysis of work accidents are applied to the industrial sector, this study propose at comparing methodologies of work analysis and verifying their suitability in hospital environment. It was selected three types of accidents, based on the institutional and national statistics on the prevalence of hospitals work accidents. The accidents selected were related with: needle stick, worker fall and inadequate effort/movement during the mobilization of obese patient. To characterise the working conditions and analysis of the perception injury in the professional, it was applied a checklist and a previously validated questionnaire were applied. After that it was applied the following analysis methodologies of work accidents. For the interpretation of possible advantages and disadvantages of the selected methodologies, seven variables were defined, such as, the degree of complexity, time spent, number of variables to analyse, accidents complexity, action plan, EUROSTAT Uniformity and hierarchy of action. The results showed that different methodologies identified common causes, additionally with the complex models, new causes were found (of different levels of organization) that complement the analysis of the simple models. The group of causes that had greatest impact in the three types of work accidents were related with the organizational influences. The application of methodologies selected is feasible for the analysis of work accidents in hospitals, however, the Registration, Investigation and Analysis of Work Accidents was shown to be an optimal technique for use in this context, because it takes into account the EUROSTAT pre-defined variables and allows a simple or complex analysis of work accident.

Keywords: Work accidents; methodologies of work accidents analysis; hospital environment.

1. INTRODUCTION

Currently it is estimated that 1.7 million people die each year as a result of their occupation (ILO, 2011). The International Labour Organization (ILO) found that, in addition to deaths, about 268 million non-fatal injuries which result in an average of three days of work lost by accident, as well as 160 million new cases of work-related diseases (ILO, 2011). In many countries, and in particular in the European Union (EU) the risk assessment is a legal requirement, together with the notification of occupational accidents (Jacinto, 2011). According to the Portuguese Standard (NP 4397:2008) on the requirements of the management of safety and occupational health, work accident (WA) is a "work-related event resulting in injury, health condition or death". According to the Portuguese legislation (article 8º in Law nº 98/2009 of 4 September), a WA is "one that takes place during working time and produces direct or indirect injury, functional disorder or sickness resulting in reduced ability to work or death". The analysis and investigation of accidents, not only represents a legal obligation (article 98º in Law nº 102/2009 of 10 September), but also aims to make improvements, both in terms of procedures and work practices, and in assessment systems and risk control.

Occupational accidents have negative impacts in terms of worker health and in the organization, but can be understood as a source of information to process improvement and self-protection system, and provide an opportunity for correction and improvement (Ballardini *et al*., 2008).

The methods of analysis of WA may be direct or indirect, or also referred to as inductive or deductive, respectively. The direct methods are those that establish risk factors prior to the accident (Risk Assessment Methodology), while the indirect methods analyse accidents, providing information on the causal factors associated (Accident Analysis Methodologies) (Miguel, 2007; Roxo, 2007). It should be noted that the causes are all factors that directly or indirectly, have contributed to the accident. The WA do not result from one single cause but multiple causes, which may be provided from all levels of an organization, such as equipment failures; action of hazardous substances; improper actions of the employee; insufficient supervision, among others (Jacinto, 2011). The accident analysis models came with the Domino Theory of Heinrich (1941), which is based on linear progression of events leading to the accident. After that, several tools with different purposes, practices and conclusions have emerged, but all aimed to improve the occupational conditions (Katsakiori *et al*., 2009). The author Laflamme (1990) ranked the models into four different approaches: decision, sequential, energy and organizational. Lehto & Salvendy (1991) distinguished models of causality in three groups: general models of the accidents process, human error models and risk behaviours and models of mechanical damage. Kjellén (2000) described five categories of models: the causal sequence, process, energy, tree logic and SHE management.

According to Hollnagel (2004), cited by Ballardini *et al*. (2008), the models are divided into sequential, epidemiological and systematic. In the sequential model, the accident is understood as a sequence of parallel or in series events that occur due to some causes, predicting the existence of a well defined cause-effect. Regarding the epidemiological model, accidents result from a sequence of events due to latent failures and active barriers in the system. These barriers, according to their position along the chain of events, delimit the presence of different work areas (safe, unsafe, and loss of control). On the other hand, the systematic model describes the accident as the result of a variability of multiple factors that are part of the production system.
The hospital organizations are among the most complex structures, given their complexity and diversity of facilities and equipment. These are composed with a very consistent and hierarchical system of several departments and professions (such as doctors, nurses, diagnostic and therapeutic health technicians, administrative personnel and general services). The hospital environment has many occupational health risks due to the variety of clinical and non-clinical tasks performed by professionals. The exposures to chemical, physical, mechanical and biological risks are common in hospital units and predispose professionals to different types of accidents (Silva, 2008).
According to the Central Administration of the Health System (2007), in Portugal a total of 4593 accidents occurred in hospitals. The professional category that presented more WA was the nurses, with 1991 cases, representing, approximately, 39.3% of total workers. However, the professional groups with a higher incidence rate of WA were the operational and auxiliary workers, with 93 and 90 accidents per 1000 professionals, respectively. The occurrence of occupational accidents, according to the action of an injury (an event that leads to injury), were mostly the “needle stick” with 1630 cases and "worker fall" with 1016 accidents. The agents that cause most injuries were tools/instruments with a prevalence of 43.6%, followed by floors, with 12.5%. The most common types of injuries were wounds with 2025 occurrences, followed by sprains, with 714 cases. In this sense, it is necessary to verify the applicability of effective models in the search of possible sources of accidents in hospital environment, in order to take corrective and/or preventive actions to eliminate or minimize occupational hazards in these institutions.
Since most of the studies and tools of analysis of work accidents are directed to the industrial sector, this study aimed at comparing methodologies of work analysis and verifying their suitability in hospital environment.

2. MATERIALS AND METHODS

This study was descriptive and observational, and included three main phases. It was made a state of the art of the theme, addressing the most relevant aspects in order to understand the context of the study. The hospital studied belongs to Portuguese public service and it is constituted by eleven storey building, two of which are located underground. It has an official capacity of 1124 beds and various medical and surgical specialties as well as a variety of supplementary diagnostic and therapeutic support.
The researcher was just an observer noting the data without intervening actively in the variables under study, analysing the cause-effect (causes of WA) (Roegiers *et al*. 1993; Cáceres, 2007). The last phase was divided into five main stages. In the first stage types of WA to analyse were selected, according to the national prevalence of work accidents in hospitals. The accidents selected for the study were: needle stick, falls and efforts of professional/inappropriate movements.
The second stage consisted of applying a checklist for the characterization of the working conditions where there were WA, analysing and applying a previously validated questionnaire to the study subjects. After that the following methodologies for analysing WA were applied:
- Causal Tree Method (CTM);
- Fault Tree (FT);
- Swiss-Cheese Method (SCM);
- Work Accidents Investigation Technique (WAIT);
- Matrix of failure (MF);
- Registration, Investigation and Analysis of work Accidents (RIAAT).

The third stage consisted in the classification of the causes, based on the Analysis and Classification System Human Factors, which takes into account the concept of Reason (1990), the active and latent failures, describing the causes into four levels - unsafe acts (errors and violations), pre-unsafe conditions (environmental factors, the condition of professional and personal-related factors), supervision insecure (inadequate supervision, planned operations improperly) and organizational influences (resource management, climate organization and operating procedures) (Wiegmann & Shappell, 2000).
In the last stage seven variables for the interpretation of possible advantages and disadvantages of methodologies selected were defined, namely, the degree of complexity, time spent, number of variables to analyse, accident’s complexity, action plan, EUROSTAT Uniformity and hierarchy of action. Below, some considerations about each method used will be specified.

2.1. Causal Tree Method (CTM)

In the 70's the Institut National de Recherche et de Sécurité (INRS), developed the Causal Tree Method. According to Hollnagel (2004), cited by Ballardini *et al*. (2008), analysis of accidents by the CTM can be associated with the sequential model but follows some of the assumptions of the systematic model. The CTM assume that accidents result from variations or deviations from the usual process, which can be related to individuals, tasks, equipment and environment. The starting point of the tree is the final event. After that the investigator has to identify various causes for the accident, relating their causal links (Katsakiori *et al*., 2009).

2.2. Fault Tree (FT)

The fault tree is the technique most widely used for WA analysis. It was developed in the early 60's by H. A. Watson Bell Telephone Laboratories (Miguel, 2007). In the analysis procedure all the factors that may give a valid contribute are selected, in order to show the relationships and possible causes of the accident. The analysis begins with the undesirable event, linking to this, events and conditions (e.g., human factors) through gates where events are interconnected by operators that show their relationship of dependence or independence (Roxo, 2007).Investigators with the application of this method can graph tree logic combinations of causes associated with the accident and make a qualitative analysis. In this area you can calculate the probability of an accident based on the probability of occurrence of events related to the event (Katsakiori *et al*., 2009).

2.3. Swiss-Cheese Method (SCM)

The theory of "Swiss-cheese" focuses on the epidemiological model and describes the undesirable event through an analogy as an appearance of a disease or a Swiss-cheese. Therefore it is understood that there are barriers along the layers of the system and can be corrupted by active faults (committed by professionals with immediate consequences) and latent (structural conditions reflect the organization and do not have immediate consequences) of the system. According to Hollnagel (2004), barriers subject to latent conditions and active failures are classified into physical, functional, symbolic and immaterial, and can be used in a pro-active as in the analysis of pre-existing systems. This classification varies from author to author, the barriers can be classified as administrative, management, preconditions, productive activities and defences (Ballardini *et al*., 2008).

2.4. Matrix failure (MF)

Matrix failures can be applied to any system, or can be adapted to workplace accidents or other cases. The technique identifies the situation, explains the causes, consequential effects, the estimated frequency and severity. On the other hand, this procedure allows a ranking of accidents by level of risk and may be a way to align priorities of preventive or corrective action (Freitas, 2011).

2.5. Work Accidents Investigation Technique (WAIT)

WAIT was developed by Jacinto & Aspinwall (2003), which integrated two approaches developed by Reason (1997) and Hollnagel (2002) (Katsakiori *et al*., 2009).The method provides a complete set for their application in research and analysis of accidents, comprising nine steps grouped into two sequential phases. The first consists of a simplified investigation, during which the causes and immediate circumstances and legal support are identified. The next step is thorough and meticulous, in order to identify other causal factors, weaknesses in management and organizational conditions, which allow the recognition of opportunities for improvement. The adopted model was specified in the OHSAS 18001 standard (1999) (Jacinto & Aspinwall, 2003; Jacinto, 2011).

2.6 Registration, Research, Analysis of Work Accidents

The Registration, Research, Analysis of Work Accidents developed in the project CAPTAR - "Learning to prevent" is the tool chosen by the Autoridade para as Condições de Trabalho to investigate accidents and to promote good practice in matters relating to accidents at work. The project objective is to increase the efficiency of the process and how the accident information is obtained, handled and used to improve security. It starts with the assumption that information is processed in a hierarchical cycle with different activities such as gathering initial information about the accident, their codification and interpretation (sometimes using pre-defined classification systems); research into the causes and underlying factors, and finally, how the information is used to learn and to develop prevention strategies. It is a tool that covers the entire cycle of the information of the accident (Jacinto *et al*., 2010).

3. RESULTS AND DISCUSSION

Figure 1, 2 and 3 presents the three types of WA analysed and the main causes responsible for its occurrence.

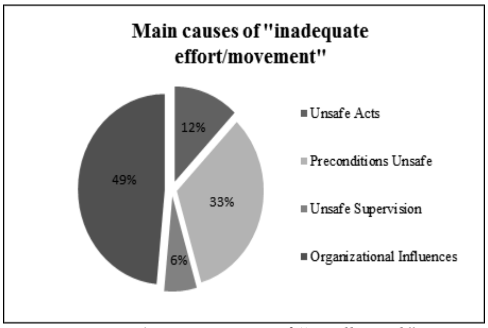

Figure 1: Main causes of "needle stick"

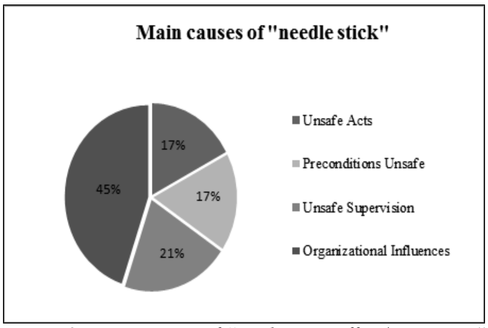

Figure 2: Main causes of "inadequate effort/movement"

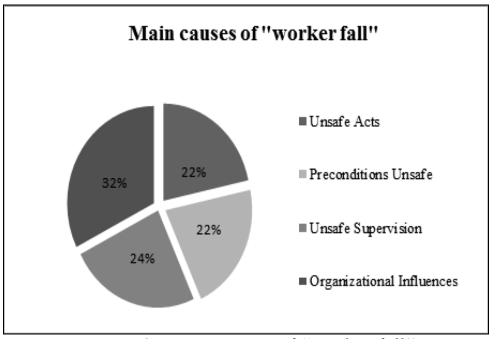

Figure 3: Main causes of "worker fall"

The group of causes that had greatest impact in the three accidents were the organizational influences. In the case of "needle stick", organizational influences accounted for 45% of the causes that led to the injury and it was relate mainly to the lack of instructions and/or work procedures and material resources (for example, absence of containers for biological waste). The lack of training contributed to the unsafe supervision and it was the second most important group of causes, representing 21%. In the accident that resulted from an inadequate effort/movement during the mobilization of obese patient, organizational influences accounted for 32% the causes responsible for its occurrence. Other groups of causes had very similar influence in accident occurrence (between 22 and 24%), which may indicate that revelation of work instructions and development of educative programs for professionals may be more viable solution. The accident involving the "worker fall" had also as the main group of causes the organizational influences (49%) associated with inadequate maintenance of infrastructure. Rollenhagen *et al.* (2010) stated that the researchers seek causes with organizational influences, so the methodologies should include variables able to analyse factors associated with top management and their influences.

Table 1 presents the results relative to the perspective of the researcher as to the degree of complexity, time spent, number of variables, accidents complexity, action plans, EUROSTAT uniformity and hierarchy of activity, standardization of performance ranking of the methods of WA analysis.

Table 1 – Overview of the investigator in the application of analysis methodologies - Advantages and Disadvantages.

	Degree of Complexity	**Time spent**	**Number of variables to analyse**	**Accidents complexity**	**Action Plan**	**EUROSTAT Uniformity**	**Hierarchy of Activity**
CTM	Simple	3-5 min.	None in particular	Simple	No	No	No
FT	Simple	3-5	None in	Simple	No	No	No

	Degree of Complexity	Time spent	Number of variables to analyse	Accidents complexity	Action Plan	EUROSTAT Uniformity	Hierarchy of Activity
		min.	particular				
SCM	Intermediate	5-7 min	5 – No standardized	Intermediate	No	No	No
MF	Intermediate	5-7 min	None in particular	Intermediate	No	No	Yes
WAIT	Complex	Above 7min.	4 - Standardized	Simple to Complex	Yes	Yes	Yes
Registration, Research, Analysis of WA	Complex	Above 7min.	4 - Standardized	Simple to Complex	Yes	Yes	Yes

The causes obtained after the application of the selected methodologies were common, but the complex models found new causes (of different levels of organization) that complement the analysis of the simple models. Ballardini *et al*. (2008) referred that many of the investigative techniques are complementary and not mutually exclusive, such as CTM and MF methodologies. The application of these methodologies depends of the experience and technical knowledge about WA, because there are no predefined variables, only an idea that causes can be related to the individual, task, equipment and environment. The main advantage of CTM and MF methodologies is that it requires little time for processing information. Nevertheless, most hospital accidents are quite complex and depend heavily on administrative policies and management, which causes problems in interpreting the possible causal factors (Katsakiori *et al*., 2009).
The theory of Swiss Cheese depends on the investigator (experience, qualifications, etc.) but has already guidelines for analysis, called barriers that when absent or outdated originate a failure, allowing the occurrence of WA. Though, these barriers cause difficulties, because there is no uniform literature for its analysis. So to overcome this disadvantage the CTM or FT methodologies can be used, not for the purpose of classifying the barriers but to provide information that can support this analysis. This limitation and its solution have also been proposed in the study of Ballardini *et al*. (2008). The MF is a methodology that ranks the priority intervention in accidents depending on the frequency, severity and/or probability of occurrence. This methodology can be completed with an CTM or FT methodologies to complete the analysis.
The application of methodologies selected for the WA analysis in hospitals are feasible, however, the methodologies WAIT and Registration, Research, Analysis of Work Accidents have pre-defined variables that contribute for WA analysis, unlike the rest which depend on the investigators practice in relation to knowledge of the infrastructure, the functioning of the workplace and activities carried out by professionals. According to Jacinto (2011), the WAIT methodology is easy and practical for use in work accidents and incidents analysis on industries. Its application in hospital context is feasible, because it takes into account the EUROSTAT pre-defined variables. Other advantage of this methodology is the ability to compare and associate with the OSH Management System - OHSAS 18001, translated by NP 4397:2008, as well as the prioritization of recommendations in terms of time and cost, as mentioned by Jacinto (2011).
WAIT and Registration, Research, Analysis of Work Accidents contribute to the harmonization of European statistical analysis by integrating the variables of the official EUROSTAT (Jacinto, 2011; Jacinto *et al*., 2010).
The Registration, Research, Analysis of Work Accidents methodology recommended by the ACT is also considered a practical and structured tool, applied to learn and develop new prevention strategies, such as WAIT. These methodologies have several variables that facilitate the interpretation of WA and should be applied in more serious and complex accident. The correct application of WAIT and Registration, Research, Analysis of Work Accidents implies that the researchers knows every step of the methodologies and have enough time for its application. The Registration, Research, Analysis of Work Accidents allows, through a decision tree, selecting more basic or detailed causes depending of the WA type. The WAIT can be a simple methodology to implement, however, does not include a technique that permits the exhibition of the analysis types, depending the WA type. This makes the Registration, Research, Analysis of Work Accidents an optimal tool for use in hospitals.

4. CONCLUSION

In many EU countries, including Portugal, the existing legislation requires the occupational risk assessment and notification of occupational accidents and the investigation of its causes. These legislative measures provide improvements, in terms of the practices/procedures, the risk control systems, minimizing the impact of work on workers' health.
This study showed that organizational factors are the most relevant cause of WA in hospitals, and that it is important to use methodologies that have variables that cover the factors associated with top management and its influence. The methods used are not mutually exclusive, but complement each other and can be adaptable to the hospital environment.
The most complex methods have the disadvantage of being more time consuming. However, the method Registration, Research, Analysis of Work Accidents in the implementation phase of the decision tree analysis allows the distinction between simple accidents (e.g. entrapment between objects) and more complex / frequent / severe accidents (e.g. needle

stick). This method, in addition to work around this issue, includes pre-defined variables WAIT method, making it a complete and proper technique.
This study represents an added value for the selection of methodologies for the analysis of occupational accidents in hospitals and can help to improve the investigation system of WA in these institutions and in similar sectors such as Health Centre Groupings and laboratories.

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Psychophysical study of manual loads transportation - a comparative study between students and seasoned workers

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ABSTRACT
The psychophysical criteria are important to develop manual material handling guidelines. It is essential that the studies that use a psychophysical approach be carried out as accurately as possible. However, the sample used in these studies can influence the results, if not appropriate. This work intends to analyze the influence of the sample in determining the maximum acceptable weight (MAW) in tasks of manual transport of loads transportation. The study involved 10 students and 10 workers. The participants' task was to carry a box for 13 minutes and travel six meters. The box had the dimensions of 60 cm length × 40 cm width x 40 cm deep and the handles had 2.7 cm width and 9.0 cm in length. Moreover, subjects were required to carry out the movement of the box with the trunk erect and the forearms perpendicular to the body. In the end, the MAW and the rate of perceived exertion (RPE) were determined. A strength test was applied to each individual. The MAW was higher for students (11.6kg) than for workers (10.8kg), however, it was not verified significant differences between groups. For students, the MAW depended on the selected IW. Students also assigned RPE values higher than workers. These results suggest that the workers' experience may be a determining factor in the MAW. Although the study has not provided conclusive results, it can be argued that samples comprised by students may affect the results, being that these groups of samples should be used with caution. So, whenever possible it should be used experienced workers in real work context for psychophysical studies.

Keywords: Index of Perceived Exertion; Maximum Acceptable Weight; Psychophysical; Transportation Manual of Loads.

1. INTRODUCTION

Musculoskeletal disorders (MSDs) have become a priority in recent years at the occupational level, since that their number are considerable (Pheasant, 2003). These occur as a direct or indirect consequence of the nature and demands of task, surrounding environment and of the ability of the individual worker (Scheer & Mital, 1997). Therefore, Manual Material Handling (MMH), awkward postures, repetitive movements, mechanical shock, grip strength, mechanical stress, vibration and extreme temperatures have been identified as factors associated to the MSDs development (Pheasant, 2003). Among these, the MMH, including the transport of loads, are recognized as the largest source of the work-related injuries and illnesses, especially in the lumbar region (Wai *et al*., 2010; DGS, 2008). The elimination or reduction of these problems can be seen through ergonomics interventions, since the ergonomic is seen as "the application of natural laws that rule the job in order to maximize safety and efficiency at work" (Scheer & Mital, 1997).

In order to reduce the risk of injury due to MMH tasks, many researches as been carried out. Researchers used different approaches to develop MMH guidelines. The biomechanical, physiological and psychophysical are the three most common approaches applied (Nussbaum & Lang, 2005). As far as the level of difficulty is concerned, these approaches are distinct of its application to the workplace, as well as the expected results. The biomechanical approach aims at "designing tasks that do not exceed the capacity of the musculoskeletal system" (Dempsey, 1998), being the lumbosacral compression the most commonly used in biomechanical criterion (Dempsey, 1999). The physiological approach, aims to design tasks where energy expenditure is limited to levels that do not result in excessive whole-body or localized fatigue (Dempsey, 1999), being the heart rate, rate of oxygen consumption, and percentage of maximum oxygen uptake used as criteria. On the other hand, the psychophysical approach aims to design tasks "acceptable" for most workers who perform them (Dempsey, 1998), being based on workers' perceptions. The psychophysical approach usually consists on tests where individuals determine forces or maximum weight that can be moved during an 8-hour shift per day, without feeling unusually tired, weakened or fatigued (Ciriello *et al*, 2010).

Between these three approaches, the psychophysical is highlighted by the active participation of individuals in determining the psychophysical criteria, for simplicity and ease of application (Ciriello *et al*., 2010), and also because it is a common approach to study the MMH tasks (see e.g. Wu & Chang, 2010, Li *et al.*, 2007, Choi & Fredericks, 2007, Wu & Cheng, 2001, Yoon & Smith,1998, Mital *et al.* 1997; Ciriello, 1990). This approach includes criteria such as rate of perceived exertion (RPE), maximum acceptable forces, maximum acceptable frequency and maximum acceptable weights (MAW) (Nussbaum & Lang, 2005; Wu & Chen 2001; Yoon & Smith, 1998 Mital *et al.* 1997; Ciriello, 1990). The criteria have, implicitly or explicitly, the assumption that individuals detect the physiological and biomechanical incentives in order to provide a subjective evaluation of physical exertion (Nussbaum & Lang, 2005). In this direction, the ratings are based on the perception that the worker has the physical effort and its results are considered subjective (Asfour *et al.*, 1980).

The psychophysical approach has been the source of so-called psychophysical criteria which have, sometimes in conjunction with criteria biomechanical, physiological and epidemiological, served as a basis for risk reduction measures, as well as for some methods of risk assessment tasks MMH, as the NIOSH'91 the equation (Waters *et al.*, 1994) and the Mital *et al.* (1997) method. Given the importance of these criteria is essential that these studies be carried out as accurately as possible. However, associated with these studies, are some limitations. According to Gamberale (1985), quoted by Nussbaum and Lang (2005), there is no relationship between RPE and MAW. Furthermore, the determination to short periods (20 ± 25 minutes) is acceptable to represent 8 hours of work on tasks of low frequency, a fact not found in moderate and high frequencies (Dempsey, 1998). Already, Ciriello *et al.* (1990) states that the psychophysical methodology is suitable for the determination of maximum acceptable weights for tasks with frequencies of 3-4 minutes or slower. In short, the working frequency influences the determination of psychophysical criteria (Jung & Jung, 2010). In this sense, one should be careful and take prudence in the design of tasks with moderate to high frequency (Dempsey, 1998). Also, Wu & Chen (2001) report that these methodologies are considered to be reliable for short distances (up to 10 meters). Another situation, the determination of MAW through psychophysical approach requires an adjustment period, i.e., the period in which individuals are able to determine the MAW that can carry 8 hours of work (Wu & Chen, 2001). In most studies of this period is short, with 15, 20, 25 or 30 minutes, and rarely use periods 45, 50 or 60 minutes (Wu & Chen, 2002). In addition to these situations we highlight the sample to be used. The analysis of the work of Asfour *et al.* (1980) revealed that several studies in the 70’s decade conducted by MMH, were based on the perception of students, that the individuals were not familiar/experienced with the tasks. However, other authors conducted the study in individuals experienced in MMH tasks (see e.g. Ciriello, 2005; Ciriello, 2001; Wu & Chen 2001; Snook & Ciriello, 1991). Therefore, begins to exist a tendency to change the samples under study, opting for the use of experienced workers, however, currently there are still authors who continue to use students as a basis for study (Nussbaum & Lang, 2005).

Given this situation, it is important to consider whether the use of students as a sample may skew the results. In this sense, this paper aims to analyze the implications of the sample in determining the MAW in tasks of manual transport of loads transportation.

2. METHODOLOGY

2.1.Sample

For the development of this study, it was considered a sample selected for convenience of 10 workers and 10 male students. For the sample used selection, were considered the following criteria: aged between 20 and 35 years, since this is a key determinant of physical capacity (Mital *et al.*, 1997) and could influence the results of the study. Individuals who present problems of hypertension, herniated disc, or surgery or suffered severe illness in the last 6 months were excluded.

2.2. Variables in study

2.2.1. Independent Variables

- The study considered the type of sample as the independent variable since it is intended to compare results between experienced workers and students.

2.2.2. Dependent Variables

- The maximum acceptable weight (MAW): each individual could determine the weight that could comfortably carry on the task for 1 hour of work because, according to Yoon & Smith (1998) is the period that is closer to intermittent work in 8 hours labor.
- Rates of perceived exertion (RPE): at the end of each task the subjects were asked to evaluate the degree of perceived exertion for the pulses (P), arms (A), shoulder (S), spine (S), legs (L) and whole body (WB).

2.2.3. Control variables

- Box dimensions: was used a cardboard box, with length 60 cm x 40 cm width x 40 cm deep. The box had handles with: 2.7 cm width and 9.0 cm in length. It was strengthened the bottom of the box and the handles with card and tape, to prevent or even get the box break and made it impossible to perform the task.
- Handle height: height of 76 cm, was corrected from the surface with a height of 34.5 cm. The box had the handle at a height of 28.5 cm.
- Transport distance: how distance used to transport the same as Wu & Chen (2001) and Cheng & Lee (2005), 6 m.
- Travel speed: standard speed about 1 m/s.
- Duration of task: according to Wu and Chen (2002), many authors use short periods of adjustment, in this sense we opted for a short adjustment period of 13 minutes.
- Environmental conditions: temperature between 20-25 °C and relative humidity of 45-60%, controlled by indoor air quality monitor, IAQ Calc (model 8760, TSI, USA).

2.3. Strength test

In order to analyze the implications of the resisting force in determining MAW, it was measured through the application of strength tests. This consisted in the repetition of crunches and abdominal exercises for each study participant. Push-ups allowed to analyze the resisting force of the upper abdominal and abdominal region and the sit-ups of the upper limbs resisting force. The exercises consisted of counting the number of sit-ups for 2 minutes and maximum push-ups made. The results were recorded on the field.

2.4. Determination of the Index of Perceived Exertion (RPE)

To determine the RPE was developed and applied an "Individual Questionnaire", in order to realize the intensity of the effort that is perceived by individuals. This was divided into two parts: "Evaluation of pain or discomfort during manual transport of loads" and "Effort made". The first aimed to analyze the feelings of pain or discomfort, through the diagram presented, adapted from Coluci *et al.* (2009), and using an increasing range of 5 degrees (0 = absent and 4 = unbearable) adapted from Silva *et al.* (2011). The second was designed to analyze the perceived exertion for the wrists, arms, shoulders, back, legs and whole body through the Borg scale, using a scale of increased 15 degrees (6 = no effort and 20 = maximum effort) (Borg, 1990).

2.5. Procedure

The task carried out by the participants consisted on carrying a box for 13 minutes, walk 6 meters in an aposture designed to isolate three major joints: shoulder, elbow and lower trunk (Nussbaum & Lang, 2005). The worker carried the box closely to the body, i.e., elbows remained in line with the trunk and the trunk erect. Moreover the box had a false bottom, in which were hidden weights that accounted for a total of 5 kg.

Initially they were asked to select the weight that they could carry for 1 hour of work. Therefore, to each individual, it was requested to adjust the weight displayed, 17.25 kg, to the weight that they found suitable for the conditions proposed. This weight was considered the Initial Weight (IW). Every 6 meters the individuals placed the box on the support surface and during this time they could add or remove weights. During the entire journey, individuals were encouraged to make adjustments to the IW (adding or removing weights) in order to get to the MAW for the period of 1 hour without pain, fatigue or tiredness (Ciriello, 2005). During this journey individuals adjusted the weight whenever necessary. The weight obtained at the end of 13 minutes was considered the MAW for 1 hour of work, which is considered representative of 8 hours of intermittent work (Yoon & Smith, 1998).

Once the task completed, MAW values were recorded in the respective field form. Later, an individual questionnaire was applied to assess the RPE and pain/discomfort.

In the end, a strength test was applied to each individual based on the performance of crunches and push-ups in order to evaluate the strength in the abdominal region and upper limbs, respectively. The former were performed during a period of 2 minutes, while the latter were performed for the maximum number the individuals could withstand.

3. RESULTS AND DISCUSSION

3.1. Anthropometric characteristics of the sample

This study aims to highlight the importance of sampling in determining the MAW, which seeks to compare the results with students and workers. In this sense, we used individuals with similar anthropometric characteristics between the two groups. The students showed on average 23.3 years, a height of 176.4cm and weights of 69.3kg. The workers showed on average 28.1 years, a height of 178.3cm and weights of 73.7kg.

Table 1- Anthropometric dimensions for students and workers

	Age (years)	Height (cm)	Weight (kg)
Students	23.3	176.4	69.3
Workers	28.1	178.3	73.7

3.2. Strength test

The students made, on average, more crunches and push-ups, 46.7 and 24.7, respectively, than workers. Workers made an average of 33.7 crunches and 21.1 push-ups. Thus, students showed a higher strength than workers and statistically significant differences were observed in relation to abdominal strength ($p<0.05$, Mann-Whitney test). The results can be explained by the fact that some students practice physical exercise and are more suitable for these activities, performing them with greater skill, as individuals engaged in exercises like crunches and push-ups gain more strength and resistance in the upper abdominal region in comparison to individuals who do not practice this type of exercise (Jacinto, 2001).

3.3. Maximum Acceptable Weight (MAW) for manual load carrying

The MAW is one of the criteria used in most psychophysical approach defined as: maximum acceptable weight that an individual can comfortably carry for 8 hours of intermittent work (Wu, 2006; Cheng & Lee, 2006; Wu & Chen, 2001).

The results obtained for the conditions of the experiment, in which individuals have walked 6m during 13minutes, are presented in Table 2. The MAW obtained for students was 11.6kg and 10.8kg for the workers. Thus, it was observed that the students carried, in average, a weight of 0.8kg more than the workers. However, no significant statistically differences were observed between groups (p>0.05, Mann-Whitney test). This difference between the samples was seen in the analysis of previous studies. For example, Wu and Chen (2001) and Cheng & Lee (2006), using the same methodology for the determination of MAW, reflected the sample implication on the MAW determination. In both studies was determined MAW to transport loads along 6 meters. The first used a sample of students and a second sample of workers. It is verified that the results obtained by Wu & Chen (2001) with students (39.9kg) are very different from the results obtained by Cheng & Lee (2006) with workers (14.8kg), so the MAW is higher in students, as in this work. Thus, it seems to exist the influence of the type of sample to determine the maximum acceptable weight.

Table 2- Average MAW obtained for students and workers

	MAW (kg)	**Standard Deviation**
Students	11.6	2.33
Workers	10.8	1.80

The influence between the strength and the IW on the MAW was analyzed. There was no relationship between the MAW and the strength (R^2<0.252). For students, there is a relationship between IW and MAW (R^2=0.859). Thus, for students, the higher the initial weight selected by the students, the greater the MAW obtained. For workers this relationship was not observed (R^2=0.019).
These results may be related with a greater experience in the transport of loads by workers, and therefore with a greater perception of risk by these individuals (Bye & Lamvik, 2007), regarding the need for continuity of effort and, consequently, increasing the perception of pain or discomfort. Therefore, a different behavior can be expected of these professionals in the psychophysical tests in particular in the MAW selection.

3.4. Rate of Perceived Exertion (RPE) for manual load carrying

The perceived exertion for the wrists, arms, shoulders, back, legs and whole body was obtained based on the "Individual Questionnaire" application, being the results presented in Table 3. Through the results obtained, it appears that, in average, students assign RPE values higher than workers. From the results presented, three areas may be highlighted for obtaining the highest values: arms (14.5 for students and 12.3 for workers), back (13.1 for students and 10.1 for workers) and whole body (12.3 for students and 10.2 for workers). However, among these, the region of the arms is the one with higher marks for both students (14.5), and workers (12.3). These results are in line with those obtained by Wu & Chen (2001) for students and Cheng & Lee (2006) for workers and may be associated with the need to maintain the required posture and thus require further efforts in this region. The results also showed that there were no significant differences between groups in relation to the RPE (p>0.05, Mann-Whitney test).

Table 3- Values of RPE obtained for students and workers

RPE	Students		Workers	
	Mean	Standard Deviation	Mean	Standard Deviation
Wrist	12.0	2.00	9.7	2.26
Arm	14.5	2.59	12.3	3.20
Shoulder	12.1	2.60	9.7	1.95
Back	13.1	2.60	10.1	2.10
Legs	10.8	1.62	8.8	2.20
Whole Body	12.3	2.06	10.2	2.25

Considering that MMH potentiates the development of MSDs in the lumbar region (DGS, 2008 and Colim, 2009), it was expected that the back would be the region with greater relationship between perceived exertion and weight that people carry, situation verified in this study only for workers (Table 4). This may be associated with their daily work that requires the handling and load transport, power factor of this perception (DGS, 2008). However, there is no significant relationship between the MAW and the RPE (R^2 <0448). These results are in accordance with the Gamberale (1985) results, quoted by Nussbaum and Lang (2005).

Table 4- Relationship between MWA and RPE obtained for students and workers

Body part	R^2	
	Students	Workers
Wrist	0.003	0.067
Arm	0.146	0.024
Shoulder	0.067	0.025
Back	0.107	**0.448**
Legs	0.242	0.080
Whole Body	0.180	0.202

3.5. **Classification of pain/discomfort**

The European Agency for Safety and Health at Work describes the back pain as one of the major health problems related to work (23.8%) in the European Union (EU-OSHA, 2007). Thus, and considering the nature of the task, it was expected that the individuals, specially the workers, would perceive greater pain/discomfort in the lumbar region. In this study, the results highlighted three areas of the body: elbows, wrists and lower back. Students attributed, respectively, 1.90, 1.10 and 1.60, and workers 1.60, 0.80 and 0.80 (Table 5).

Among the three, the region of the elbow was the one with a higher rate of pain/discomfort in both groups during the transportation of the load. This may be associated with the obligation to maintain the position of the forearm perpendicular to the body, as requested.

Although students assigned higher values of perceived pain/discomfort than workers for all areas under analysis, there was no significant difference between groups for all outcomes of the sensations of pain/discomfort ($p > 0.05$, Mann-Whitney test). These results may be related with the higher loads carried by students and the fact that they are not accustomed to MMH tasks.

Table 5- Values of pain/discomfort experienced by students / workers

Pain/Discomfort	Students		Workers	
	Mean	Standard Deviation	Mean	Standard Deviation
Neck	0.70	1.06	0.20	0.42
Shoulders	1.00	0.82	0.40	0.52
Column	0.60	0.97	0.30	0.48
Elbows	**1.90**	**0.88**	**1.60**	**1.17**
Pulses	**1.10**	**1.20**	**0.80**	**0.79**
Lumbar	**1.60**	**0.84**	**0.80**	**0.92**
Buttocks	0.80	1.03	0.40	0.70
Knees	0.50	0.71	0.10	0.32
Feet	0.30	0.68	0.10	0.32

4. CONCLUSIONS

The psychophysical approach applied in this work allows the development of measures in order to create acceptable working conditions for most individuals, in order to reduce/eliminate the appearance of MSDs. The psychophysical approach is easier to apply to the workplace than the biomechanical and physiological approaches, moreover, the results are simple to interpret. This approach can also be seen as a complement to methods of risk assessment. However, and considering the subjectivity associated with this approach, is essential that it is carried out in a proper way.

The sample used for the psychophysical studies may be a conditioning factor of the MAW determination. Therefore, in this paper, the implications of the sample in determining the MAW, in tasks of manual transport of loads, was analyzed.

This study demonstrated that the MAW was depending on the sample groups (students and workers). Despite there was no significant differences between groups, the MAW obtained was higher for students (11.6kg) than for workers (10.8Kg). In addition, it was found that, for students, the MAW depends on the selected IW and the resisting force does not interfere in the determination of MAW in both groups.

It is expected that the workers' experience in the transport of loads and their perception of the work reality and their physical limitations may be a determining factor in the MAW. They are those who know better the task demands and its resulting fatigue. So, samples comprised by students may affect the results, being that these groups of samples should be used with caution. Therefore, whenever possible, sample groups should comprise workers, the studies must be adapted to the work conditions and include other factors as years of experience and training.

5. STUDY LIMITATIONS

Sample size may be a limitation in the present study. A larger sample might prove statistically the influence of the sample in determining the MAW. As the study was developed in a company, the sample was limited to the available workers. Therefore, subjects were exposed to the same working conditions (daily weight carried, working patterns, temperature, humidity, age, among others), and there was only 10 workers that satisfied with the stipulated conditions. So it was not possible to use a larger sample in this work. The introduction of workers of another company could lead to bias in the results.

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When the Unexpected Attacks

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ABSTRACT
The unexpected can hit any one of us, any organization or even any country, in just a fraction of second but it can cause damage for centuries to come. Take the disaster at Fukushima as example, and see how a natural event such as an earthquake that led to a tsunami can cause such great devastation to that specific area of Japan, and the consequences for the environment and society for years and centuries to come. In the Fukushima disaster we have several different kinds of unexpected events: natural, as the earthquake and the tsunami, industrial, as the nuclear power plant failure, and environmental with the nuclear disaster. The concept of unexpected is broad and considers phenomena such as financial, natural, human, industrial, or environmental. This project is part of a Doctoral thesis in progress that aims to explore how organizations learn by transforming negative events like crises and unexpected events with negative effects into positive achievements. This study aims to explore the diversity of unexpected events that might occur and to establish existing similarities and differences between them, following a systematic approach to the subject. The data are still being collected and analyzed, preliminary results and conclusions being presented.

Keywords: Unexpected events, Crisis, Disasters.

1. INTRODUCTION

When the unexpected hits, it does so in a quick, sudden, surprising way, but giving us alarm signals that for some reason humans tend to ignore or, even when acknowledging them, consider them as alarm signals that may affect other potential victims but not themselves. It is part of human nature to think that bad things only will happen to our neighbor but not to ourselves; that is why man still compete with nature and stays in danger areas to face hurricanes, take off protective part of work engines and say "it is for the purpose of better working", or refuses to follow legal rules and keeps saying that: "it does not make sense". 'Men just do not get' that they are their first enemies when we are talking about unexpected events. Accidents do not happen by chance, but rather because an order of factors had come together in that particular time to cause the unexpected event. Following this perspective and considering the radical sports or activities, we may conjecture that for some people it is exciting to look for the unexpected, and that is the reason why so many people face risks knowing that what they are doing is dangerous.

On the other hand we have the victims of events such as earthquakes, tsunamis, terrorist attacks, explosions, for whom such events were frightening and traumatic, with possible effects throughout their entire lives (e.g., post traumatic stress, depression, physical disabilities). It depends on several factors that co-exist in each unexpected event, for instance the kind of event, the type of personality of the victim, the injuries suffered, the help received at the moment, and afterwards, etc. Additionally, we may consider as unexpected, events as different as the terrorist attack to the Ministry building and the blood massacre in the Utoeya Island in Norway, the current International Financial Crisis or the Libyan War, the 9/11 attack, or the Russian plain crash that killed almost an entire sports team.

So, what does 'unexpected event' mean? The concept of 'unexpected event' is broad and may be analyzed from different scientific perspectives. For example, financial crises can be studied by financial and economic science, natural disasters can be approached by different perspectives (e.g., sociology, anthropology, geography, natural and physical sciences, and health sciences) (Alexander, 1991). In the safety context, the factors contributing to the unexpected events are studied by the lenses of sciences like engineering (e.g., Jacinto & Aspinwall, 2004), organizational behavior (e.g., MacPhail & Edmondson, 2011, Muñiz, Peón & Ordás, 2005) or management (e.g., Cooper, 2001).

Albeit the multidisciplinary characteristic, consensus does exist between different scientific approaches in studying similar factors: i.e., causes, consequences, phases, similar events or specific events (e.g., Barings Bank).

In different literature streams, from different scientific fields, these questions were not systematically addressed, but there is consensus that events as different as environmental or natural disaster, human calamity, financial crises or industrial disasters are all considered as unexpected events. So, in this sense the 'unexpected event' is a broad concept. In fact the main discussion and disagreement only begins when the analyses consider the concepts of 'calamity' and 'disaster', or become more specific in defining what kind of unexpected event we are talking about, especially their consequences.

This paper is focused on the diversity of unexpected events that can occur, and aims to establish the similarities and differences between them, in a systematic way. In the future we aim to develop a Multiple Correspondence Analysis [MCA] trying to identify patterns between unexpected events and some characteristics. At the end it is pursuit to establish some tendencies in terms of similarities between unexpected events, and by that will be possible to establish ways of how organisations should act facing such kind of events.

The data are being collected and analyzed; further information will be discussed in the future considering the results obtained. The preliminary results and conclusions will be presented.

2. UNEXPECTED EVENTS

Studies about unexpected events are spread in different scientific publications and may refer to natural, environmental, or industrial disasters. They include work accidents, industrial disasters, tsunamis, famine, financial crises, and environmental jolts as a strike, fire, or simply the price of Brent. In this diversity, even being unexpected, it is essential to define what really means 'unexpected event', and in what context we can consider an event as unexpected. They all are unexpected, because even when knowing that they will eventually happen sometime, we cannot predict exactly the timing, what would be their severity and their real consequences. Even being capable of predicting that a volcano could explode its lava at any time, we do not know the intensity of the smoke, the size of the ashes, the kilometres that the lava would run, the intensity of the poisoning gas entering the atmosphere until it actually happened. The alarm signals will always be present, and identifiable, but we do not know when it will happen, and how.

According to the theory of 'man-made disaster' (Turner & Pidgeon, 1997) accidents do not happen by some unhappy situation, but rather because an amount of pre-existing factors combine themselves in that moment and originate the accident, notwithstanding the fact that they previously send signals to people, that ignore it. If men were aware of those signals they could prevent that accident. If man does not prevent them, man made it, and if man built the system and the machine, man made it, also if man is responsible for the errors that lead to the accident, man made it. In this perspective unexpected events can be caused by man, even the natural events can be caused by man, when they change nature and the environment. Would this question be relevant to identify 'unexpected events'? Perhaps within the development of further analysis we may answer it.

The responsibility of people does not end in this theory. Considering the 'black swan' (Taleb, 2007), men can be responsible for unexpected events, when they are so accustomed to doing something and thinking in the same way. If something new appears, like the first observed 'black swan' that they think is inexistent, they don't know how to behave. So, they would not know how to solve that crisis and sometimes ignore that the black swan is the result of being formatted to think in a different way, and not being open to new and unexpected things. Authors consider that being a HRO, is mainly associated with the ability to think in new and different ways, to think the unthinkable. In the analyses of papers would it be possible to identify events like the 'black swan'? It would be interesting to verify if organizations could identify these kinds of events. This could be another factor to take into account in the databases.

When an unexpected event occurs, a crisis may begin and it must be managed; in this perspective a crisis is considered as "...an unexpected, unlikely, yet high-impact event that may cause significant change in human knowledge and performance at the individual, group, organizational, and community levels." (Hutchins, 2008, pp. 302).

We consider that these events have great impact in human and organizational lives, and an important contribution for human development and organizational knowledge that cannot be ignored. It is in that perspective that this work intends to progress.

Following this definition, we can have many different kinds of unexpected events in the work safety context, such as work incidents, near misses, work accidents (i.e., individual accidents) and also industrial disasters (i.e., organizational accidents). In the natural disaster context we may find events so different as floods, famine (also considered as human disaster), tsunamis, earthquakes, or landslides. In the environmental context we may talk about pollution in the ocean, rivers, air, land, nuclear disasters, draught, or even plagues.

All these events are similar in that they all are unexpected but all differ in kind (i.e., natural, industrial, environmental, financial) and in the analysis approach; hence the focus of study in terms of crisis in general is also similar (i.e., causes, consequences, phases).

Alexander, (2005) gives some contribution in establishing the status of disaster literature and he points out the lack of a definition of disaster as a gap, which hampers researchers to establish exactly what is and what is not a disaster. The author considers that a definition of disaster should consider some main points as area, magnitude or other criteria that could be followed to facilitate the process of identification of a disaster. Alexander (2005) gives the example that it is possible to have a landslide of large dimensions without deaths (e.g., Alaska, 1964) and a small landslide with deaths (e.g., Aberfan Landslide, 1966). By that the author intends to raise the question that we can have unexpected events with minor dimensions but great consequences, even disastrous, and we can have major unexpected events with minor or even no consequences at all. So, it is crucial to define what is a 'disaster', a 'calamity' and also an 'unexpected event'. Alexander indicates that contrary to what has been done regarding hazard, risk and disaster "...little attention has been devoted to disaster as mindset, fixity of opinions or states of mind created by events" (Alexander, 2005, p.28).

If a crisis is something unexpected, unlikely, yet high-impact, with severe repercussions to people and organizations, we may propose that it could never be predicted. But that it is not true. In fact even being unexpected, such events provide alarm signals through time warning us that at any time a crisis or an unexpected event could happen. Before a severe earthquake, there are always minor earthquakes that can occur for months or weeks, before the major earthquake, before the tsunami there is always an empty sea, before a work accident there is always several work incidents and near misses. So, there are warning signals, but sometimes people ignore them or tend to dismiss them. In the work safety context it is well known that work accidents happen after several work incidents and near misses have occurred, giving information that should have raised the attention of organizational actors that an accident was eminent (see Miguel, 2010, and references to the seminal work of Heinrich). Unfortunately that information is often ignored, banned, less regarded or simply forgotten resulting in severe work accidents and even in industrial disasters.

3. HIGH RELIABILITY ORGANIZATIONS

Some organizations, however, differ by being capable of managing quite well the chaos of the situation and at the end achieve positive results. Those organizations are attentive to alarm signals and information, they act preventively and always before the event strikes; those organizations are called HROs (i.e., High Reliability Organizations). HROs are defined by Roberts (Bourrier, 2005), as organizations "...in which errors can have catastrophic outcomes, but which conduct relatively error free operations over a long period of time, making consistently good decisions, resulting in high quality and reliability operations" (Bourrier, 2005, p. 94).

HROs are attentive to minor events and to all the associated information to learn to prevent future similar events and to avoid major unexpected events with greater consequences. They develop a mindful infrastructure (Weick & Sutcliffe, 2007) based in five principles, which are: 1) preoccupation with failure; 2) reluctance to simplify; 3) sensitivity to operations; 4) commitment to resilience and 5) deference to expertise. Those principles can be developed by any kind of organization and in different levels (Weick, Sutcliffe & Obstfeld, 1999). These characteristics should also apply to a broad number of 'support services', such as firefighters, emergency rescue services, hospitals, civil protection services, etc.

Researchers tend to identify the 'Normal accidents' theory as an opposite of High Reliability Theory, but authors from both theories (i.e., Karl Weick and Charles Perrow) do not consider their theories as opposite rather as complementary. For Perrow (2009) the normal accident theory is based on system failures whereas high reliability theory is much about behaviour. They are not opposite, they complement each other. For Perrow (2009), when analysing accidents or unexpected events, all theories are needed, we cannot say that one is right and the other is wrong. The understanding of unexpected events requires several different approaches, perspectives and types of knowledge. When an unexpected event happens we need to analyse factors as broad as organizational systems, mechanical engines, geology, human behavior, building infrastructures, and other things, so multidisciplinarity is needed to analyze unexpected events that are normal as the one described by Perrow or the other kind of unexpected events, the black swans, for which we are not prepared, unless we unfreeze our brain and are open to new and different concepts. For this reason, this study tends to be broad and focus in all this different kind of literatures, as well as to study how high reliability organizations learn with unexpected events and how they define it as such, considering that the characteristic that differentiates these organizations from the other ones is the resilience present in the way they face and solve crises.

4. MATERIALS AND METHOD

This study will be developed using article databases as information and documentation sources for our research. In the first moment the articles in the databases of the authors are being introduced in a SPSS databases, then new articles would be searchable in articles databases as for instance: EBSCO, B-ON, etc. The search for articles would follow some criteria; first authors would identify in the literature some key-words that they would use to search for articles (e.g., crisis management, work accidents, disasters, environmental jolts, etc). All the collectable articles would be analyzed and introduced in the SPSS databases created for this purposed by the authors.

The databases were created in SPSS to allow the classification of events in type of risk (i.e., risk perspective or hazard perspective), in type of unexpected event (e.g., natural, industrial, work accident, work incident), environmental jolts (e.g., strike), crisis management (e.g., environmental, financial), type of disaster (e.g., landslide, explosion, flood) and also other variables such as area of knowledge, science of approach, type of study, location, population, and economic sector. All the collectable articles could be classified regarding each one of the variables existing in the databases. In the end, authors will look for similarities and differences and especially for what kind of unexpected events are more covered by the literature and in what field of knowledge.

5. PRELIMINARY RESULTS AND DISCUSSION

An analysis of the literature in general indicate consensus in how different types of events are classified in the broad category of 'unexpected events', as well as in the definition of 'unexpected event' that follows.

Whenever the analysis becomes thinner, different points of view appear, for instance in attributing the classification of 'calamity', 'disaster' or even 'accident'

Another interesting finding is that, notwithstanding the scientific approach used, there is a common perspective in terms of identifications of phases, causes and consequences of unexpected events.

Until now 37 papers were analyzed and included in the databases, 19 of them were published in Journals and the other 18 are book chapters. The majority (i.e., 32) do not refer to crises but rather to disasters and follow the perspective of risk as hazard. In this first step of the study only descriptive analyses were taken, but in the future other analyses are predicted. Next results about the type of study, the area of knowledge of authors, the key concepts presented in the articles and the crisis type referred will be presented.

In what refers to type of study, the papers were classified in qualitative, quantitative, triangulation and conceptual, Results obtained so far are presented in table 1.

Table 1 – Type of study.

Type of study	Number of papers
Qualitative	8
Quantitative	1
Triangulation	0
Conceptual	28

Results indicate that there is a proliferation of conceptual papers and in what concerns to empirical work the methodology is mainly qualitative rather than quantitative.
In terms of area of knowledge, disaster literature is dominated by sociological studies and crisis literature by management studies. Even so, we found a proliferation of management papers in the 'disaster' studies, as described in table 2.

Table 2 – Area of knowledge of authors.

Area of Knowledge	Number of Papers
Management	7
Sociology	9
Emergency management	11
Anthropology	2
Economy	2
Methereology	1
Geography	3
Architectural	1

All the papers were analyzed to identify some key concepts some similarities, components and relations between the use of concepts and approaches taken or perspectives followed. In this moment only a descriptive analysis was developed considering the size of the sample (i.e., 37), but the preliminary results indicate a predominance of the use of 'disaster' and 'vulnerability'. Curiously the concept 'vulnerability' appears also in some papers that follow the 'crisis' perspective, when referred to a natural or human crisis, and on papers referring to natural disasters. That could indicate that the concept of 'vulnerability' is linked with human condition and considered as a key concept in what refers to unexpected events with natural causes (e.g., famine, war, migration, flood, earthquakes). The database was developed to consider the key concept of 'prevention', but in the first analysis, 'prevention' is not the main factor of 'crisis management' or 'disaster management', but instead a focus in the concept of 'risk mitigation'. So, authors will take in consideration this question in the next analyses, and will revise the databases. The results regarding the identifiable key concepts are presented in table 3.

Table 3 – Key Concepts.

Key Concepts	Number of papers
Disaster	34
Calamity	1
Prevention	5
Resilience	4
Vulnerability	12
Expertise	2

In terms of type of crisis, (i.e., financial, natural which includes human, environmental and industrial), most papers focus on natural and human ones. This could be explained by the kind of papers collected in this phase, since several papers are from a Journal specialized in disasters, which could influence our results. So these results should be interpreted with caution. The results are presented in table 4.

Table 4 – Crisis Type.

Crisis Type	Number of papers
Financial	1
Natural	6
Human	6
Environmental	0
Industrial	1

Nevertheless more data are still being collected and analyzed and deeper conclusions are necessary.

6. ACKNOWLEDGMENTS

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BLEVE of a road tanker LPG - A Short Review

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ABSTRACT
The BLEVE is a kind of technological accident with a major impact on society due to the possibility of causing death and disability on people as well as property damage. This kind of accident is the result of the production of a pressure wave generated by the release of stored energy, of the heat flux generated by a fireball and the projection of fragments generated by the rupture of the shell and materials from other sources. The probability of a BLEVE happening is greater when the equipment is portable, especially if the transport is made by road. In this work is shown a brief survey of the state of the art in relation to the type of accident BLEVE (phenomenon, construction of tanks and consequences), simulation models of explosions and of the combination of the assessment of the consequences with a road tanker LPG. Finally some conclusions are drawn about the state of the art in this area.

Keywords: BLEVE, Accident, transport, tanker.

1. INTRODUCTION

LPG is a fuel gas, butane or propane, which is in a liquefied state and is used domestically for heating sanitary water, central heating and cooking. It is also used industrially in the production process for generation of energy or for water heating and thermal comfort. Currently, for energetic and environmental reasons the LPG is used as well in vehicles as fuel.
To carry the LPG from the large storage tanks up to the intermediate reservoirs is used road transport with trucks. The risk of accidents with LPG increases substantially due to the inherent risk the carriage by road and the impossibility to control the surrounding environment through which the vehicle passes.
One of the main types of accidents with LPG tanks is the BLEVE (Boiling Liquid Expanding Vapour Explosion). This concept was first introduced in 1957 by Smith, Marsh and Walls from Factory Mutual Research Corporation (Center for Chemical Process Safety, 2010 p. 311).
Accidents involving pressure equipment are from the type technologic. They have consequences very serious for those who are in their neighbourhood due to the fluid pressure being released from an uncontrolled manner. The main consequences of the uncontrolled release of LPG from a portable tank are the formation of a shock wave, a fireball and the projection of fragments (Center for Chemical Process Safety, 2010 p. 320).
The measures of protection should be strengthened by several reasons including the fact that potentially affected people have no knowledge of the presence of danger, not have knowledge about the risks associated with, or even have not any knowledge about preventive or self-protection measures. In addition, everyone in the population can be affected by the effects of a BLEVE, namely children, adults, seniors and persons with limited mobility.

2. MATERIALS AND METHOD

The origin of knowledge included in this communication is from scientific papers published in journals, with referees and reference books, such as the CCPS (Center for Chemical Process Safety) or VROM (Ministry of Environment of the Netherlands). This methodology was used until 5 October 2011.
The research was conducted through communications Information System MetaLib@ and Google Scholar search engine, considering the following words: BLEVE, explosions and LPG, both in Portuguese, Castilian and English.

3. REVIEW OF LITERATURE, RESULTS AND DISCUSSION

3.1 BLEVE

T. Abbasi (Abbasi, 2010, p. 271) has considered the BLEVE as an explosion of physical type. However, due to the peculiarities of the causes of such explosions, they are classified separately from traditional physical explosions of bursting pressure equipment. The BLEVE is one of the most onerous type of explosion (Geneva, 2008, p. 110).
BLEVE was typified by the first time as an accident in 1957 by J. B. Smith, W. S. Marsh and W. L. Walls from Factory Mutual Research Corporation (Walls, 1978, p. 46). This phenomenon consists in a sudden release of a liquid or a liquefied gas after rupture of the tank which results in an instantaneous vaporization (Center for Chemical Process Safety, 2010 p. 311). For Walls (Walls, 1979, p. 22) the definition of this phenomenon consists in a major break from a reservoir into two or more of their components, when the liquid is at a much higher temperature than the boiling point at NTP conditions. For Birk (Birk, 1994, p. 474) a BLEVE is an explosive release of expanding vapor and boiling liquid when a container containing a pressure liquefied gas fails catastrophically. In the definition of these authors the concept is not introduced.

For several authors (Birk, 1993, p. 120) (Shaluf, 2007, p. 748) the BLEVE can be divided into three classes: BLEVE, hot BLEVE and cold BLEVE, depending on the type of event / mechanism. In figure 1 is described in the explanation of the phenomenon and its consequences.

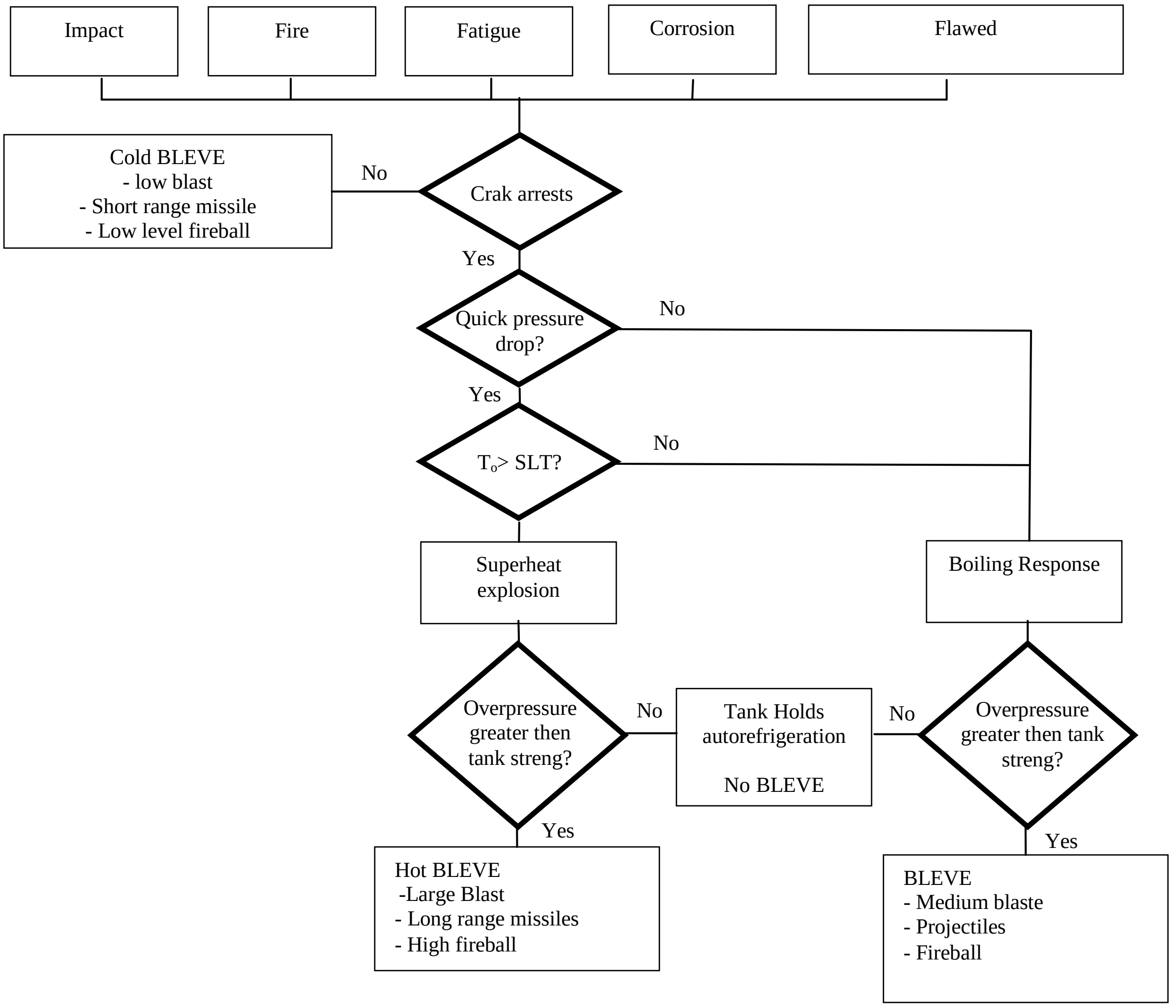

Figure 1 - Diagram of the process of BLEVE (Adapted Shaluf, 2007)

Reid presented a thermodynamic explanation for the phenomenon of BLEVE, through the theory of overheating limit , SLT (Reid, 1979, p. 1264). When there is a sudden decrease of pressure of a liquefied gas, this result in a change of state from liquid to vapor / gas without the fluid to have time to full boil. Thus the fluid passes into an overheated state when the fluid pressure is lower than the saturation pressure. Under these conditions the fluid enters in a zone of thermodynamic metastability (Mengmeng, 2007, p. 10). Thus, when the fluid moves to a position in the zone of metastability an explosion can occur, but not the BLEVE occurs (change A, Figure 2). The BLEVE can occur only when going to the unstable zone, ie when the spinodal line is crossed (change B of Figure 2).
The spinodal line, or boundary line of overheating, is defined by the points where the partial derivative of the equation of Van der Waals or Redlich-Kwong equation becomes zero, ie.

$$\left(\frac{\delta P}{\delta v}\right)_T = 0$$ Sallaa, Demichelab, & Casal, 2006, p. 693.

The temperature limit of overheating at atmospheric pressure can be calculated using the approximate formula SLT = $T_C[(0,11P/P_C)+0,89]$, where T_C is the critical temperature, P is atmospheric pressure and the P_C is the critical pressure (Prugh, 1991, p. 70).

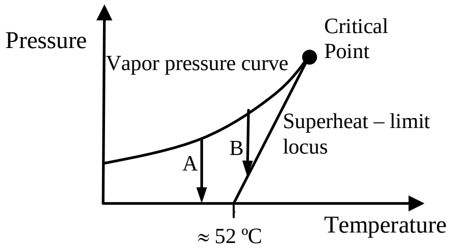

Figure 2 - curve / line limit overheating (spinodal) and propane vapour curve (Adapted - Reid, 1979, p. 1264)

On studies carried out by other researchers were found phenomena of BLEVE for temperatures below the temperature limit of overheating (Prugh, 1991, p. 15), (Birk, 1996, p. 236).
The causes for the rupture may be due to (VROM, 2005 p. 7.16):

- -the increase of the energy stored inside the tank to a value higher than the one for which it was designed;
- -the fact of the tank to have an external request higher than the projected.

A study conducted by Prugh to 49 BLEVE accidents, found that 17 of them were caused by exposure to fire, 12 due to faults in the mechanical resistance, 10 by overfilling, 6 due to chain reactions, 3 were caused by overheating and 1 by the steam explosion (Prugh, 1991, pp. 10-12).
This kind of accident has as results a shock wave with the projection of primary fragments (from rupture of the reservoir) and secondary (materials designed by the shock wave - glass, building materials, ...). If the released content, is fuel, may be also produced a fireball (Center for Chemical Process Safety, 2010 p. 320). In the human body, the shock waves can cause breakage of the internal elements such as lungs and eardrums and also the projection of people. The structures can also be damaged (VROM, 2003 p. 5). The fireball generated by the explosion may cause burns and fires.
The likelihood of a BLEVE is estimated by the HSE between 1×10^{-5} and $2{,}5\times10^{-5}$ occurrences per year (HSE - Health and Safety Executive, p. 33). The probability of a BLEVE in transportable tanks is less than 2.15×10^{-6} per year (Chakrabarti, 2011).

3.2 Consequences

The main consequences of a BLEVE are: Shockwave / pressure, projectiles and fireball.
When the shell bursts the energy released is distributed primarily by the last three parameters. These consequences of BLEVE are relatively well studied as a single phenomenon, but do not incorporate the surrounding environment.
In order to estimate the consequences of explosions BLEVE there are two main methodologies: the North American by CCPS (QA Baker), and by enterprise Dutch VROM (Van den Berg and Molag).

3.2.1 Pressure wave and projectiles

The calculation of the consequences of a BLEVE begins by determining the mechanical energy released. This energy is characterized by the pressure, by the mass and by the internal energy of the initial and final state, ie before and after the accident.

Consequences generated by the shock wave / pressure

Baker through the law of scale stemming from the law-Hopksion Cranz, will determine the distance scale $\bar{\boldsymbol{R}}$

$$\bar{R} = \frac{R}{(E/P_0)^{1/3}}$$

Where *R* is the distance between the origin of the explosion and the point at which aims know the parameters, *E* is a fraction of energy released by the explosion converted into shock wave / pressure and P_0 is the atmospheric pressure.
With the distance value is determined the pressure rise and the impulse caused by the explosion.

Consequences generated by the projectiles through the empirical model of Baum's (Doormaal & Wees, 2005, p. 7.48)
The maximum speed (v) of the projectile can be calculated using the following equation

$$\mathbf{v} = \sqrt{\frac{\mathbf{0{,}08.}\boldsymbol{E}}{\boldsymbol{M}}}$$

Where E is the energy released by the explosion and M the total mass of the reservoir.
After calculating the initial velocity will be determined the maximum radius reached by the projectile.

3.2.2 Fireball

To determine the consequences of the fireballs are calculated two parameters: the diameter (D) and duration (t) of the fireball. These two parameters are a function of the mass (m) of fuel in the tank. These functions vary with the values of the constants k_i, which take different values according to different authors. Abbasi, for example, has developed about 20 formulas, between 1973 and 1999 for the determination of the diameter and length of a fireball (Abbasi et al., Pp. 2007. 489-519).

$$D = k_1 m^{k2} \text{ e } t = k_3 m^{k4}$$

With the two previous parameters is possible to calculate the radiation received by a receiver (q) at a given distance from the center of the fireball.

$$q = \frac{2{,}2\tau R H m^{0{,}67}}{4\pi L^2}$$

Where: t is the atmospheric transmission, R is the fraction of heat radiated, m is the mass of fuel and L the distance from the center of the fire ball until the receiver.

3.3 Accidents in Southern Europe

In the Iberian Peninsula occurred two significant accidents both in Spain. In the Iberian Peninsula occurred two significant accidents both in Spain. One in July 11, 1978, in San Carlos, where a propylene leak caused 25 deaths and 211 wounded and another on June 22, 2002 with the release of 48 m3 of liquefied natural gas, LNG, in Tivissa, which resulted in one dead and two wounded.
The last reported incident occurred on June 29, 2009 with one train with fourteen freight cars of LPG in Viarreggio, Italy. 30 people died in this accident causing thousands of euros in property damage (Landucci et al., 2011).

3.4 Risk in traffic

The risk associated with this kind of transportation has increased gradually with increasing traffic (Van der Torn, pp. 2008. 343-379) and the quantities transported.
It is estimated that between 1940 and 2005 in the world died about 1,000 people, 10,000 has been injured and the property damage amounted to billions of euros (Abbasi et al., 2007).
The risk associated with an accident of the type BLEVE, in a static reservoir, is assessed based on the conditions of the reservoir at the time of rupture and characteristics of their content (VROM, 2005 p. 7.16). When the reservoir is subject to transportation, other factors are introduced. Among these are to emphasize the type of road, the traffic density and the population density of the areas through which passes (VROM, 2005 p. 1.1) .

3.5 Prevention of BLEVE

Research on the prevention of BLEVE, at the project level of the reservoirs / tankers, focuses mainly on two areas:
- Assessing the performance of safety valves
- Passive protection by improving the behavior of the reservoirs to heat.

One of the main lines of research on the performance of the road tankers to BLEVE is headed by Birk in Canada (Birk & Vandersteen, 2006, p. 648) and in Europe by TNO (Molag & Krruithof, 2005). This issue is so important that in 2006 was constituted an informal working group within the Economic and Social Council of the United Nations for the study and reduction of the BLEVE. The initiative was from Dutch government whose territory is crossed by one of the main routes of LPG road tankers (Gomes, 2008).
This group proposed technical measures (safety valve, thermal insulation, sunshades, aluminum ball inside the tank, additional protection against impact, ...) and organizational measures (periodic inspections, dedicated routes, speed control, training, management safety system, control of alcohol and drugs, ...). At present, the group continues to develop studies for which it was created, trying to find the most appropriate measures, taking into account their economic viability. The development of this study is expected to last until 2012 (Working Party on the Transport of Dangerous Goods - Economic Commission for Europe, 2011).
By improving the performance and reliability of safety valves will go to improve the flow of the fluid and thereby prevent rupture of the reservoirs by excess pressure (Pierorazio, et al., Pp. 2000. 60-65), (Jonathan, et al., pp. 2002. 227-236).
Improving the heat resistance of the tanks through coatings, will be increased the amount of time which the shell will resist to the collapse, allowing thus to take all necessary measures for evacuation of people and lessen the damage, with an estimated decline of the individual risk by 50% (Landucci, pp. 2009. 1182-1192).
The study of the behavior of tanks remains important, since, for market reasons the requirements of the building codes are decreasing, jeopardizing the safety of persons and goods (Birk, 2005 p. 55).

4. CONCLUSIONS

BLEVE is an technological accident that has serious consequences for people and property. It is caused by the pressure wave, by the projection of fragments and by the fireball (in case of fluid fuels). The probability of occurrence of such an accident is low. However, this probability increases when pressure devices are installed on mobile devices (road tankers). The trend to improve the prevention of BLEVE focuses on the construction of reservoirs, since the use of building codes, application of coatings and improving the efficiency of the safety valves.

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Usage and effectiveness of Adaptive Cruise Control: a focus group study

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ABSTRACT
A wide number of Advanced Driver Assistance Systems (ADAS) have been developed with the objective of helping the driver in the primary driving task. Among the first ADAS available on vehicles, Adaptive Cruise Control (ACC) assists the drivers in keeping the desired speed and headway to the preceding vehicle by controlling fuel flow or by slightly braking. Through the partial automation of the longitudinal driving task, ACC could reduce the driver's workload and, therefore, increase drivers' comfort. However, a new task will be introduced for the driver: the monitory of the system. Based on the studies already carried out, there is concern in the academic community about the possible negative effects of ACC on road safety (e.g., reduction of situation awareness and behavioural adaptations to the system). Furthermore, there is a lack of research performed with real users of the system as participants. In order to fill this gap, the first step on that direction could be represented by the subjective assessment of drivers' behaviours and patterns of use with the system. In this context, this study aims at investigating the perceptions of ACC drivers concerning the usage and effectiveness of ACC. Two focus group sessions were carried out in Braga (Portugal) with ACC users aged 33-61 years. Results showed that drivers use the system in high speed roads and with stable or low traffic conditions. Drivers are, globally, satisfied with the system but pointed out that, in some situations, the system is not comfortable and they prefer to deactivate it. Some positive effects of ACC were mentioned but, on the other hand, improper usages of the ACC were also revealed by the participants. Finally, concern was shown with respect to the drivers travelling behind the car equipped with ACC. Further research confirming or rejecting the finding is suggested.

Keywords: ADAS; ACC; Focus groups; Road safety; Acceptance.

1. INTRODUCTION

1.1. Road safety and Intelligent Transport Systems

According to a report recently published by the European Commission (EC, 2000), the introduction of Intelligent Transport Systems (ITS) might play a significant role for the improvement of road safety in the next years. ITS include "several combinations of communication, computer and control technology developed and applied in the domain of transport to improve system performance, transport safety, efficiency, productivity and level of service, environmental impacts, energy consumption, and mobility" (Sitavancova & Hajek, 2009). ITS applications are extended to all modes of transport but, in the limited context of road, ITS can be defined as the "road based, vehicle based, vehicle to road based or vehicle to vehicle based technologies supporting the driver and/or the management of traffic in a transport system" (Linder et al., 2007).
The latest technology available on automobiles, such as In-Vehicle Information Systems (IVIS) and Advanced Driver Assistance Systems (ADAS), are part of the broad category previously identified as ITS. Despite it is not always easy to discern between them, the main difference among ADAS and IVIS is that the former includes those systems which assist the drivers in the primary driving task (activities undertaken by the driver to maintain the longitudinal and lateral vehicle control, within the traffic environment). ADAS actively stabilize or manoeuvre the car whereas IVIS, which include equipment such as radio and navigation systems, provide information related or not with the driving activity.
Among the first ADAS to be introduced in the market, Adaptive Cruise Control (ACC) is an assistance system derived from the traditional Cruise Control and it is the ADAS under analysis in this study.

1.2. Adaptive Cruise Control

Adaptive Cruise Control is a driver assistance system brought to the market about 20 years ago in high-end vehicles, and becoming more and more widespread in modern cars during the last years. The system is, at the moment, available in various models of different brands such as Audi, Volvo, Mercedes, BMW and Ford. ACC is designed so that the drivers can choose both the desired speed and headway to the preceding vehicle. In response to those settings selected by the users, the system adjusts the vehicle's speed and headway by controlling fuel flow or by slightly braking, detecting the driver ahead through the frontal radar/laser sensor (SWOV, 2010). Despite the partial automation of the longitudinal driving task, the system can be overridden or deactivated by the driver at any time in order to allow him/her to take back the control of the vehicle.
Recently, car makers have undertaken technological developments of the Adaptive Cruise Control, such as the introduction of the "Stop&Go" feature (also called "Queue assistant"). This function allows the vehicle to slow down up to a complete standstill (SWOV, 2010) and, in case the vehicle is provided with automatic gearbox, to accelerate it until

reaching the set speed or the selected headway to the vehicle ahead. This feature has been added to the previous version of ACC, having in mind the situation of a vehicle standing in a queue, at low speeds.
ACC has been marketed by car makers as a “Comfort and driving pleasure” device. Indeed, through its usage, it is expected a decrease in drivers' workload and, as a consequence, a global beneficial effect on road safety. However, on the other side, the partial automation of the longitudinal driving task will introduce a more difficult duty, the monitoring of the driver assistance system (‘automation irony’, Bainbridge, 1983). Based on this assumption, the automation of the task does not directly bring a commensurate reduction of workload for the driver, being actually true the opposite (rise of overload) in some cases.
The so called ‘automation irony’ is not the sole concern that human factors experts should take into account when speaking about the partial automation of the driving task. As already reported by previous research, several concerns often interrelated, can be distinguished. Table 1 displays a list (not at all exhaustive) of those issues describing them shortly.

Table 1 – List of the main issues related with the introduction of automation in the driving task

Issue	Definition
Low acceptance	Low reaction towards an object (Schade & Schlag, 2000).
Overtrust	Psychological state in which the trust in a system is inappropriately high (Inagaki & Itoh, 2010)
Behavioural adaptation	Behaviours following the introduction of changes to the road-vehicle-user system and not intended by the initiators of the change (OECD, 1990)
Distraction	Drivers' involvement in doing things that are not related to the primary driving task and that disturb attention needed when driving safely (Patten et al., 2004)

Being aware of the issues listed in Table 1, researchers carried out studies before and after the introduction in the market of ACC, in order to investigate how the system might affect traffic safety. Among the first ones, Stanton et. al. (1997) concentrated their attention on the drivers' ability to take back control from ACC. During a driving simulator experiment, the participants had to react to an unexpected acceleration of the system and avoid the vehicle ahead. The findings showed that one-third of the sample failed to regain control of the vehicle and crashed into the car in front. Besides that, driving with the system was associated to a reduction of driver's workload: participants engaged more in a secondary task when driving with ACC compared to the situation of manual driving.
Later, Hoedemaeker & Brookhuis (1998) evaluated, in a driving simulator study, drivers' acceptance and reactions while driving with ACC. The results of the study were threefold: with ACC activated, participants showed a tendency to increase the speed, to pay less attention to the vehicle's lateral position and to stop closer to the vehicle ahead when hard braking was required. The last finding confirmed what already found by Stanton et al. (1997): a later drivers' reaction to an emergency situation when the system was activated. The conclusions on the workload, in Hoedemaeker & Brookhuis (1998) were as well, coherent with the findings of Stanton et al. (1997).
In a successive closed track study, Rudin-Brown & Parker (2004) supported the findings of Stanton et al. (1997): again, drivers took longer to brake in a safety-relevant detection task and performed better in a secondary task while driving with ACC. Furthermore, in accordance with Hoedemaeker & Brookhuis (1998), lane-keeping performance deteriorated when using ACC compared to the manual driving condition. In the study of Rudin-Brown & Parker (2004), it was also shown the relevance of personality traits, such as Sensation Seeking and Locus of Control, to determine drivers' reliance on Adaptive Cruise Control.
During a more recent research, Vollrath et al. (2011) compared driving with and without the system in a driving simulator experiment. Again, in accordance with previous studies, the drivers' reactions to the critical situation (entering in a fogbank) were slower when using ACC compared to driving without the system. On the other hand, positive effects of the system were also derived: driving with ACC, the participants perceived a lower workload level and, as well, decreased their maximum speed.
The mentioned studies are only a small part of the research performed, up to now, on Adaptive Cruise Control. However, even from this brief selection, it is evident that there is concern in the academic community about the possible negative effects of ACC on road safety (reduction of situation awareness, behavioural adaptations to the systems, overtrust in the system, etc.). Although many studies have been already carried out, there is still need for more research.

1.3. What is lacking?

Regardless of the outcomes, the mentioned studies evaluated the effects of ACC based on participants who, in large majority, never used the system before the research experiment. Then, it is not clear how real ACC users will behave when they face analogous critical situations: we might expect their reactions will be different considering that they went through a learning phase with the system. However, in order to clearly understand the impact of ACC on road safety, it is necessary to perform research which involves real users of the system as participants. Though not exhaustive, the first step to understand drivers' behaviours and patterns of use with ACC is achieved directly asking to the users, through subjective assessment.

In the United States, Dickie & Boyle (2009) carried out a survey with 58 ACC users. The main core of the survey consisted of 30 questions which focused on users' general perceptions, patterns of use and understanding of the system and its limitations. Based on the answers, 3 clusters of ACC users were distinguished: the unaware, the unsure and the aware cluster. The results showed that people in the unaware and unsure clusters were not conscious of the limitations of ACC when driving in curvy roads and were more prone to use the system when tired. Furthermore, all the 3 clusters indicated high levels of trust in the system. Globally, some concern arose due to the combination of low awareness of systems limitations and high level of trust for the drivers in the unaware and unsure clusters.
Later, Strand et al. (2010) performed focus group sessions with ACC users in Sweden. The scope of their research was to understand the usage, the driving behaviour and the risks associated with the ACC utilization. From their study, the users appeared satisfied about the system. Furthermore, according to the participants, ACC bring some positive effects on traffic safety: the driving task is more comfortable, the drivers follow the traffic pace and stay more on the right lane. On the negative side, participants stated they had already experienced some critical situations with the system, such as in curvy roads and roundabouts or during overtaking manoeuvres. The researchers concluded that, for many participants, the functioning principle of the system was still based on a rudimentary mental model. Therefore, they suggested that car makers should take some training actions in order to help users to develop a working mental model of the system.
Always in Sweden, Larsson (2011) performed a survey to understand drivers' specific experience and patterns of use with ACC. The questionnaire consisted of 17 questions where drivers could report situations in which the system behaved in a surprising manner. Overall, 130 questionnaires were received back. The results showed that drivers were, in general, informed of the limitations of the system and this awareness was related to the system's ownership: the longer the drivers had the system, the more they were aware about its limitations. The critical situations encountered by the drivers were similar to the ones found in Strand et al. (2010). Larsson came to the conclusion that the usage of the system may actually be less detrimental to driver performance than previous research has suggested but, on the other hand, underlined that more effort is required to help drivers in developing an appropriate mental model of ACC as already suggested by Strand et al. (2010).
Overall, previous studies on Adaptive Cruise Control have underlined several positive and negative effects of the system on road safety. However, until now, few studies were based on the perspectives of real ACC users. Then, further research is required to build a complete picture and, especially, to take into account the differences between countries (e.g. Southern Europe vs. Northern/Western Europe) as it is demonstrated that the impact on traffic safety depends also on economic, societal and cultural factors (Özkan, 2006).

1.4. Purpose of the study

This study aims at collecting drivers' perceptions and attitudes about the usage and effectiveness of Adaptive Cruise Control from a sample of Portuguese ACC drivers. Focus groups interviews were performed to get the widest range of ideas and feelings about the system and to understand differences in perspectives among the people participating (Krueger & Casey, 2009). The appropriateness of this technique for the set aim is demonstrated by former studies already performed to investigate drivers' opinions on IVIS and ADAS (Young & Regan, 2007; Strand et al., 2010; Pereira et al., 2010).

2. METHOD

2.1. Participants

The study involved overall 13 participants, 12 males and 1 female, aged 33-61 years. In the two focus group sessions, 7 and 6 people respectively took part. All the participants were experienced and regular drivers, having driven more than 150000 km since they got their driving licence and using their vehicle daily. All the people were Volvo drivers and the vehicles mostly used by the participants were S60 and V60. All participants were users of ACC and all of them had driven more than 50 Km with the system activated.
Due to the still low market introduction of the ACC in Portugal, the participants were contacted and recruited through the help of a Volvo dealer located in Braga. Therefore, the selection strategy can be defined as a 'convenience sampling' (non-probabilistic sampling) because the sample was simply available by virtue of its accessibility (Bryman, 2008).

2.2. Procedure

The discussion was led by a moderator, helped by an assistant moderator and a note taker who had exact tasks to accomplish (Table 2).
About 1 week before the session, a letter of invitation was sent to the participants to remind them the date, time and location of the focus group. Attached to the letter was a document where people were asked to list the critical situations experienced with the system activated. This document had the aim of facilitating the discussion on this topic.
Both focus groups started with a short presentation of the research team followed by a description of the purpose, the confidentiality issues and the modality of the session. During the introductory explanation, special attention was dedicated to explain to the participants that the objective of a focus group is not to reach the consensus but to have the widest range of opinions from all the participants.

Once the introduction was completed, a short video about Adaptive Cruise Control was played. The purpose of the video was to remind the participants of the basic functionality of ACC and to be sure they were aware of which was the system under discussion. Then, participants filled the consent form, a personal questionnaire and a questionnaire concerning the usage of ACC.

Table 2 – Task for each member of the research team.

Moderator	Assistant moderator	Note taker
Welcome participants	Welcome participants	Welcome participants
Introduce study and research team	Arrange material for ACC presentation	Sketch participants' position
Lead the discussion	Keep the time during discussion	Take notes about striking moments

The discussion about the ACC followed a previously developed guide which included open-ended questions, according to the suggestions found in Krueger & Casey (2009). The questions aimed at obtaining information on 3 topics:

1. Satisfaction: participants were questioned on their expectations about the system (*'Before using ACC, which were your expectations about the system?'*) and their fulfillment ('*How were your expectations about ACC satisfied?'*).
2. Critical situations and problems: participants, using the document sent to them earlier, were asked to mention the critical situations (*'Which are the critical situation did you already experience while driving with ACC activated?'*) and, more in general, the problems experienced with the system (*'More than the critical situations, which are the other problems you found during the utilization of ACC?'*)
3. Type of usage of the ACC: participants were questioned about what they do while they drive with the system activated (*'What do you usually do when you drive with ACC activated?'*)

In order to enrich the research, the participants were free, at any time of the discussion, to raise other topics of discussion, always under the supervision of the moderator. At the end of the session, the participants were asked if they had any suggestion for the improvement of the system or if they had anything to add to the discussion. Each focus group session lasted approximately 1 h and it was video-recorded in order to help the later transcription.

2.3. Analysis of the data

The focus group sessions were, first, transcribed through the help of the software "f4" developed for such aim and freely downloadable at the website http://www.audiotranskription.de/english/f4.htm. Then, a qualitative content analysis of the discussions was performed using the software MAXQDA. The categories used for the analysis were the three main topics reported in the previous section. From the main categories, sub-categories were also retrieved during the qualitative analysis. Due to the very small sample available for the study, the analysis did not take into account variables such as gender, age and driving experience and no statistical analysis was carried out.

3. RESULTS

3.1. Usage

From the questionnaire administered before the session it was possible to get some preliminary information concerning the usage that drivers make of the system. Participants revealed to use the system, primarily, on highways and roads with speed limit higher than 100 kph. Furthermore, they stated to drive with ACC activated in any weather conditions exception given for few drivers which don't use the system with hard rain or fog. Participants stated also to use the system indifferently during the day and at night (only one participant admitted not using the system at night fearing to fall asleep with the system activated).

Concerning the usage of ACC in the different conditions of traffic, through the questionnaire and the group discussion, it came out that the drivers, in large majority, use ACC with stable or low traffic conditions because, with heavy levels of traffic, the system has abrupt reactions, due to the constant presence of other cars and trucks ahead. However, some drivers admitted to use the system even in heavy transit conditions. One driver said "In trips with low traffic, I avoid using the system, due to the issue of monotony".

Participants indicated that the system is, probably, perfectly adapted for the Swedish market but, on the other hand, it is not completely operable in countries such as Portugal due to the different existing driving styles in the 2 countries. Notably, one participant said "In a market (car market) like the United States or Sweden, where all drivers respect the speed limit, the system is fantastic. When we consider a market like the Spanish, the Italian or the Portuguese one, all this is not true anymore because people don't respect the speed limits and, certainly, don't drive at the same pace than trucks, as it happens in the United States".

Despite generally using the system, the participants stated to deactivate it in some circumstances due to the low comfort perceived. Notably, the drivers mentioned 2 situations: in heavy traffic since the system has abrupt reactions (continuous braking and acceleration) and in long trips because the system reduces the average speed that the driver would like to maintain. One participant mentioned to anticipate the system's action: "Sometimes, we want to wait until the system brakes but, eventually, we are afraid and we decide to brake ourselves, not leaving the system working at its maximum".

Unlike the other drivers, one participant stated not to use the system as he likes to manage his driving without the system interfering in it.

3.2. Satisfaction

The large majority of the participants were satisfied about the system since it makes the driving task more comfortable and safer, compared to driving without the system. One person, who is driving as well a vehicle not equipped with ACC, summed up this way: “When I move from my car to another one which does not have the system we are talking about (ACC), there is a clear difference since it is very comfortable to drive with this help”.

The participants mentioned that ACC is a good enhancement compared to the ‘previous’ Cruise Control. Notably, the ACC gives a higher feeling of relaxation and safety because it allows the drivers to maintain a defined speed and distance to the vehicle in front. One participant mentioned the following: “When a person is driving long time with the Cruise Control, he/she takes out the feet from the pedals and if, suddenly something occurs, probably we are not going to press the brake because the feet are in a position which is not normal and this might cause an issue. However, in case it is a car equipped with ACC, since it brakes, there is an advantage”. Only one participant stated to prefer the Cruise Control to the ACC motivating his claim with the fact that the former is more comfortable and more apt to various driving conditions (compared to ACC which is only good in highways).

Referring, then, to the ACC “Queue Assistant” (for car provided with automatic gearbox), the participants were extremely satisfied since it is very favourable when the driver is stuck in a queue. The system brakes and accelerates following the vehicle ahead and it works also at lower speeds than 30 kph, leaving to the driver only the task of steering the car in the proper direction. Despite using this function, the drivers seemed aware of the fact that special care is required considering that the system won’t be able to stop the vehicle if the traffic light turns red and no car stops ahead.

However, despite the global positive opinion about the ACC, some discontent was also shown by the participants. The main reason of discomfort was resulting from the abrupt braking actions undertaken by the system when it detects a vehicle travelling at lower speed. This situation is mostly common in conditions of heavy traffic and it often leads the drivers to deactivate the system (as mentioned in the previous section). One participant mentioned “The feeling that we have is that it (the ACC) is constantly braking. The system gets completely confused with any objects, even if it not a vehicle and that feeling of comfort is wiped out”.

3.3. Concerns

Among the participants, only one had an unpleasant experience with the system. He reported: “The truck slightly deviated and I was trapped between the truck and the guardrail. If I had paid attention to the working of the system, I would have realized what was going on and, maybe, I would have not placed myself close to the truck. However, I trusted that the system would have worked and I almost damaged the car”. The remaining participants did not reveal any critical situations for safety, encountered while driving with the system activated. However, they also mentioned that, in order to have a safe approach to the system, people need to be aware ‘a priori’ of the system’s working principle and limitations.

The main concern emerging from the discussion was for the people travelling in the vehicles behind. The participants were worried that the behaviour of the system could seem, in some occasions, odd for the following drivers due to the continuous braking activity undertaken by the system. This system’s operation might be perceived as strange by other drivers since the equipped vehicle is braking even if there is a large amount of space in front. One participant reported: “Basically, the drivers who are in the vehicles behind probably think: Why this mad guy is braking since there is nothing in the front?”. When the ACC drivers feel this uncomfortable situation, they usually deactivate the system.

Another issue which was cited during the sessions is the behaviour of the system in curves. In those situations, according to the participants, the system is not adequate to be used because it gets confused. Indeed, in some cases, it might detect an obstacle and brake and, in other case, it might suddenly accelerate when the vehicle in front is out of the detection range of the radar. This behaviour might affect safety in case the driver is not ready to react.

3.4. Impact on road safety

The drivers think that the system, maintaining the speed and the headway to the vehicle ahead, makes the driving task more relaxing. However some participants stated that the comfort and the relax brought by the system might be excessive, leading people to pay less attention to the road or to their actions up to the point of forgetting how they reached their destination.

Drivers mentioned further positive aspects of driving with the system activated, as reported in Table 3.

Table 3 – Positive aspects in driving with ACC

Keep a safer distance to the vehicle ahead
Feel more concentrated while driving with ACC
Maintain a lower speed compared to driving without ACC
Avoid crashing with the car in front in one occasion

During the discussion, the participants were also asked what they usually do when they drive with ACC activated. In Table 4, it is reported a list of the answers cited by the participants.

Table 4 – Activities undertaken by the drivers when using ACC

Remove feet from pedals in order to get a more comfortable driving position
Call with the phone
Use internet on smart phone in situation of low traffic (queue)
Reading a book

Concerning the pure usage of the system, improper behaviours were detected during the discussion. Some participants revealed to drive without pressing the pedals, only using the buttons of the ACC (speed and headways buttons). Then, 2 participants respectively mentioned to use the system seeking a vehicle in front and to set short headways while driving with ACC. Those two behaviours were undertaken by the drivers in order to avoid the abrupt reactions of the system (as already previously mentioned).

3.5. Suggestions

Before ending the discussion, the participants were asked to provide some suggestions for the future improvements of the system. The majority of participants revealed that they were satisfied with the current version of the ACC and no other functionality was required. However, two participants mentioned that it could be a further improvement to have a directional radar (similar to the concept of directional headlights) in order to allow the system to detect the vehicle ahead even when travelling on a curvy road. Another driver mentioned that the smoothness of the system could be improved in order to avoid abrupt and continuous braking actions. With the same aim in mind, a participant stated that it would be good to cross the clues of the different systems available on the car (Pedestrian detection, Emergency braking, GPS) in order to have more detailed information about the vehicle in front and about the location where the car is situated.
Finally, 2 participants stated that no other function should be added because, otherwise, the automation of the driving task would be pushed too much forward, taking the driver out.

4. DISCUSSION

4.1. General findings

The main goal of this research was to get the opinions on Adaptive Cruise Control from regular users of the system. Notably, the attention was centred on three aspects: usage, satisfaction and implication for road safety when using ACC.
Concerning the usage of ACC, the findings are comparable with the ones reported in the Swedish study (Strand et al., 2010). Participants stated to use the system mainly in high speed roads and with stable or low traffic conditions. They deactivate ACC for two main reasons: the system has abrupt reactions in some driving contexts and, as well, it lowers the desired average speed. The same reasons led the participants to remark that ACC is not completely suitable to a market such as Portugal where there is, almost constantly, intense traffic and drivers are not obeying to the speed limits.
Overall, the participants were satisfied about the system since it makes the driving task more relaxed and safer. The ACC was, generally, considered more comfortable compared to the previous Cruise Control due to the possibility of adjusting both the speed and the headway to the vehicle in front. With respect to the “Queue assistant” function, great appreciation was expressed by the drivers who owned a vehicle with automatic gearbox. Some discontent was shown for the jerky behaviour of the system in heavy traffic conditions.
Only one driver experienced a critical situation with ACC activated. In contrast with the finding of Larsson (2011), few limitations of the system (driving on curvy roads and braking suddenly) were mentioned by the participants. On the other hand, as already found in Strand et al. (2010), high concern was shown for the vehicles travelling behind the equipped car. Indeed, due to the nervous behaviour of ACC, the drivers in the back might not clearly understand what is happening in the front.
Concerning the impact of ACC on road safety, drivers stated to keep a safer distance to the vehicle ahead and a lower travelling speed. Those positive effects of the system clash with the findings of Hoedemaeker & Brookhuis (1998). On the other hand, participants revealed to engage in secondary activity (calling at the phone, using internet or reading a book) when driving with ACC. Furthermore, few participants revealed improper usages of ACC, like driving only using the ACC buttons, seeking a vehicle in front and setting short headways while driving with ACC.

4.2. Limitations of the study and next steps

In the findings presented with this article, there are certain limitations which should be addressed by further research. The small size and the absence of randomization in the sample prevent us from extending the outcomes to a general population of ACC users in Portugal. However, as already mentioned, drawing a statistical inference was not among the objectives of the research which was simply a pilot study.

As a methodological shortcoming, the focus groups interviews are only based on participants' opinions and, therefore, the study still lacks objectivity in the findings. In order to fill this gap, a Field Operational Test (FOT), involving a limited sample of drivers, is planned for the next months to confirm or reject the results extracted from this study.

5. ACKNOWLEDGMENTS

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Road (Un)Safety: A Comparative Analysis Brazil vs. Portugal

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ABSTRACT
This article deals with a comparative analysis of road safety in Brazil and Portugal, and it presents an attempt to identify the causes, statistics and socio-economic costs of accidents in both countries. To this end survey was carried out and analysis of secondary data collected in places officers in both countries. From the analysis it is clear that in both countries the phenomenon is multicausal prevailing behavioural issues of drivers, passengers, pedestrians and road traffic management.

Keywords: Road Safety, Brazil vs. Portugal, Road Accidents.

1. INTRODUCTION

According to projections by the World Health Organization (WHO, 2000), in 2020, road accidents will be the third leading cause of death worldwide. According to the European Commission statistics to Road Safety (COM, 2003), in the European Union there are annually, 1.3 million road accidents that cause more than 40 000 deaths and 1.7 million injuries. Vulnerable groups are young people, pedestrians and cyclists. According to the same study, the cost of these accidents was estimated at 160 billion euros, i.e., representing 2% of the GNP in the European Union (EU27).

1.1. Causes of road accidents

The Haddon Matrix was developed in 1968 by the American doctor William Haddon Jr., with the aim of determining the causal factors related to an injury or death; (before, during or after the accident. This matrix classifies causal factors or attributes in: human or personal factors (drivers and pedestrians), vehicle factors due to the infrastructure and environmental factors (ANSR, 2009).

1.1.1 Due to drivers, passengers and pedestrians

Man is considered the key element in the road traffic system, and, "human error" worldwide, accounts for over 90% of the registered accidents (Carvalho & Leyton, 2000). The major indiscretions concerning fatal accidents in Brazil are in order of incidence: speeding, driving under the influence of alcohol and drugs, insufficient distance from the front vehicle and disregarding traffic signals. The following factors can be listed as crucial for such carelessness: better legal framework, enforcement, little education, devaluation of life, lack of community spirit and exacerbation of individualistic and more important, vehicle use as a demonstration of power and virility (CNT, 2010).

A. Drunk Driver

Several laws regulate alcohol use by drivers of motor vehicles. Within the legal framework in different countries, legal limit values to blood alcohol concentration (BAC) were set. Carvalho & Leyton (2000) published BAC levels (in grams per litre of blood), allowed in certain countries:
Australia, Finland, France, Japan, Portugal and Sweden: 0.5 g/l.
Belgium, Canada, Denmark, Spain, Italy and Germany: 0.8 g/l;
United States, in some states is 1.0 g/l;
Brazil: Administrative scope level: 0 g/l (zero); criminal level: 0.6 g/l

B. Pedestrians Behaviour

A pedestrian is, according to the Portuguese Road legal framework, every individual who walks on sidewalks, tracks, pedestrians' crossways (zebra crossing) or in its absence, in public roads berms. To avoid accidents, pedestrians must, among other strategies, hold a better knowledge of their travel needs and behaviour, take care to see and to be seen, exercise caution in sharing space, guided by respect, common sense and legal compliance and take into account the adaptation of the elderly pedestrian environment.
Road accidents are the leading cause of death and serious injury in children aged 0-14 years and road accidents are also the cause of 34% of deaths from accidents involving children in the European Union (EU) each year, comprehending pedestrians, cyclists and passengers of motor vehicles. Death and/or serious injuries of children under the age of 10 years, are, very often, caused by the failure to use appropriate children restraint equipment in vehicles (ECSA, 2007).
Documents issued by the European Child Safety Alliance, with reference data from 2003, show that the vast majority of road accidents in the EU15, involving children aged 0-14 years, occur inside the vehicle, probably due to negligence, incompetence or carelessness of parents (Figure 1).

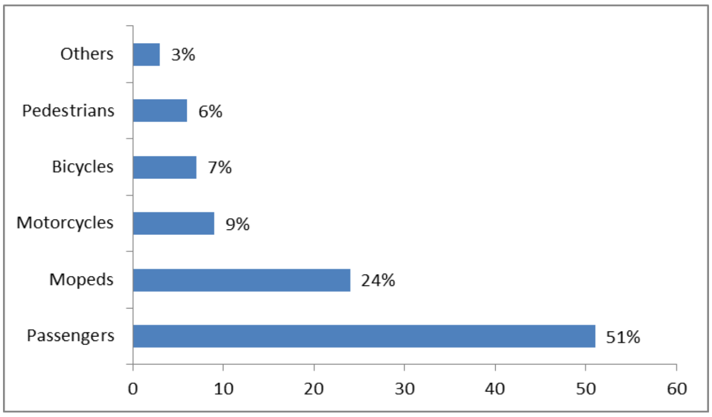

Figure 1 - Road Traffic injury in children from 0 – 14 years (EU-15)
(IRTAD Database, 2005, for IT+LU data from 2004, for IE data from 2003)
Source: European Child Safety Alliance (ECSA, 2007:11)

It is estimated that 200 000 families, each year suffer due to the death or lifelong disability of at least one family member due to a road traffic injury while circulating in the European Union (EU). It is also estimated that approximately 150 lives could be saved, every year, if parents made use of these children seat belts equipment in their children. Young people aged between 15 and 19 are the group at most risk, being males the most exposed (75% of fatalities).

1.1.2 Due to causes related to the road infrastructure

*A. R*oad surface

The road surface is a structure designed and built to withstand the traffic volume of motor vehicles under various weather conditions and to improve the conditions of driving in comfort and safety (Senço, 1997). Defects in the road surface, such as cracks, holes, depressions, corrugations and other type of road surface deformations can endanger user security and increase the time and cost of travel (CNT, 2010).
According to a survey conducted by the Brazilian National Confederation of Transport concerning the quality of the Brazilian roads in 90 945 km of paved road network, 43.9% of the total length, corresponding to 39 935 km, the condition of the road surface is absolutely perfect, while 32.2 %, i.e., 29 278 km, the road surface showed signs of weariness. On the other hand, in 23%, (20 944 km) road defects, potholes and depression prevail. The condition of road surface completely destroyed represents just 0.9%, or 788 km of the road system researched (Figure 2).

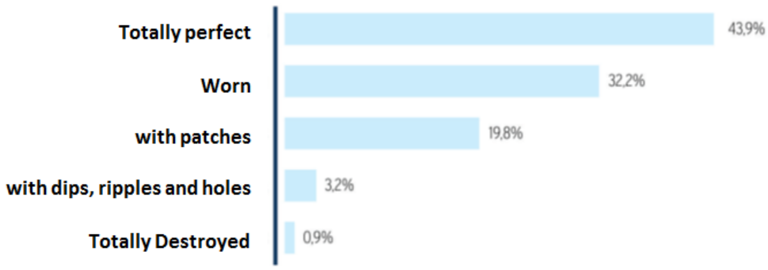

Figure 2 - Conditions of Brazilian paved road surface
Source: CNT (2010:26, 27)

These findings, in a traffic safety perspective are worrisome, meaning that 56.1% of the road surface presents considerable risks of accidents resulting from the lack of quality of the road. Another aspect to consider is that in 43.9% of excellent quality, users typically use to speed up and catch up on defective parts, which keeps them at risk of an accident, perhaps even greater than in faulty parts.

B. Berm

The berm is an element of road geometry very important for users, because in case of mechanical failure, allows the safe stop of the vehicle. For this reason, rules require a road edge width, wide enough to accommodate a car and a person working beside it (CNT, 2010). In the CNT survey, in 2010, berm was found in 54 705 km, for 60.2% of the total surveyed kilometers. Of these, 10.9% exhibit defective or destroyed berms, compromising its effectiveness in the protection and accident prevention (Figure 3).

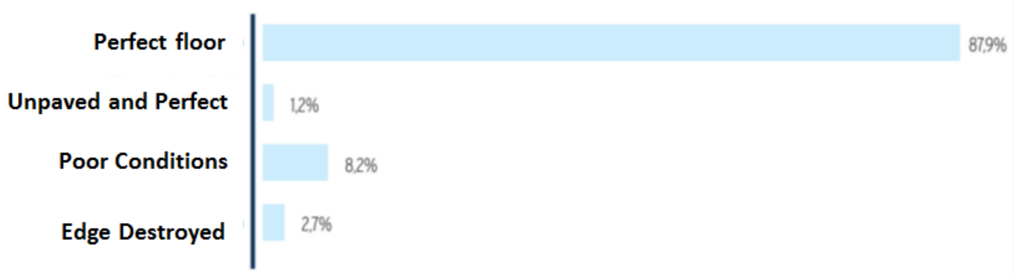

Figure 3 - Situation of Berm
Source: CNT, (2010: 27)

1.1.3 Due to vehicles

Vehicles can contribute to accidents, whether by its own design and structure, is the time of use and wear. The elements of the design and protection of users of transport, there are the motorcycles, because they are nimble, cheap, economic, but too expose the user to the accident, in most fatal cases.

The specific severeness of traffic accidents is obviously linked to the involvement of the vehicles, which can become extremely dangerous instruments as a result of the violence of the shock, maintenance of defects, or misuse.

Despite a continuous and considerable collective effort of the automobile manufactures, in case of shock, from a certain speed, the vehicles remain extremely dangerous. It is particularly critical in the event of a collision between a vehicle and an unprotected user (pedestrian, cyclist and motorcyclist) and in case of collision between vehicles of different strength: car vs. truck, for example. The drivers do not have this in mind and do not evaluate the potential violence of the accident.

Other aggravating factors for accidents resulting from vehicles, flat tires, or lack of calibration, faulty lights or poorly adjusted mirrors disabled, mechanical failures on the highway, visibility impaired, or cargo badly stowed overhead.

According to the Brazilian Association of Manufacturers of Motorcycles (ABRACICLO), the overall average:

- The majority (80 to 85%) of motorcycle purchases is made by men under 40 years of age (83%);
- Most users (90%) live in urban areas and use the bike to and from work or school (75%).

1.1.4 Causes resulting from weather events

Atmospheric issues have a major influence on road accidents in most countries. Northern countries, Scandinavia and mountainous regions of Europe, have as an environmental cause of road accidents, adverse weather conditions such as high winds, snow and ice. In Brazil, the main climatic factors of risk of road accidents are the rain and fog.

1.2. Social-economic impacts of road accidents

Traffic accidents, beyond the loss of life, can have serious implications for physical and psychological health of those involved. In physical terms beyond the immediate suffering, the consequences may include termination temporarily partially or completely daily life activities, due to the severity of injuries, which may include fractures, paralysis, amputations and nerve damage that interfere with the life of the injured but also everyone related to (Mayou, Bryant, & Ehlers, 2001).

Accident severeness, the involvement of deaths, the seriousness of the injuries involved and the impact on the life of the injured person, responsibility and guilt, and the issues in dispute with insurance companies that often arise are, among others, referred by authors as fundamental analysis of this issue with the victims of road traffic accidents, and are important in the perception and meaning that are experienced accidents (Blanchard *et al.*, 1997 *apud* Pires and Maia, 2004: 4).

Knowledge of the social-economic costs of accidents is necessary to warn society about the size of the problem and how to calculate the feasibility of measures to reduce or prevent accidents. It is important not to underestimate the social-economic costs of accidents, because it would derail the project. Costs include: property damage (vehicles, objects and equipment), medical and hospital costs, operating systems of care, costs of traffic congestion, funeral expenses, insurance administration and administrative cost of litigation and loss of future income.

The NPO "Way Safe" (Brazilian Association for Prevention of Traffic Accidents) estimated, from data from surveys conducted in the state of Sao Paulo (Brazil, 2004) and data from the Traffic Engineering Company of the State of São Paulo in 33.7 billion of Brazilian Real (R$) financial costs of traffic accidents in Brazil.

A study conducted by the Autonomous Department of Roads of Rio Grande do Sul (DAER), provides the following estimates of costs per accident (Masiero, 2009:7):

- Casualties: R$ 270 165.00;
- Victims with injuries: R$ 36 305.00;
- Property Damage: R$ 1 040.00

It should be noted that, compared to expenditures for inpatient treatment by natural causes, Mello Jorge and Koizumi (2007:186) show that, even with less time spent in hospitals, patients who suffer from traffic accidents are more expensive than the others and have higher hospital mortality rate.

2. MATERIALS AND METHODS

The method employed in this research was deductive descriptive. Data collection was through a literature review on road safety in Brazilian and Portuguese sites of public, private and NPO. The objective of the comparative analysis of data tried to understand the similarities of the causes of road accidents between Brazil and Portugal.

3. RESULTS AND DISCUSSION

3.1. Road Accidents in Brazil

Brazilian statistics of traffic accidents are dispersed in three different data sources:

- National Department of Transit - DENATRAN: crafts its yearbooks from police reports drawn up by the police computer, so only deaths that occur on the spot or within 24 hours after the accident, and therefore the data more understated;
- Database of the Unified Health System/MS - DATASUS: This system of the Ministry of Health computes the fatalities of people treated in health facilities;
- Insurance Personal Injury Caused by Motor Vehicles Land or on its load the person transported or not - DPVAT: The third source is the Compulsory DPVAT, established in 1974 to protect the victims of vehicle accidents.

During the period 1994 to 1997, Brazil experienced a very strong increased in the number of deaths from traffic accidents. To combat this public health problem, the Brazilian government created the Brazilian Traffic Code (CTB). In the following years (1998-2000), the number of deaths of the total population and young people fell, but soon rebounded and, at the end of a decade, between 2001 and 2008, the number of deaths increased by 20.8%, slightly higher than the increase in population of the country, which was 17.2% in the same period. This fact shows that the code had little impact in reducing fatal accidents in Brazil (Figure 4).

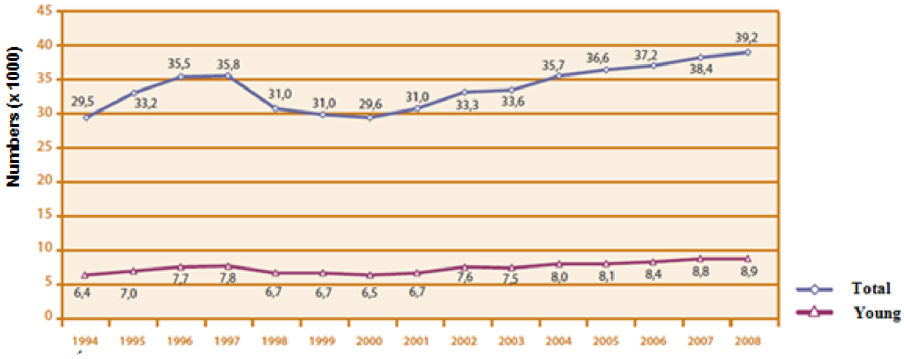

Figure 4 - Evolution of fatalities by road accidents (x 1000). Brazil, 1994 – 2008.
Source: SIM/SVS/MS apud Waiselfisz (2011: 77).

In the period beginning in 2001, there was a marked increase in the number of deaths of about 4.8% per year, and as early as 2004, the quantity returned to the 1997 level, and then continued growing continuous and systematic up to 2008. The year 2008 showed an increase of 31.99% when compared to the year 2000, and during this period the Brazilian fleet of vehicles has nearly doubled (Table 1).

Table 1 – Statistics of Road Accidents in Brazil (2000 – 2008)

Years	Vehicles Fleet	Fatalities by Road Accidents	Fatalities/10.000 Vehicles	Fleet of Motorcycles	Fatalities by Motorcycle Accidents	Fatalities/10.000 Motorcycles
2000	29 722 950	28 995	9.75	3 550 177	3 910	11.01
2001	31 913 011	30 524	9.56	4 025 566	4 541	11.28
2002	34 284 967	32 753	9.55	4 945 256	5 440	11.00
2003	36 658 501	33 139	9.03	5 332 056	6 046	11.33
2004	39 240 875	35 105	8.94	6 079 361	6 961	11.45
2005	42 071 961	35 763	8.50	6 934 150	8 089	11.66
2006	45 372 640	36 367	8.01	7 898 925	9 191	11.63
2007	49 664 025	37 407	7.53	9 410 110	10 392	11.04
2008	54 506 661	38 273	7.02	11 045 686	11 471	10.38

Source: MS/SUS, Waiselfisz (2011), DENATRAN (2010)

Unlike developed countries, in Brazil, the number of fatalities in road accidents increased from 2000 to 2008. From these data, it can be concluded that in 2008, an average of 105 deaths per day in the Brazilian traffic, more than 4.0 deaths per hour (Table 1).

Data released by DENATRAN revealed that the Brazilian fleet increased by 8.4% in 2010 when compared with 2009, for a total of 64 817 974 vehicles around the country. Cars account for 37 188 341 units, representing 57.37% of the total fleet. It adds 13 950 448 motorcycles and 21.52% of the national fleet. Of the 26 Brazilian federative units (states), in eight of them, the fleet of motorcycles exceeds that of cars car, being: Acre, Pará, Rondônia, Roraima, Tocantins, Ceará, Maranhão and Piauí.
Analyzing the data in Table 1, compared to DENATRAN, Jorge Mello and Koizumi (2007:185) found that about 71% of the deaths occur in the actual crash site, and the remaining 29% are going to happen any time after the withdrawal of the injured site (Figure 5). In 2005, in contrast to 35 763 deaths collected by the Ministry of Health, 25 427 deaths were referred by DENATRAN and registered "on site" of the accident.

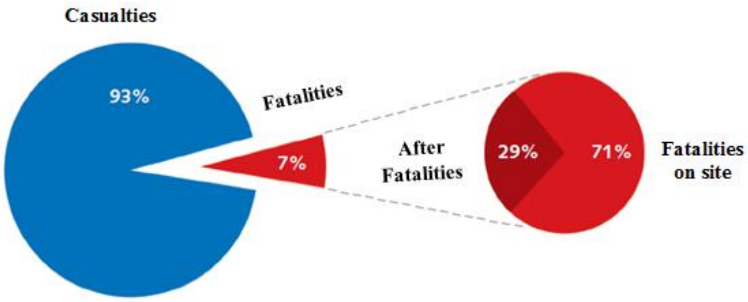

Figure 5 - Victims of traffic accidents and fatalities (on site and after), Brazil, 2005
Source: Mello Jorge e Koizumi (2007: 185)

Another pressure on the Brazilian claims refers to the growing fleet of motorcycles, which poses a major challenge for the managers of the Brazilian traffic. The volume of motorcycle traffic in Brazil increased between 1999 and 2008 approximately 266%, reaching over 11 million, or 20.26% of Brazilian vehicles circulating on the roads.
From the beginning of this century, deaths from motorcycle accidents are always superior to the vehicle as a whole, and constitute veritable epidemic to public health in Brazil. Research IPEA / ANTT (2003:40) shows that the share of costs attributed to motorcycle accidents corresponds to 19% of the total cost of road accidents in Brazil, although the fleet of motorcycles representing 11% of the national fleet of vehicles.

3.2 Road Accidents in Portugal

To respond to the high road accidents registered in Portugal up to 2002 (Table 2) was approved in 2003, the National Road Safety Plan (PNRS) which set the overall objective of 50% reduction in the number of fatalities and seriously injured, until 2010. Among the actions outlined, a set of goals was established enshrined in the National Road Safety Strategy (NRSE), as the reduction of accidents at 78 deaths per million inhabitants in 2011, equivalent to a reduction of 14.3% (based 2006) and improve this indicator to achieve in 2015, 62 deaths per million inhabitants, equivalent to a reduction of 31.9%.

Table 2 - Statistics of road accidents in Portugal (2000 – 2008)

Years	Vehicles Fleet (light + heavy)	Road Accidents with Vitims	Fatalities	Fatalities/Road Accidents (x100)	Fatalities/ Vehicles (x10.000)
2000	3 457 000	44 159	1 629	3.7	4.71
2001	3 603 800	42 521	1 466	3.4	4.07
2002	3 900 000	42 219	1 469	3.5	3.77
2003	3 901 100	41 495	1 356	3.3	3.48
2004	4 115 200	38 930	1 135	2.9	2.76
2005	4 215 270	37 066	1 094	3.0	2.60
2006	4 305 000	35 680	850	2.4	1.97
2007	4 394 100	35 311	854	2.4	1.94
2008	4 423 400	33 613	776	2.3	1.75

Source: IMTT (2011); Pordata - update: 2011/05/03

Figure 6 charts fatalities from road accidents accompany the observed decrease in total accidents. This drop in road accidents is due, among other things, to the change in legislation making it more stringent when the offenses and the prevention of accidents.

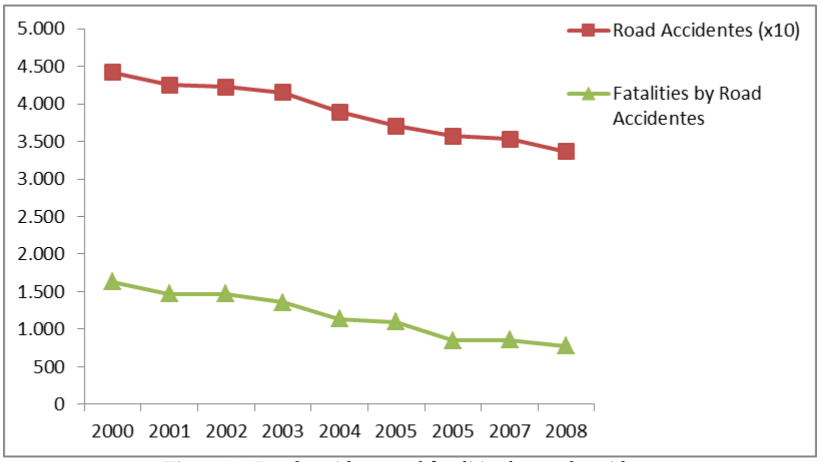

Figure 6 - Road accidents and fatalities by road accidents
Source: Table 2

When analyzing data from the CARE (EU Road Accidents database, 2011: 9), fatalities statistics by type of traffic traffic, reveals that drivers are most affected, followed by pedestrians and passengers (Table 3). In the area where the accident occurs, fatal road accidents prevail, explained possibly by speeding, driver fatigue and sleep.

Table 3 - Fatalities by type of user in Portugal (2000 – 2008)

User	Zone	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	%	Average
Drivers	**Urban**	366	401	361	383	315	328	268	244	254	3395	24.06%	339.5
	Non-urban	678	554	587	570	457	440	360	361	307	5004	35.46%	500.4
Pedestrians	**Urban**	250	222	225	186	153	129	100	99	103	1725	12.22%	172.5
	Non-urban	135	115	114	95	80	86	56	57	52	926	6.56%	92.6
Passenger	**Urban**	107	97	113	90	89	80	80	46	60	894	6.33%	89.4
	Non-urban	321	282	275	222	201	185	105	166	108	2169	15.37%	216.9

Source: Adapted from CARE (EU road accidents database, 2011: 9)

4. CONCLUSIONS

Even if Brazil has a considered up-to-date legal framework, it exhibited in 2008, a road accident statistics, with 7 fatalities per 10 000 vehicles. When analysing the increase in the number of fatalities related to motorcycles, for the same year, 10 deaths per 10 000 motorcycles occurred, representing 30% of the total of road accidents.

Road accidents statistics in Portugal showed in 2010, 3.3 road accidents per 1 000 inhabitants, 854 being fatal accidents. If considering death statistics per type of traffic user, drivers are more vulnerable, followed by pedestrians and thirdly passengers. In the site where road accidents occur, fatal accidents in non-urban roads prevail, possibly explained by speeding, sleepiness and drivers' fatigue.

When comparing road accidents statistics between Brazil and Portugal, it can be concluded that in both countries, the phenomenon is multicausal, with relevance to the behavioural issues related to drivers, passengers, pedestrians and road traffic managers. This perception is based upon the fact that Portugal holds good roads and a vehicle fleet with annual inspection, whereas Brazil holds only 43.9% of road surface in good traffic conditions and the vehicle fleet has no annual inspection procedure. Nevertheless, both countries present high road accidents statistics, representing very high social-economics costs for both societies. In Brazil, an aggravating factor concerns the growth of the number of motorcycles traffic, accompanied by very high road accidents statistics, accounting for, in 2011, for approximately 19% of the total costs in road accident statistics

Regarding socio-economic costs of road accidents, Europe alone, annually accounts for 160 billion euros, i.e., representing 2% of the GNP in the European Union (EU27). Comparing both countries: i) Portugal - every year, socio-economics costs of road accidents are estimated to be approximately 4.5 billion € (EUR), representing 3% of the Portuguese GNP; ii) Brazil, in 2008, road accidents socio-economic costs account for approximately R$ 33.7 billion, representing 1.16% of the Brazilian GNP.

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Latest developments on musculoskeletal disorders research: a literature review

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ABSTRACT

This paper aims to review the literature concerning the latest developments on the musculoskeletal disorders research, including emerging risk factors as well as the most recent prevention, and treatment and management approaches. Results seem to indicate that socioeconomic, psychosocial and lifestyle factors are likely to contribute to the increased risk of MSDs and to point out multidisciplinary/interdisciplinary interventions based on the active participation of interested individuals as the most effective on prevention, treatment and management of musculoskeletal disorders and related outcomes.

Keywords: Lifestyle risk factors, socioeconomic risk factors, psychosocial risk factors, participatory ergonomics, biopsychosocial model, education.

1. INTRODUCTION

Musculoskeletal disorders (MSDs) include a diversified group of pathologies of the musculoskeletal system (Lidgren, 2003). Despite the high morbidity associated, only after 1998, thanks to the initiative of Professor Lars Lidgren (The Bone and Joint Decade, 2010), MSDs have got international recognition as an enormous public health problem (Bergman, 2007a). In 1999, during the declaration of Bone and Joint Decade 2000-2010, the former UN Secretary General Kofi Annan stated "Musculoskeletal disorders are the most common causes of severe long-term pain and physical disability, affecting many millions of people across the globe. They have an enormous impact on the individual, society, and health care social systems" (cited in Lidgren, 2003). Affecting more than 100 million citizens in the European Union (European League Against Rheumatism, 2010) (EU-27 population: 501 million) and more than one in each four Americans (The Bone and Joint Decade, 2010) (USA population: 312 million), MSDs represent an estimated economic cost to society in the amount of approximately 240 billion Euro in Europe (European League Against Rheumatism, 2010; The Work Foundation, 2009) and more than 250 billion Dollar per year in USA (Lidgren, 2003). At the same time MSDs are responsible for almost half of all absences from work and for 60% of permanent work incapacity in the EU (The Work Foundation, 2009).

Due to demographics (e.g. increasing numbers of elderly worldwide, and longer life expectancy) and lifestyle changes (e.g. increasing physical inactivity, unhealthy diets, overweight and obesity) (European League Against Rheumatism, 2010), healthcare costs are expected to increase exponentially (The Bone and Joint Decade, 2010). Furthermore, the recent deterioration in global economics may contribute to worsening this serious situation, and so renewed and more cost-effective approaches are needed in order to avoid its dramatic consequences.

This paper aims to briefly review MSDs emerging risk factors and latest approaches on their prevention, treatment and management.

2. MATERIALS AND METHODS

A literature review was developed using the online search in ISI Web of Knowledge and Science Direct, between 1995 and August 2011, and occasionally complemented by MEDLINE, EBSCO and Google Scholar databases, as well as by searching on institutional Websites, such as The Bone and Joint Decade, European League Against Rheumatism (EULAR), and The Work Foundation. In the online search procedure, different associations of the words/expressions "musculoskeletal", "socioeconomic risk factors", "socioeconomic status", "socioeconomic inequalities", "psychosocial factors", "lifestyle factors", "participatory ergonomics", "participatory interventions", "biopsychosocial model", and "biopsychosocial approach" were used. Studies were selected according to their relevance for the topics to be developed in this paper, namely emerging risk factors, prevention strategies, and treatment and management approaches.

3. RESULTS AND DISCUSSION

3.1. Emerging risk factors

MSDs have a multifactorial origin (Bongers, Ijmker, van den Heuvel & Blatter, 2006) and, beyond the most studied physical risk factors, over the last decades, the increasing role played by psychosocial (Bergman, 2007b; Janwantanakul, Pensri, Jiamjarasrangsi & Sinsongsook, 2009a, 2009b) and lifestyle factors (Bergman, 2007a, 2007b) on the onset and progression of disease have been recognized. Even though some authors have found that the risk of MSDs is more influenced by physical and psychosocial aspects than by socioeconomic factors (Gillen et al., 2007), most recent economic changes in many countries worldwide may imply an increased role of these factors as well.

3.1.1. Socioeconomic factors

Individuals' socioeconomic status (SES) is indicated as influencing their health (Adler & Ostrove, 1999; APA, 2007). The most common indicators used to assess SES are education, income and occupation levels (Adler & Ostrove, 1999; Hagen, Zwart, Svebak, Bovim & Stovner, 2005), although residence/geographical area is also considered by some authors (Adler & Ostrove, 1999; World Health Organization, 2003). Factors such as low education, low income, low level jobs, poverty, and living in deprived areas/regions have been associated to an increased risk of MSDs complaints (Bergman, 2007b; Brekke, Hjortdahl & Kvien, 2002; Gjesdal, Bratberg & Maeland, 2009; Hagen et al., 2005; Macfarlane, Norrie, Atherton, Power & Jones, 2009) and both short and long-term physical disability (Gjesdal et al., 2009; Krokstad, Johnsen & Westin, 2002). Low SES is also associated to musculoskeletal pain, either regional or widespread, which is another important outcome of MSDs (Brekke et al., 2002; Gjesdal et al., 2009; Macfarlane et al., 2009), and is indicated as a predictor of its severity as well (Brekke et al., 2002).

APA (2007) pointed out education as the most important indicator of SES based on the fact that, usually, higher education levels are associated to higher level jobs, higher income levels and living in more wealthy areas, and so influencing the remaining dimensions of the SES. According to APA (2007), education provides individuals with fundamental tools to achieve better life outcomes, although recognizes that a higher education level is not necessarily a guarantee of high income, most qualified jobs or dwelling are found in wealthier areas. On the other hand, income is considered as the second most important indicator of SES, not only because it allows better access to healthcare but also due to several adverse effects on mental and physical health associated to the lack of financial resources (APA, 2007). By its side, occupation may have beneficial effects on individuals health, although it is very often indicated as risk factor for health problems such as MSDs, being that low SES jobs are frequently associated to higher physical and psychological workloads (APA, 2007). Finally, the residence/geographical area is indicated as influencing health, as well. APA (2007) also pointed out the important role of individuals' perceptions of SES on their mental and physical health.

3.1.2. Psychosocial factors

No single definition of psychosocial factors does exist. However, most of them agree that they relate to individuals perceptions (Erez, 2008; Lacey, Lewis & Sim, 2007; Lanfranchi & Duveau, 2008), these being understood as "the conscious recognition and interpretation of sensory stimuli that serve as a basis for understanding, learning, and knowing or for motivating a particular action or reaction" (Mosby, 2009). For instance, psychosocial factors for work-related MSDs refer to the way how workers understand and react to work characteristics, organization and conditions of its performance (Erez, 2008; Lacey et al., 2007; Lanfranchi & Duveau, 2008), although non-work-related psychosocial factors are also indicated as influencing the onset and progression of MSDs (Bongers, Kremer & ter Laak, 2002).

During the last decades, the dramatic changes occurred in people´s life and in both work and work environment and organization, have led to an increased importance of psychosocial aspects as risk factors for many health problems, including MSDs (Henderson & Bass, 2006). Associated to other risk factors, psychosocial aspects may contribute to aggravate MSDs outcomes, to difficult the recovery process and even lead to disease chronicity (Bergman, 2007b). While aspects such as low job control, low supervisor support, poor co-workers relationship, low skill discretion, work pace, monotony and repetitiveness, mental stress, job insecurity, job dissatisfaction are some of the commonly indicated psychosocial risk factors for work-related MSDs (European Bone and Joint Health Strategies Project, 2004; Haukka et al., 2011; Janwantanakul et al., 2009a; Lanfranchi & Duveau, 2008), in the general population, psychosocial risk factors for MSDs integrate depression and anxiety (Henderson & Bass, 2006), stress, poor quality social networks, poor family and social support (Haukka et al., 2011; Janwantanakul et al., 2009a).

An experimental study, among typing workers, aiming to quantify the effects of mental workload and time pressure on perceived workload and physiological responses of the distal upper extremity, appears to support the idea that psychosocial conditions, such as mental workload and time pressure, can increase the risk of MSDs (Hughes, Babski-Reeves & Smith-Jackson, 2007). Also an association between musculoskeletal symptoms in lower extremities and mental demands and work repetitiveness was found among office workers (Janwantanakul et al., 2009b), while a longitudinal study among 385 kitchen workers showed that mental stress and psychosocial factors at work seem to be strongly associated to multiple-site musculoskeletal pain (Haukka et al., 2011). Association between upper extremities problems and psychosocial factors, such as high perceived job stress and non-work-related stress reactions, was also found in a systematic review performed by Bongers et al. (2002).

Several studies appear to indicate that the lack of social support, beyond contributing for the onset and progression of disease (Bergman, 2007a; European Bone and Joint Health Strategies Project, 2004; Nahit et al., 2003), may also difficult the return to work (Bergman, 2007b) and the disease self-management (Bair et al., 2009), while others point out an inconclusive relationship between MSDs and some psychosocial factors. For example, a systematic review aiming to identify the most important psychosocial risk factors for neck pain found some evidence supporting the association between neck pain and psychosocial factors such as high job demands, low co-workers support, low job control and low job satisfaction but was inconclusive concerning the association between neck pain and aspects such as high job strain, low supervisor support, conflicts at work, low job security, although authors recognize that conclusions made may have been influenced by the methodology used for the studies' quality assessment (Ariëns, van Mechelen, Bongers, Bouter & van der Wal, 2001).

3.1.3. Lifestyle factors

During the last half century lifestyle was significantly transformed and some of the most relevant changes, such as growing physical inactivity, unhealthy diets, overweight and obesity, are recognized as important risk factors for many serious health problems. While physical inactivity weakens musculoskeletal system structures (e.g. muscles and bones) and promotes bone loss, development of osteoporosis and increases the risk of bone fracture (Bull et al., 2004; European Bone and Joint Health Strategies Project, 2004), excess of body weight causes stress on bones and joints which increases the risk of osteoarthritis, that is a major cause of disability (World Health Organization, 2009), as well as growing levels of pain (International Association for the Study of Pain, 2009). Poor diets are frequently associated to insufficient intake of fundamental nutrients (calcium and vitamin D), particularly important for bone mass formation or maintenance (Keen, 2007), and that are associated to an increased risk of bone fracture. Moreover, additive habits such as smoking tobacco, alcohol abuse and drugs consumption are also considered risk factors for MSDs. While smoking tobacco is considered as having adverse effects on bone mineral density and fracture risk (European Bone and Joint Health Strategies Project, 2004), alcohol abuse is indicated as decreasing bone formation and reducing bone mineralization due to its ethanol content (Diamond, Stiel, Lunzer, Wilkinson & Posen, 1989), although alcohol moderate consumption is considered to have beneficial effects in rheumatic diseases.

3.2. Prevention strategies

3.2.1. Participatory ergonomics

Single interventions have revealed very low efficacy in fighting MSDs multidimensional problem, and over the last decades multidisciplinary/interdisciplinary approaches and participatory interventions have been indicated as the most effective on their prevention, treatment and control (Bergman, 2007a, 2007b; Bremander & Bergman, 2008; Evanoff, Bohr & Wolf, 1999; Finestone, Alfeeli & Fisher, 2008; Hanada, 2003; Hignett, Wilson & Morris, 2005; Keefe et al., 1996; Laitinen, Saari, Kivisto & Rasa, 1998; Noonan & Wagner, 2010; Rivilis et al., 2008; St-Vincent, Bellemare, Toulouse & Tellier, 2006; Vink, Urlings & van der Molen, 1997). Participatory ergonomics interventions in the workplace, including either working conditions related interventions or involving work organization changes, are also indicated as improving product quality and productivity (Nagamachi, 1995). Nagamachi (1995) shows participatory ergonomics as a powerful macroergonomic strategy for workplace improvement, based on the workers' participation.

Although there is no consensual definition, and along time it has been labelled as "a philosophy, an approach or strategy, a programme or even a set of tools or techniques" (Wilson & Haines, 1998), participatory ergonomics is usually characterized by the joint participation of key stakeholders in the design/redesign (Kleiner & Shewchuk, 2001; Seim & Broberg, 2010; Vink et al., 1997) and implementation process of integrated ergonomic measures whether it aims to implement changes (St-Vincent et al., 2006) or solve ergonomic problems and adopt healthy behaviours (Robertson et al., 2002). The important role played by "end users" (e.g. workers, etc.) is highlighted by regarding them as active agents in the transformation process (Saintfort, Taveira, Arora & Smith, 2001).

Although participatory ergonomics is usually considered more effective than single interventions and "the improved ownership of the ergonomic ideas, the acceptance of the proposed solutions, the confidence and competence to solve problems, satisfaction with the outcome, and willingness to change" is indicated as one of the most important outcomes attributed to the participatory ergonomics process (Imada & Nagamachi, 1995), some authors advise that the success of the process depends on the involvement of the right participants, the appropriate ergonomic training and the clear definition of responsibilities (van Eerd et al., 2010) while others warn that participatory ergonomics process must take into account the unique history of the organization, its structure and culture, in any particular case (Liker, Nagamachi & Lifshitz, 1989).

Even though most of the published literature on participatory ergonomics relates to work (Carrivick, Lee & Yau, 2002; Carrivick, Lee, Yau & Stevenson, 2005; Halpern & Dawson, 1997; Moore & Garg, 1998; Rivilis et al., 2006; Rivilis et al., 2008; Rosecrance & Cook, 2000; St-Vincent, Chicoine & Beaugrand, 1998; Udo, Kobayashi, Udo & Branlund, 2006; Vink et al., 1995; Vink et al., 1997), it can successfully be applied in other contexts such as community-based interventions (Chinman et al., 2004; Garcia, Gadea, Jose Sevilla, Genis & Ronda, 2009; Goh et al., 2009; Kushner, Stewart & Letourneau, 2010; Senarak, Chirawatkul & Markovic, 2006) and other issues such as non-communicable diseases in general (Senarak et al., 2006), smoking (Kushner et al., 2010), adolescent obesity (Goh et al., 2009), drugs abuse (Chinman et al., 2004) or adolescent nutrition behaviour change (Thayer, Morris, Rollins & Cook, 2010), beyond the prevention or risk reduction of MSDs (Carrivick et al., 2002; Garcia et al., 2009; Rivilis et al., 2006; Rosecrance & Cook, 2000; St-Vincent et al., 2006).

3.2.2. Healthy lifestyles

Since lifestyle is recognized as an important risk factor for MSDs, adopting healthy lifestyles is a core issue for their prevention. The importance of physical activity in the prevention and control of musculoskeletal problems is vastly recognized, as demonstrate Bone and Joint Decade 2010-2020 choice of "Keep People Moving" as its main lemma (The Bone and Joint Decade, 2011) and WHO recommendations (World Health Organization, 2010). Regular and adequate physical activity is considered as an important health benefit at any age because it helps to build and maintain healthy bones, muscles, and joints (European Bone and Joint Health Strategies Project, 2004). Healthy diets also play an important role on MSDs prevention and control, not only because of its importance for the maintenance of a healthy weight and the prevention of overweight and obesity but also because of the supply of some fundamental nutrients for musculoskeletal system health, such as calcium and vitamin D, that are particularly important in younger and older people (Keen, 2007; World Health Organization, 2003). On the other hand, maintaining a healthy or "ideal" weight (European Bone and Joint Health Strategies Project, 2004) and avoiding obesity is of capital importance for the prevention of MSDs as either underweight or overweight are risk factors for the onset and progression of some of such diseases (World Health Organization, 2003). Developed countries in general and some developing countries, where more than 50% of the population is overweighted or obese (Mexico, South Africa and Brazil) or that although presenting overweight lower levels (China and India) are rapidly moving in the wrong direction (OECD, 2010), show a very concerning situation and demands behavioural and cultural changes. Moreover, avoiding additive habits such as smoking tobacco, alcohol abuse and drugs consumption are important for the prevention and maintenance of healthy bones (European Bone and Joint Health Strategies Project, 2004).

3.3. Treatment and management approach

The latest approaches to prevention, treatment and management of MSDs are mainly based on the perspective of human being as a whole system as well as on the multifactorial nature of health and disease.

3.3.1. Biopsychosocial model

The traditional biomedical model has long been recognized as representing a reductionist approach of health and disease (Fava & Sonino, 2008; Gatchel, Peng, Peters, Fuchs & Turk, 2007), which has been proved not able to fully explain MSDs symptoms and consequences. In 1946, the Constitution of the WHO adopted a more comprehensive concept of Health, where this is defined as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 1946), in response to the changing healthcare needs of the populations (Barkway, 2009). Then, in 1977, George L. Engel, considered as the father of North American psychosomatic medicine, presented the biopsychosocial model, which beyond the human biological aspects also integrate psychological and social factors (Fava & Sonino, 2008), and that, despite several limitations, is still considered as the best medical model available (Berquin, 2010). According to Waddell (2004), to help patients and relieve human suffering demands that all the biopsychosocial dimensions of pain and disability are addressed, even though he recognizes that the biopsychosocial model have mainly focused on psychological issues while social aspects have been relatively ignored. Although biopsychosocial model is contested, and even criticized, by having devolved into mere eclecticism (Ghaemi, 2009) and some other authors consider that biopsychosocial approach faces many challenges as well as opportunities (Frankel, Quill & McDaniel, 2003), it still appears to be the dominant trend on treatment and management of multifactorial MDSs and is considered as the most effective in most of the analysed literature (Noonan & Wagner, 2010; Waddell, 2004), despite not enough good evidence has been found in some studies aiming to show its effectiveness in interventions such as multidisciplinary rehabilitation programmes for sub-acute low back pain (Karjalainen et al., 2001), and neck and shoulder pain (Karjalainen et al., 2003). Many authors refer to the need for further research (Bremander & Bergman, 2008; Finestone et al., 2008; Janwantanakul et al., 2009a). However, according to Frankel et al. (2003), a wide range of researchers found evidence suggesting that the biopsychosocial approach "is associated with more accurate diagnosis, more satisfying visits, better memory for medical information, greater likelihood of following medical recommendations" (p. 265), beyond many other health-related outcomes.

The biopsychosocial model is based on integrated multidisciplinary interventions as well as on patient´s active participation (Berquin, 2010). It is indicated as having the potential for highly effective treatment and management of MSDs as well as for the avoidance of chronicity and disability, and in the return to work but, at the same time, it is recognized as very demanding in terms of both financial and human resources (Berquin, 2010).

3.3.2. Early diagnosis and treatment

Early diagnosis and treatment is considered as the best strategy to avoid the progression of disease and chronicity (European Bone and Joint Health Strategies Project, 2004; Gatchel, 2001; Noonan & Wagner, 2010). Some authors highlight, however, the importance of interdisciplinary systematic patient-screening or pre-treatment assessment (Gatchel, 2001), as well as the need for diagnostic capacity and access to health care (Woolf, Brooks, Åkesson & Mody, 2008), and recognize that it requires more health care professionals and better undergraduate medical education in rheumatology (Dequeker, Rasker & Woolf, 2000), while others consider that education at both undergraduate and graduate levels do not reflect the impact of MSDs on individuals and society and are aware of the need of medical students´ clinical training in assessing patients with bone and joints problems (Åkesson, Dreinhofer & Woolf, 2003).

3.4. Education

Education, training and awareness play an important role on prevention, treatment and control of MSDs symptoms and outcomes. Their increasing importance have been highlighted by the latest multidisciplinary/interdisciplinary prevention strategies (participatory ergonomics) and treatment and management approaches (biopsychosocial model) which are based on deep involvement of interested people (e.g. workers, patients, patients' family and population in general) (Bergman, 2007b), which is also referred to as people "empowerment" (European League Against Rheumatism, 2010; Garcia et al., 2009; Rosecrance & Cook, 2000; The Bone and Joint Decade, 2010). Education and awareness are also indicated as a vital issue for a cost-effective measure, which is the "self-management" of disease and its outcomes (Bremander & Bergman, 2008; European Bone and Joint Health Strategies Project, 2004; Hanada, 2003). Barlow et al. (2002) defined self-management as "the ability to manage the symptoms, treatment, physical and psychosocial consequences and lifestyle changes inherent in living with a chronic condition" (cited by Bair et al., 2009).

4. CONCLUSIONS

Psychosocial and lifestyle aspects are now recognised as important risk factors for MSDs. Due to the current economic crisis, renewed attention must also be paid to socioeconomic risk factors. Evidences have been found supporting the effectiveness of participatory ergonomics interventions in the prevention of MSDs and associated outcomes, as well as the efficacy of biopsychosocial approaches on their treatment and control, despite some contradictory positions. Key stakeholders (e.g. workers, managers and educators) are considered to play an essential role in the success of the design and implementation of prevention strategies (participatory ergonomics interventions). Conversely, the multidisciplinary biopsychosocial model is still considered the best medical model available for the treatment and management of MSDs. These most recent approaches on MSDs problem highlight the participation of all people at risk or suffering from the disease on their prevention or treatment and management, respectively, what led to the increased importance of education, training and global awareness as the most effective way of changing attitudes and behaviours. Meanwhile, the difficult economic situation lived in large regions of the world may hamper the implementation of policies and strategies adopted during the last decade in order to reverse the concerning trend of MSDs. Since most of MSDs outcomes are associated to low SES, and socioeconomic factors have crossed effects on both psychosocial and lifestyle factors, we may be in front of an uncontrolled increase of MSDs problem with all the associated negative consequences on individuals' health and well-being, as well as on society. Particularly the costs to society may represent the failure of the welfare state adopted in the EU countries, unless new solutions are found and implemented.

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Qualitative Occupational Risk Assessment model – an introduction

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ABSTRACT
Occupational risk assessment (ORA) is the core of any safety practice in the construction industry. It is a complex process with many ill-defined parameters, which are difficult to quantify or estimate accurately. In this work we use Fuzzy Set Theory to model the intrinsic vagueness and imprecision of important ORA parameters, to produce more realistic and better results. The focus is on the versatility of the new developed fuzzy Qualitative Occupational Risk Assessment (QRAM) model. QRAM model includes audit items regarding: a) safety climate, b) work accidents severity factors, c) work accidents possibility factors and d) safety barriers.

Keywords: Risk assessment, construction industry, occupational safety, fuzzy sets.

1. INTRODUCTION

Due to its specific characteristics (which include dangerous work exposure, changing environments, multi-employer sites, exposures to work of multiple trades, etc.) construction industry always records high rates of work accidents (Tam et al., 2004) Construction industry is an aggregate of many specialized groups working together to build, maintain, repair, renovate, and demolish buildings, highways, dams, bridges, viaducts and any other structures. The labor nature ranges from difficult physical tasks to fully mechanized operations. It is often performed under extreme conditions and in isolated or, conversely, heavily congested areas.

A generalist view of risk assumes that risks are characterized by some combination of aspects such as (Nilsen and Aven, 2003): probability of occurring accidents; accidents severity; intentionality; disorganization of the work place; workers inexperience; lack of leadership and so on. In fact, there is no universal set of rules for taking or characterize the risk, i.e. there is no universal set of characteristics for describing the occupational safety risk (Aven et al., 2011). The characterization must depend on which context the risks are undertaken. So, risk analysis models must take into account the context and the scope of the analysis.

When conducting Occupational risk analysis (ORA) at construction sites, there is often inadequate data or imprecise information available and safety practices encountered at construction sites are as variable as the sites themselves. Therefore, the use of quantitative occupational risk assessment models based on probabilistic techniques, using data collected at different construction sites and in various types of construction projects, seems that it can lead to distorted results and do not really reflect the reality of the site under analysis. On construction, the ORA problem is even more acute (comparing with other industries) because an occupational safety knowledge base, i.e. a data bases with accumulated knowledge and experience is not available (Pinto et al., 2011a).

Many authors (Karwowski and Mital, 1986; Cornell, 1996; Wang and Ruxton, 1997; Pender, 2001; Sii et al., 2001; Tixier et al., 2002; Faber and Stewart, 2003; Nilsen and Aven, 2003; Kentel and Aral, 2004, Pinto et al., 2011a) have discussed the limitations of traditional (probabilistic) methods for ORA and stated that many sources include scarce or incomplete data, measurement errors and qualitative data obtained from expert judgment, or subjective interpretation of available information. On the other hand, humans are capable of abstracting, thinking and reasoning, thus, assessing risks without having necessarily to experience their consequences. Hollnagel (2008) stated that safety cannot genuinely be improved by only looking to the past and taking precautions against the accidents that have happened, it must also look to the future.

From all pointed limitations of ORA methods, it seems that the use of Fuzzy Set Theory (FST) (Zadeh, 1965) may help produce more realistic representations and solutions, as shown by many authors (Herrera and Viedma, 2000; Nunes, 2003; Andersson, 1986; Mure et al., 2006; Liu et al., 2004; Maglaras, 1995). FST presents a natural way of modelling the intrinsic vagueness and imprecision of everyday concepts by providing a very precise approach for dealing with uncertainty which grows out of the complexity of human behaviour. It also allows the inclusion of human creativity and intuition, which is an essential ingredient for successful ORA (Ru and Eloff, 1996). In fact, even when probabilities are known (in occupational safety it is always made by oversimplifications), analysts should take into account *utility* aspects (Bernstein, 1996), such as (in occupational safety context) risk perception, and usefulness or workers satisfaction - which are fuzzy concepts. For example, there are people who are terrified of thunderstorms even when being aware that it is highly unlikely that lightning will strike precisely where they are standing. These people value more the possible consequences, instead of the probability of being hit.

From the above, it seems that FST can address, more easily than probability theory, the perceptions of all stakeholder groups, facilitating constructive discussion and elucidating the points of ORA results disagreement. However, FST and

probability theory are not contending or incompatible mathematical frameworks and Zadeh (1978) argues that fuzzy logic is different in character from probability and is not a replacement for it. There are four main differences between the two techniques (Engelbrecht, 2007): 1) degrees of certainty (given by statistical probability) are meaningful only before the event occurs, fuzzy sets membership degree are relevant even after the event occurs, 2) probability assumes that events are independent, fuzziness is not based on that assumption, 3) probability assumes a closed world model when every data are known, fuzziness never assumes that everything could be known and, 4) probability is based on subjective frequency measures, fuzziness is based on descriptive measures (by membership functions) of the domain.
In this paper we discuss a novel QRAM model, based on preliminary works (Pinto et al, 2011a, b, c, d)), which uses FST to represent the relevant characteristics to assess occupational safety risks in construction sites. We focus on the main characteristics and user-friendly usage of the developed fuzzy QRAM model.

2. QUALITATIVE OCCUPATIONAL RISK ASSESSMENT MODEL (QRAM)

QRAM is based on the following four dimensions: Safety Climate (SC), Severity Factors (S) Possibility Factors (OAP) and Safety Barriers (SB). To define the four dimensions we follow some rational on the risk concept, namely: 1) Aven and Renn (2009), *risk is the uncertainty about the severity of the consequences of an activity with respect to something that humans value* and, 2) EU (2000), *the probability and severity of an adverse effect/event occurring to man or the environment following exposure, under defined conditions, to a risk source(s)*.
So, the risk expresses a combination of (Christensen et al, 2003): a) the possibility of occurrence (probability when using probability theory) of an unwanted outcome (a work accident, in an occupational safety context), b) the severity of the work accident (physical or psychic workers'injuries, in an occupational safety context) and, c) the extent of consequence/effect under given specific circumstances (i. e. existence of safety barriers).

2.1. QRAM Dimensions

Safety Climate (SC). It is a very important dimension, since it is related with facilitate on or impediment of maintaining safety barriers and consequently the management of safety risks (Landeweer et al., 1990, Trbojevic, 2008), i.e., safety climate factors are not direct agents in the occurrence of work accidents but can create the conditions for accidents happening (HSE, 2003). Safety Climate includes factors related with the workers, management and work environment.
Safety Climate is composed by the following parameters: a) safety rules and procedures, b) workers' competence, c) safe work behaviour, d) management commitment, e) supervisory action towards safety, f) communication and participation, g) supportive environment, h) safety planning, i) work pressure over safety and, j) safety management system. Data should be obtained by interviews (performed at a convenience sample) with workers, foreman, engineers and site managers.
The model includes this list of safety climate parameters, which will be assessed using the linguistic variable "adequacy" defined for qualitative elicitation of knowledge (Pinto et al, 2011c,d). After obtaining the evaluations for each parameter they are aggregated with fuzzy-Or operator to obtain the classification for the SC (Pinto et al, 2011 c, d).
Severity factors (S). This dimension includes 8 parameters corresponding to 8 different fuzzy functions defined for each type of accident mode. We defined these severity functions using two main aspects (Pinto et al, 2011b): a) predictors related to the amount of energy dissipated/absorbed that can be evaluated in situ, such as: heights, speeds, weights, morphology of moving vehicles, etc.; b) by using the biomechanical limits of the human body, as pointed in several studies.
Possibility factors (OAP). This dimension accounts for thepossibility of work accident occurrence for each accident mode (listed on section 2.3). Each accident mode may be caused by a specific set of factors that determine the greater or lesser possibility of occurring a work accident and these should be assessed using the defined linguistic variable "adequacy" (Pinto et al, 2011c, d)).
Safety barriers (SB). This dimension is divided into four types of safety barriers, according to (Hollnagel, 2008): 1) physical or material, 2) functional, 3) symbolic and, 4) incorporeal.
For estimating safety barriers effectiveness we will use the linguistic variable "Effectiveness" defined in (Pinto et al, 2011c, d). This variable allows the safety expert to elicit the qualitative knowledge about safety barriers on the construction site. After obtaining the classifications for the Barriers types these are aggregated using a fuzzy-or operator to obtain the final classification for the SB effectiveness (Pinto et al, 2011c, d).

2.2. Qualitative ratings for the four dimensions

The data collection will be performed by observation of reality, interviews with workers, foreman and engineers and consultation of site documents (working procedures, reports of work accident investigation...). Information sources include observation of reality (attitudes, behaviours, communication flows, traffic flows, housekeeping), workers, foreman and engineers' opinions and site documents (safety plans, working procedures, training records, reports of work accident investigation, safety meeting minutes, safety inspections reports, safety audit reports, instruction manuals of machinery and equipment) and physical measures (heights, weights…).
To elicit the ratings for each parameter we defined 3 types of qualitative evaluators - linguistic variables (Zadeh, 1975), which allow us to perform the knowledge elicitation in a simple and user-friendly way.

In our case we defined (Pinto et al, 2011c, d) two linguistic variables, which allow us to perform a qualitative elicitation but with the advantage of also providing the numerical aggregation since linguistic variables include terms and respective degree of membership (value) (Zimmerman, 1993). The qualitative terms for each linguistic variable are:

1- "Effectiveness" which is composed of 6 qualitative terms: Excellent", "Very good", "Good", "Partial", "Insufficient" and "Bad", used to estimate safety barriers effectiveness.
2- "Adequacy" which is composed of 6 qualitative terms: "Strongly adequate", "Very adequate", "Adequate", "Almost adequate", "Low adequate" and "Inadequate", used to estimate safety climate and possibility of work accidents occurrence.

For reasons of space we do not present more details about how to proceed with the elicitation process but they are explained in (Pinto et al, 2011c, d).

2.3. QRAM Model

The four dimensions just defined, are used to estimate the risk of the following accident modes:

- Falls;
- Contact with electricity;
- Struck by moving vehicle (including heavy equipment);
- Injured by falling/dropped/collapsing object/person/wall/vehicle/crane which falls under gravity (including building or structure collapse and slipping hand held tool);
- Cave-ins (while or after excavation);
- Hit by rolling/sliding object (including stuck against object or equipment and caught in or compressed by equipment or objects);
- Contact with machinery moving parts (including injured by hand held tools operated by oneself);
- Lost buoyancy in water;
- Fire and Explosion.

Some explanations for the high accident rates in construction include organizational factors (Landeweer et al., 1990) such as: 1) management style, 2) companies safety policy, 3) personal characteristics (like age and experience), 4) knowledge, 5) risk perception and, 6) motivation. The Health and Safety Executive (HSE, 2003) found that human behaviour is the factor that contributes to 80% to work accidents in the construction industry. The erosion and degradation of work conditions in this sector, is most likely due to unworkable procedures, inadequate maintenance, conflicting objectives, failures in communication or inadequate training (Trbojevic, 2008). This allows us to conclude that the causes of most work accidents at construction sites are related with safety climate hence, this parameter is included in our model.

Each accident mode is characterized by the four dimensions defined, which are sub-divided into several parameters, as explained in the previous sections. After aggregating the parameters to obtain a rating for each respective dimension, these dimensions are also aggregated to assess/evaluate each accident mode risk. Then the result is used to rank the accident mode risk.

Using the QRAM model, the analysis could be performed in two ways: in a faster way by accident mode that can occur in workplaces or, more in-depth, listing all activities for each job performed at the site, analyzing and ranking the risk by the accident modes for each activity. The level of detail will depend on: 1) what we want to do with the results and, 2) operational factors, including: a) type and relevance of available data, b) degree of accuracy required to the obtained results, c) available resources.

The formal model for QRAM for each accident mode is depicted in Table 1.

Table 1 - QRAM Model for each accident mode

Falls (F)	$R_F = \oplus_{or}(SC, S_F, OAP_F, B_F)$
Contact with electricity (E)	$R_E = \oplus_{or}(SC, S_E, OAP_E, B_E)$
Struck by moving vehicle (S)	$R_S = \oplus_{or}(SC, S_S, OAP_S, B_S)$
Falling objects (F_O)	$R_{Fo} = \oplus_{or}(SC, S_{Fo}, OAP_{Fo}, B_{Fo})$
Cave-ins (C_I)	$R_{Ci} = \oplus_{or}(SC, S_{Ci}, OAP_{Ci}, B_{Ci})$
Hit by rolling/sliding object (H)	$R_H = \oplus_{or}(SC, S_H, OAP_H, B_H)$
Machinery moving parts (M)	$R_M = \oplus_{or}(SC, S_M, OAP_M, B_M)$
Fire or explosion (FE)	$R_{FE} = \oplus_{or}(SC, S_{FE}, OAP_{FE}, B_{FE})$

As can be observed in table 1, the index in each parameter represents the accident mode being analysed, for each of the four dimensions considered: safety climate, severity factors, possibility factors and safety barriers.

ORA methods used in construction aim to obtain a value for the risk and to rank the different risks. Usually they do not exploit correlations among risk-reducing opportunities, based on risk factors. As a result, they generally make suboptimal risk management recommendations. Cox (2009) stated that" priority lists do not generally produce effective risk management decisions".
So, ORA methods should have a tool/metric by which the results of a risk analysis can be translated into recommendations on the risks tolerability and respective improve actions.
QRAM uses the ALARP (As Low a level As Reasonably Practicable) framework (French et al., 2005) as a guide to ranking risks and achieving a satisfactory outcome for the practical management of occupational safety risks. The ALARP approach requires site safety managers to demonstrate that: 1) the site is fit for its intended purposes, 2) the occupational safety risks associated with its functioning are sufficiently low and 3) sufficient safety and emergency measures have been instituted (or are proposed).
At the top of ALARP framework are the risks that are unacceptable whatever the benefits associated with the activity. Any legal requirements that are not meet should be considered always unacceptable. At the bottom are risks that are broadly acceptable and can be regarded as insignificant if adequately controlled. Between these two areas of risk is the tolerable (ALARP) region within which risks need to be reduced ALARP. When risks are in the ALARP area a "dynamic" to identify best practice to decrease risk level should be created, and then seek to ensure that it becomes the general practice at site in order to decrease risk level to the acceptable region.
QRAM results presented risks by 3 regions: acceptable (below 0.3), ALARP (between 0.3 and 0.7, including this values) and unacceptable (above 0.7).
It should be noted that an acceptable risk means that it is not regarded as negligible or something that can be ignored, but rather as something that needs to be kept under review and to be reduced, if and when it is possible.

3. QRAM VALIDATION

QRAM was validated, by "peer" review by a pool of 11 safety experts from Brasil (2), Greece (3) Portugal (2), Turkey (3) and Bulgaria (1). This way seems appropriate to evaluate the rationality of the framework structure and the criteria and the adequacy to which the risk is scored. According to Habermas (1998) the rationality of science stems not from any objective, external measures, but from agreed formalisms involving transactions between knowledgeable human beings and agreement between them about what can be considered to be "rational", given the base of available knowledge and experience.
In each of the referred countries, QRAM were presented to a of safety experts, to which was explained the features and rational underlying of QRAM development, after that the was applied to real construction sites, were the safety experts were requested to verify if the results correspond to their empirical knowledge. To do so a 5-point traditional Likert scale questionnaire was presented to the safety experts. Questionnaires were taken individually. In general experts agreed with the QRAM results but all have made comments, which are summarized below.
The main causes of criticism are about the S_B division. Some of the experts considered the categorisation is confused and incomplete and stated that should be re-examined to make a clear distinction between types. They also consider that legal requirements are present in all categories of safety barriers. They suggested to consider safety barriers as layers of immediate (physical, mechanical etc.), basic (procedures, training, signs) and underlying measures (management commitment, organisational arrangements), and do not incorporate health and safety legislation in these since this can be taken into account in all types of measures as minimum requirements.
About safety climate some experts consider that for make the model more practical, some questions should be removed because they are repeated.
About severity they stated that more risk sources and their severity functions should be added because the functions provided do not cover all sources of hazards present in construction sites.
Three of the experts stated that the expected quality of the output of ORA using QRAM depends on the ability of users because the way it estimates the proposed factors are quite subjective.
For most experts, both efficiency and effectiveness of the QRAM analysis process and results will depend on risk analyst experience, knowledge and commitment to safety.

4. CONCLUSIONS

ORA process is often based on historical data, fitted to some probability distribution (usually the normal distribution). At construction industry, reliable historical data does not exists, so they use data from other industries or similar sites. Another problem is that occupational historical data may include no extreme observations (for the proper statistical treatment), but this does not preclude that such events occurring in the future.
The construction industry needs ORA models that can allow the use of real data and where information should be elicited and treated in an easy and understandable manner to assure that safety practitioners understand the results entirely, thus improving the sites safety.
ORA models must consider safety climate. Safety climate omission from ORA results correspond to the assumption that the design, plan and construction are "human error-free". Safety climate traditional methods were assessed in an independent way (not integrated with the other risk factors) and required significant expertise to evaluate, beside s

requiring a lot of time. QRAM provides a practical and integrated way to estimate safety climate at construction sites, which also incorporates the results in the risk accident modes.

Fuzzy Set Theory proved to be a good framework for ORA, especially because it allows representing empirical knowledge in a qualitative and quantitative way, thus providing tools to assessing risks in construction sites in a more systematic way.

According to the safety expert pool, our QRAM method seems to be a good tool for occupational safety risk assessment on construction sites. The specific checklists used for the elicitation of knowledge are a good aid to analysts and the use of the linguistic variables to assess them, is a better way to make the estimates more objective.

Different perspectives on occupational risk influence the risk management (Aven, 2009). ALARP principle is based on the principle of ‘‘reversed onus of proof”, it means that for that all identified risk, reduction measures should be implemented, unless it can be demonstrated that there is gross disproportion between costs and benefits. Therefore, it makes more sense that the results of ORA are presented in ALARP levels instead of a numeric value without a precise meaning.

Using QRAM enforces a more systematic risk assessment process, leaving little space to the analysts’ creativity.

5. ACKNOWLEDGMENTS

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Evaluation of Indoor Air Quality in Day Care Centres for the Elderly

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ABSTRACT
The indoor air quality has been reported as a major environmental risk to public health. The elderly are one group particularly sensitive to indoor air pollution. Considering the increasing aging population and the need to promote a better life quality for the elderly population, it is essential that spaces where these individuals remain provide an adequate indoor air quality. In this context, it was carried out a study that had as main objective to evaluate the indoor air quality in centres for the elderly and analyse the symptoms perceived by its occupants. The quantification of environmental parameters was based on: characterization of the building, measurement of physical parameters and sampling of chemical and biological parameters. In the analysis of symptoms perceived by the occupants proceeded to the application of a questionnaire interview. The results showed that, for thermal parameters all the sites manifested air's temperature greater than those established by national law and values of air's velocity inferior to the minimum internationally recommended, which can indicate that the air renewal is not made properly. In general, the chemical agent's average concentrations did not exceed the limits legally established. However, it is important to noteworthy the high concentrations of total mesophilic at 37ºC and moulds at 25ºC, which may indicate inadequate ventilation conditions and overcrowded spaces. Air drafts, the low temperature and the saturated air were the environmental factors most identified by seniors to cause discomfort. The main symptom reported by the spaces occupants was "fatigue". The symptoms perceived by the elderly were not consistent and may possibly be related not only with environmental factors, reason why it is proposed to extend the study. The improvement of ventilation conditions is one of the measures that can help in solving the problems of indoor air quality detected in the evaluated institutions.

Keywords: Indoor air quality; day care centres for the elderly; elderly.

1. INTRODUCTION

The issue of Indoor Air Quality (IAQ) has attracted the interest of the scientific community and the general public. From the factors that directly affect IAQ we point out the sources of indoor pollution such as building materials, cleaning products, the occupants' behaviours and activities and HVAC systems. As sources of outdoor pollution are identified the smoke from burning vehicles, industrial emissions, pollen and waste disposal (Martínez e Callejo 2006; EPA, 2009; APA, 2010). Generally, we can categorize indoor air contaminants into three main types: chemical, physical and biological (Chan *et al*., 2009). The chemicals agents associated with IAQ in buildings and that should be monitored are the airborne particles (PM_x), carbon dioxide (CO_2), carbon monoxide (CO), ozone (O_3), formaldehyde (HCHO), volatile organic compounds (VOCs) and Radon. With regard to biological agents, are included bacteria and moulds that thrive in conditions of high humidity, reduced ventilation, nutrient availability and existence of inside and/or outside sources contamination. The relative humidity, air's temperature and air's velocity are related parameters that influence thermal comfort and the concentrations and dispersion of indoor pollutants.

Maximum reference concentrations (MRC) for the above agents are defined in Decree-Law No. 79/2006 of April 4th [Regulation on Energy Systems in Buildings, which recommends criteria for legal compliance to take into consideration in audits of IAQ. In 2009, it was published a Technical Note (TN-ESA-02) establishing the methodology for IAQ audits.

The IAQ is considered a determinant of public health (WHO, 2006). However, some groups of individuals are particularly sensitive to indoor air pollution, such as the elderly. These individuals spend much of their time indoors, which means greater exposure to potential contaminants in indoor air, as well as present, in general, chronic disease that makes them vulnerable (Simoni *et al*., 2003). In addition, it is expected that by 2050, the number of elderly is twice the number of children (UN, 2007). In Portugal, according to recent data from the National Statistics Institute (2009), it is anticipated a trend towards an aging population, estimating that by 2060 there will be roughly three elderly per each young person.

Considering the prediction of an aging population and the need to promote a better life quality for the elderly population, this study was conducted to assess the environmental parameters affecting IAQ, in particularly, carbon dioxide (CO_2), carbon monoxide (CO), airborne particle (PM_{10}), total viable microorganisms, air's temperature (t_a), relative humidity (HR) and air's velocity (v_{ar}) in day care centres for the elderly. The analysis of the symptoms perceived by the occupants and the propose of corrective and/or preventive measures to improve IAQ, were also conducted.

2. MATERIALS AND METHODS

The current study was conducted in four day care centres for the elderly, located in the municipality of Vila Nova de Gaia. The evaluated sites were living rooms, once they represent the spaces with greater elderly permanence. The methodology applied was based on:

- Characterization of the structural and operational conditions of the day care centres;
- Assessment of environmental parameters;
- Analysis of the symptoms perceived by the occupants through the application of an interview survey.

In order to maintain the confidentiality of data, the four day care centres were coded as: C1, C2, C3 and C4.

2.1. Characterization of the structural and operational conditions of the day care centres

For the structural and operational characterization of the building it was created a checklist composed with different fields: general setup (type of coating materials, furniture, etc.), type of activities, type of ventilation systems and identification of potential pollution sources, indoor and outdoor.

2.2. Evaluation of environmental parameters

The sampling points in the living rooms were determined taking into account the rooms' layout, the doors and windows location and the existence of inner or outer contamination sources. The evaluation of thermal parameters (air's temperature, relative humidity and air's velocity), chemical parameters (CO_2, CO and PM_{10}) and microbiological parameters (total mesophilic microorganisms at 37 °C and moulds at 25 °C) were also conducted. The measurement of environmental parameters was based on the recommendations outlined in the Technical Note - NT-SCE-02 and the "Technical Guide for Indoor Air Quality", published by the Portuguese Environment Agency. There should also be noted that the method for sampling and analysing viable microorganisms took into account Procedure 0800 - Bioaerosol Sampling (Indoor Air) – National Institute for Occupational Safety and Health (NIOSH). In the analysis and results interpretation were used MRC set out in Annex VII of Decree-Law No. 79/2006 of April 4th for IAQ and Decree-Law No. 80/2006 of April 4th parameters for air temperature and relative humidity, as well as international recommendations of the Indoor Air Quality Association (IAQA) and American National Standards Institute (ANISI)/American Society of Heating Refrigerating and air-conditioning Engineers (ASHRAE) Standard 62.1.

For microbiological agents were used, Triptycase Soy Agar (TSA) for quantifying total mesophilic microorganisms and Malt Extract Agar (MEA) for moulds quantification. The samples incubation temperature was 37 °C for total mesophilic microorganisms, during two days, and 25 °C for moulds, during five days. After the incubation periods, the colonies were counted and it was calculated the Colony Forming Units per cubic meter (CFU/m^3).

For evaluation of the environmental parameters there were used the equipment described in Table 1.

Table 1 – Parameter and equipment of measure.

Parameter	Equipment
CO	IAQ-Calc 8760
CO_2	IAQ-Calc 8760
Particles	Dust Track
Viable microorganisms	MAS 100
Air's Temperature and Relative Humidity	IAQ-Calc 8760
Air's Velocity	VelociCalc 8345

2.4. Questionnaire application

The developed survey for the analysis of the symptoms perceived by the occupants focused mainly on the identification of symptoms and their temporal and spatial pattern. The survey also contained fields intended for the perception of environmental conditions of the space. The survey was conducted by interviewing the occupants who were subsequently coded and underwent statistical treatment.

2.5. Evaluation Criteria

The values obtained in chemical, physical and biological parameters evaluation were compared with the Decree-Law n.º 79/2006 of April 4th (Annex VII – Maximum Reference Concentrations of pollutants within the existing buildings) and the Decree-Law n.º 80/2006 of April 4th (article n.º14 – Interior conditions reference). The reference values are presented in Table 2.

Table 2- Reference values for IAQ

Decree-Law n.º 79/2006 of April 4th					
CO	**CO_2**	**PM_{10}**	**Total mesophilic microorganisms (37ºC)**	**Moulds**	**Air's velocity**
10,7 ppm	984 ppm	0,15 mg/m^3	500 CFU/m^3	500 CFU/m^3	<0,2 m/s

Decree-Law n.º 80/2006 of April 4th	
Air's Temperature	**Relative Humidity**
20ºC- Summer 25ºC - Winter	50%

3. RESULTS AND DISCUSSION

The characterization of the accessed buildings and spaces enabled to collect useful data for identifying potential sources of indoor air pollution. Tables 3 and 4 show some characteristics of the evaluated buildings and rooms.

Table 3 – General building characterization.

Characteristics	Building			
	C1	**C2**	**C3**	**C4**
Localization	Urban	Urban	Urban	Urban
Sources of pollution in the surrounding area	Road	Road and Railroad	Road	Road
Latest structural remodelling	2009	2006	2001	1997
Ventilation system	Natural	Natural	Natural	Natural

Table 4 – General room characterization.

Characteristics	Building			
	C1	**C2**	**C3**	**C4**
Evaluated Room Area	150m^2	100m^2	60m^2	75m^2
No. of occupants	24	17	25	13
Signs of moisture and/or infiltration	No	Yes	No	No

Table 5 presents the average values obtained for the thermal parameters evaluated.

Table 5 – Mean values for thermal parameters.

Thermal Parameters	Building			
	C1	**C2**	**C3**	**C4**
Temperature (Cº)	24,7	25,8	26,4	24,1
Relative Humidity (%)	54,3	44,9	48,4	61,8
Air's Velocity (m/s)	0,07	0,04	0,08	0,14

As observed in Table 5, the average of air's temperature ranged between 24,1 °C and 26,4 °C, of relative humidity between 44,9% and 61,8% and air's velocity between 0,04 m/s and 0,14 m/s. Generally, all evaluated sites presented values of air's temperature above the established by in force legislation for the time of year when the assessments took place (Spring/Summer) (20 °C). The occupants are outside the comfort zone, with regard to the relative humidity, with most of the sites near the reference values recommended by national and international recommendations. The air's velocity values obtained are below the threshold set in the Portuguese law (0,2 m/s), however, they are below to the minimum value proposed by the IAQA (0,05 m/s), which can lead to the conclusion that the air renewal is not properly done.
TheTable 6 presents the average concentrations obtained for chemical parameters evaluated.

Table 6 – Mean values for chemical parameters.

Chemical Parameters	Building			
	C1	**C2**	**C3**	**C4**
CO_2 (ppm)	667	1029	753	642
CO (ppm)	4,8	3,1	3,7	5,9
PM10 (mg/m^3)	0,031	0,032	0,006	0,016

For the chemical parameters presented in Table 6, the average CO_2 concentrations detected ranged from 642 ppm to 1029 ppm, and it was verified that only one of the rooms exceeded the limit value established in the Annex of the Decree-Law

No. 79/2006 of April 4th. Considering that CO_2 is a good indicator of the adequacy and efficiency of ventilation (Heudorf *et al.*, 2009), the concentrations obtained in the room of the building C2 may indicate that this area has an insufficient ventilation rate. The average CO concentrations ranged between 3.1 ppm and 5.9 ppm, below the legally established limit (10.7 ppm). In the absence of internal sources related to the emission of this agent it may be suggested that the CO peaks found within the building are related to traffic, as Chaloulakou *et al*. (2002) found. However, to better understand the source of this agent, it would be necessary to study the variations inside and outside. The PM_{10} concentrations obtained were below the MRC (0.15 mg/m^3).
The Table 7 shows the average concentrations of viable microorganisms found in evaluated spaces.

Table 7 – Mean concentrations obtained for microbiological parameters

Microbiological Parameters	Building C1	C2	C3	C4
Total mesophilic microorganisms (37ºC) CFU/m^3	600	1250	469	659
Moulds (25ºC) CFU/m^3	1404	571	513	1065

As observed in Table7, microbiological parameters showed concentrations ranging between 469 CFU/m^3 and 1250 CFU/m^3 for total mesophilic microorganisms at 37 ºC and 513 CFU/m^3 to 1404 CFU/m^3 for moulds at 25ºC. For these parameters, only one room showed concentrations of total mesophilic microorganisms at 37 °C lower than the national legislation (500 CFU/m^3). It is assumed that human occupation and poor ventilation may have promoted the microorganisms concentration increase in these spaces. Ribéron *et al.* (2002), states that a major source of bacteria in the indoor environment is the human being and its activities.
To better characterise the microbiological quality of indoor air of day care centres for the elderly, proceeded to the identification of moulds, classifying them by gender. The most common genera were *Cladosporium spp*. and *Aspergillus spp.*
Through the analysis of Figure 1, it is observed that air currents, low temperature and saturated air were the most environmental factors identified by the elderly as cause of discomfort.

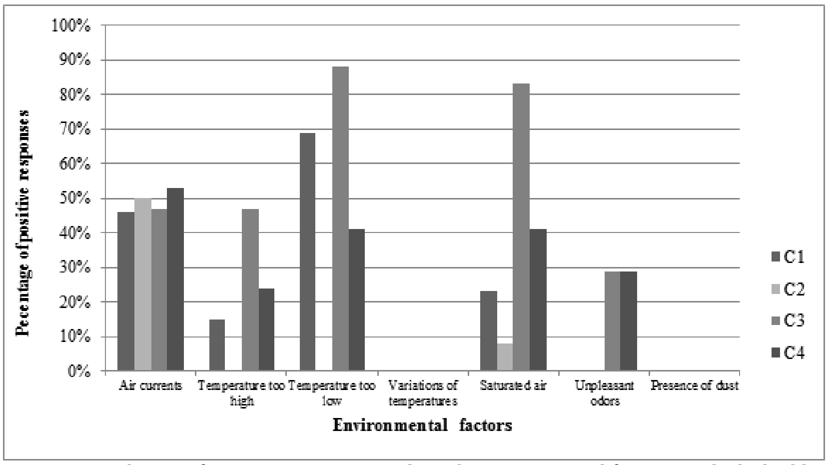

Figure 1 – Distribution of occupants perception about the environmental factors inside the buildings.

The main symptom reported by the occupants of the spaces was "fatigue". However, this symptom can be related with non-environmental factors such as pre-existing diseases that are consequence of the age. It was found that is difficult to relate the symptoms with the results of concentrations/mean values of environmental parameters.

4. CONCLUSIONS

The day care centres for the elderly represents a particular group of buildings, where the guarantee of good indoor air quality is crucial to the elderly wellbeing and comfort.
The results of this study indicated that IAQ problems may be primarily related to poor ventilation conditions and, in some cases, with the overcrowding of the spaces. These factors support the high concentrations of total mesophilic microorganisms and moulds. The high concentrations of moulds, including the genus *Aspergillus* spp., are indeed cause for concern, since these agents have allergen proprieties that may have negative impact on the elderly health. With regard to symptoms perceived by the elderly, these were not consistent and may possibly be related not only to environmental factors. In this sense it is proposed to extend the study, specifying/characterizing better the group of seniors to enquiry, for exclusion of bias, and extend the study to more institutions.

In this matter, it is suggested some organizational measures as: the implementation of only wet cleaning processes and the adoption of a plan for cleaning the spaces, stating the frequency of cleaning and disinfection of all utensils, equipments, materials and facilities. There can also be considered the adoption of constructive measures, to improve spaces ventilation and ensure minimum flows of new air in the proportion of $30m^3/h$ per occupant, as recommended in Annex VI of Decree-Law No. 79/2006 of April 4th and respect the maximum number of occupants/m^2, in order to avoid overcrowding. It is therefore proposed the installation of mechanical forced ventilation systems that introduce “fresh air”, the installation of air conditioning systems with outdoor air intake, the installation of vents in window frames and/or installation of awning windows.

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Effects of thermal environment on cognitive response in sedentary activities. A short revision

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ABSTRACT
The study about the influence of the thermal environment on cognitive response is fundamental to understanding better the connection between the basic variables and cognitive performance. This also helps the better understanding of safety situation, guidance and decision-making, especially to avoid critical situations. The main objective of this work is to relate the physiological with cognitive response, trying to find exposure limits covering both occupational settings and social environments in high temperatures. For this purpose, was used a systematic cross-linked search, relating several key words and search phrases in different electronic data bases with different criteria. According to the survey results, it`s clear the importance of studying the core temperature and the sweating rate to understand the relationship between the thermal environment and the cognitive response So, in this review, different topics are considered by different authors as fundamental for the study of thermal environment influence on cognitive response as: type of tasks, dehydration, brain, skin and core and temperature. It was concluded in relation to sedentary activities that the results are still questionable. However, this brief survey indicates that the cognitive response is affected by, at least, four parameters, core temperature, dehydration, psychological factors and the type of the tasks.

Keywords: Thermal Environment; Cognitive function; Heat; Alertness; Task.

1. INTRODUCTION

The present literature review is comprised within a broader project that aims to study the Human response to different conditions of thermal environment, which is being developed at the University of Porto, as part of the Doctoral Program in Occupational Safety and Health (DemSSO).

All human activity is influenced by the environment of the place where it is held. In this perspective, studies of the thermal environment are fundamental to better understand the integrators factors of different basic variables (air temperature, air velocity, relative humidity and radiant temperature, combined with clothing and metabolism) with the cognitive performance.

Cognitive performance is defined as a set of mental processes, such as information processing, learning, perception, memory and reasoning, alertness and troubleshooting. In this point of view, the cognitive aspects play a key role in security, guidance and decision making, especially to avoid critical situations (Faerevick, 2010). The psychomotor functioning (reaction time, movement time, speed of performance) has also been included in this concept (Antunes et al., 2006). On the other hand and according to Annunziat (2011) the cognitive functioning is also included in the concept of quality of life.

Health problems and heat stress as well as their impact on human activity, have been gaining an increasing importance internationally, both in organization and in research. However, despite numerous studies have been conducted to know the physiological answer to high temperatures and humidity and their consequences in health, the respective effect on cognitive functions remains ambiguous (Gaoua, 2010).

It is intended in this paper, to present the state of the art related to the influence of the moderate or hot thermal environment on cognitive response in sedentary activities. As a specific objective, it seeks to relate the physiological response to the cognitive response, trying to find exposure limits covering both occupational and social environments from moderate to hot environment. The relevance of this work is justified by the significant increase in the complexity of industrial tasks that require high cognitive level and the increase in sedentary jobs due to automation of the industrial processes. In this context, the importance of the issue stems from the high temperatures being a consequence not only of specific working conditions, but also due to natural conditions e.g, climate changes that remains a global problem in the fields of public health and economy.

2. MATERIALS AND METHODS

For this purpose, a systematic search was conducted and cross-linking multiple keywords as well as various search expressions in different electronic databases and with different criteria:

PubMed, - using simple search using the following Keywords: Thermal Environment, Cognitive Function, Heat and Cognition, Simple Mental Task and Mental Alertness, found a total of 228 papers, from which 37 related to cognitive were selected and further 7 of these were selected according to the purpose of research.

The research was also made in the search engine for scientific literature of FEUP (Met Lib) as listed in table 1, from the Advanced Meta Search option Goal of Library and information Services of the institution, in seven databases. The Key words used were Heat and Cognitive, having been chosen only those items on which those words were mentioned together. The area selected it was in the multidisciplinary and health category.

Table 1 – Advanced Meta Search results

Designation	Key Words	Results
Pub Med	Thermal Environment; Cognitive Function, Heat and Cognition, Simple Mental Task, Mental Alertness	228
Academic Search Complete	Heat and Cognitive	16
Compendex		2
Current Contents		18
ERIC		3
Inspec		1
Scopus		0
Web Of Science		31
Combined results		71

It was explored a database at a time, with only the subject of papers in the study at the Academic Search Complete (16) and Web of Science (31). Of these 47 articles were selected only those who had common points, taking into account the relevance of the study and were given priority published in the last decade, but with particular focus between 2007 and 2011, taking into account the meta-analysis by Hancok (2007). In the end total of 35 articles was left and including those found in Pub Med and from the search engine of FEUP which were analysed in detail.

3. RESULTS AND DISCUSSION

Based on the analysis of selected literature there is agreement among authors regarding the visible importance of studying the thermal environment on cognitive response. The World Health Organization (WHO) defines health as a state of physical well-being, mental and social and not merely the absence of disease and more recently conducted research to include cognitive functioning within the concepts of Quality of Life. The cognitive functioning, e.g. a series of mental processes including memory, attention, executive functions, language, and perception, plays a fundamental role in people's life, particularly in social and work independence, once many times well-being in a general way, and in general populations, remains incomplete because of cognitive difficulties, in addition and despite this general practice, cognitive impairment can also occur as a consequence of mood disorders or psychi-emotional distress (Annunziata et al. 2011).

The climate changes have a major contribute on this behaviour, and according Berry (2009) different aspects of climate change may affect mental health through direct and indirect pathways, leading to serious mental health problems, possibly including increased suicide mortality. According to the study the debate about the impact of climate change on human health has, very recently, included consideration of mental health. By increasing the frequency, severity and duration of adverse weather events, climate change will affect mental health via at least three ways. It will, firstly, directly affect mental health by inflicting more and worse natural disasters on human settlements which, typically, cause serious anxiety-related responses and, later, chronic and severe mental health problems. Secondly, it will increase the risk of injury and physical health problems which are causally and reciprocally related to mental health. Thirdly, it will endanger the natural and social environment on which people depend for their livelihoods and wellbeing (Berry et al. 2009).

As referred by Parsons (2003), to assess human thermal environments it may be necessary to quantify the environment (basic parameters), and its effects (physiological, psychological, and so on) and interpret the values obtained in terms of health, comfort and performance of those exposed. The present study, intends to relate the physiological response to the cognitive response. For that, the basic variables, mentioned in the introduction, can be quantified using measuring instruments; physiological responses can be measured using transducers connected to the body and psychological responses are quantified using subjective and behavioural measures. Concerning the cognitive performance, can be measured through tests of cognitive function (arithmetic, visual tracking and recent memory) (Ribeiro, 2010), among others.

As Parsons (2003) also asserts, in hot environments the body will sweat and core temperature may rise. The resulting distress or discomfort may lead to behavioural changes and affects cognitive performance, for example mental performance, information processing, memory and so on. Refers, as well, that many tasks and task components require both physical and cognitive function, like for example: reaction time, some type tasks may require perception, information processing, and physical action (manual).

In this review different topics considered by different authors were highlighted as key influence of the thermal environment on cognitive response: typed of tasks, dehydration, skin /core Temperature and Brain, being related to each other.

3.1 Kinds of tasks

Regarding sedentary activities, particularly in offices, different studies have developed research over the past years, as Sepanen (2005), Tanabe (2006), Tanaka (2006), Lan (2008), Parsons (2009), Than (2009) and Lan (2010), among others. After a selection of relevant issues and based on the results of several authors it can be seen that, over the years there has been a central controversy about the effects of thermal conditions and mental performance. Some authors like for example Pepler and Warner (1968) and Sundestrom (1987) reported; for their part, that mental performance is generally not affected by heat, others such as Wyon (1979), Parsons (2003) and Seppanen (2003) postulated that cognitive performance declines with heat. More recently O´Neal stated that the results obtained are in agreement with previous research suggesting that changes in cognitive function of individuals exposed to physical activity in hot environment can increase, decrease or change very little (O`Neal 2010). This paradox between results, occurs by interference from various factors, such as the type of task, characteristics of the worker, the level of motivation (Tanabe, et al. 2006), psychological factors and characteristics of buildings, severity of exposure to temperature, complexity and duration of cognitive task (Gaoua, 2010), among others.

Hancock (2007), in order to quantify the effects of thermal stress on human performance in their meta-analysis confirmed the negative influence of heat stress on performance. It was established, that cognitive performance was less affected than psychomotor performance and perceptual tasks, and in the latter case, it was important the task type, exposure duration and intensity of stressors. In addition the combined effect of intensity and type of task (perceptual, cognitive and psychomotor), and intensity, duration, performance task in the same three perspectives (perceptual, cognitive and psychomotor). The results confirmed the importance of the type of task, duration of exposure and intensity of stress indicators as *Key* variables to understand how the thermal conditions impact performance results were consistent with the theory that stress forces individual to allocate attention resources to assess and deal with the threat, which reduces the ability to process information relevant tasks.

According to the meta-analytical review (Pilcher et al. 2002), the effect of exposure to high temperatures results in an inverted U curve, function between performance and the degree of temperature exposure. However, this situation depends also on the type of task and the time of exposure. The results of this meta-analysis refers that temperatures between 21,11-26,62 ºC WBGT, results in a very little effect on performance. The short exposure to temperature and short tasks durations resulted in worse performance than longer durations and pre task temperature exposure of more than 60 minutes resulted in a substantial decrement in performance. It was suggested in the same data that industries that require workers to perform under hot temperature, should be aware of the potential negative effects of temperature exposure on performance.

3.2 Dehydration

Dehydration is a reliable predictor of impaired cognitive status (Wilson et al., 2003). The performance of both physical and mental tasks, can be adversely affected by heat and by dehydration. There are well-recognized effects of heat and hydration status on the cardiovascular and thermoregulatory systems that can account for the decreased performance and increased sensation of effort that are experienced in the heat (Maughan 2007).

It has long been known that dehydration negatively affects physical performance. Examining the effects of hydration status on cognitive function is a relatively new area of research, resulting in part from our increased understanding of hydration’s impact on physical performance and advances in the discipline of cognitive neuropsychology. The research available in this area, although scarce, asserts that decrements in physical, vasomotor, psychomotor, and cognitive performance can occur when 2% or more of body weight is lost due to water restriction, heat, and/or physical exertion. Additional research is needed, especially studies designed to reduce, if not remove, the limitations of studies conducted to date (Grandjean et al.,2007). As shown by Ribeiro (2010) is not only the physical performance that suffers damaged by dehydration but also the cognitive performance that is essential in team sports (Ribeiro, 2010). Other results confirmed the importance of hydration on cognitive function and it has been suggested the need for studies to monitor fluid intake for 24 hours before and during the experimental trials. The ability of individuals should be assessed before carrying out cognitive tasks. Like Grandjean (2007) refers increasing the understanding of the effects of hydration status on cognitive performance could be applied to health care, education, and other areas where cognitive performance is assessed and/or treatment is rendered.

Also Lieberman (2007) affirms that due to lack of data, definitive conclusions concerning the effects of fluid restriction on cognitive performance are not possible. However, it is clear that dehydration induced by exposure to heat, exercise and fluid restriction impairs cognitive performance and mood. Adverse effects are present at levels of dehydration of 1,3% of weight loss. Maugham’s study refers that provision of fluids of appropriate composition in adequate amounts can prevent dehydration and can greatly reduce the adverse effects of heat stress. There is growing evidence that the effects of high ambient temperature and dehydration on exercise performance may be mediated by effects on the central nervous system (Maughan 2007). Body water deficits or hypohydration (HYP) may degrade cognitive performance during heat exposure and perhaps temperate conditions (Adam, 2008). A critical deficit of 1% of body weight elevates temperature during exercise (Sawka and Montain, 2000).

Water and electrolyte balance are critical for the function of all organs and, indeed, for maintaining health in general. Water provides the medium for biochemical reactions within cell tissues and it is essential to maintain an adequate blood volume and thus the integrity of the cardiovascular system. During exercise in the heat, sweat output often exceeds water intake, resulting in a body water deficit (hypohydration) and electrolyte losses (Sawka, 2000). The same author refers that to support the contraction of skeletal muscles, physical exercise routinely increases total body metabolism up to 5–15 times the resting rate. Approximately 70–90% of this energy is released as heat, that needs to be dissipated to achieve body heat balance. The relative contributions of evaporative and dry (radiation and conduction) heat exchange to total heat loss vary according to climatic conditions. In hot climates, a substantial volume of body water may be lost via sweating to enable evaporative cooling.

Maughan (2007) emphasize that there is growing evidence that the effects of high ambient temperature and dehydration on exercise performance may be mediated by effects on the central nervous system (CNS). While the precise role of the CNS in the development of fatigue is yet to be determined, preliminary evidence supports a neurotransmission role in the fatigue process. A number of circulatory perturbations, including reduction in cerebral blood flow and increase permeability of the blood-brain barrier, may also influence performance when exercise is undertaken in high ambient temperatures, particularly in the presence of significant levels of dehydration.

Although a lot of studies were carried out, Grandjean (2007) refer that future research and challenges is also necessary to reduce ambiguity concerning the dehydration, for there are several potential confounders, like for example: extension of the dehydration phase; time of the day that neuropsychological assessment is conducted; macronutrient and micronutrient composition of the diet, as well as non-nutritive compounds; circadian rhythm; quantity and quality of sleep; individual differences (e.g IQ, resourcefulness, motivation, competitiveness, psychopathology).

3.3 Skin and Core Temperature

When skin temperature exceeds environmental temperature, heat can be lost to the environment through radiation, convection, and evaporation. Heat loss by conduction is negligible when exercising in open air, but becomes significant when immersed in water. Once environmental temperature exceeds skin temperature, evaporation is the only mechanism by which the body can lose heat. Sweating is evoked when core temperature rises and increases in proportion to core temperature, but the sweating rate is also influenced by skin temperature. Sweat evaporation will depend on the water vapour pressure gradient at the skin surface: this in turn depends on skin and environmental temperature and the relative humidity at the skin surface (Maughan, 2007).

According Parsons (2003) , core temperature has no definition. Nevertheless it is generally considered as internal body temperature or the temperature of the vital organs including the brain. If core temperature rises or falls, then there are practical consequences for the body in terms of health, comfort and performance. The main finding of Alonso et al (1999) studies was that fatigue during exercise in the heat was related to high internal body temperature. According Maughan (2007) a change in body temperature may be regarded as a failure of homeostasis or as a re-setting of the point around which regulation occurs. Small fluctuations are normal: over the course of the day, core temperature varies by about 1°C. During exercise, some degree of core temperature elevation is normal with the increase proportional to the absolute and relative (expressed as a fraction of VO_{2max}) power output. Rise in body temperature is also influenced by the environment. Core temperature rises faster in hot environments when power output is maintained at a constant rate, and a higher core temperature is observed at the point of fatigue.

O`Neal (2010), demonstrated that rates of unsafe behaviour and accidents in industrial environments increase both with the activity and the temperature rise. That is, when an environment exceeds 24ºC values (WBGT) and when the body´s core temperature exceeds 38ºC. Recognition of this situation, would allow supervisors to more effectively manage employees exposure and eventually make the workplace safer in cases where a mental error can result in an accident (O´Neal et al. 2010).The most serious consequence of exposure to intense heat is heat stroke which may be fatal. It is caused by a quick failure in temperature regulation, leading to an increase in the heat content of the body. The rectal temperature may be 40ºC or higher (Tanaka, 2006). Nevertheless other author refer that core body temperature is maintained within a very thin range of normality generally between36 and 39 ºC (96.8–102.2 ºF), even in extreme environmental conditions, through an intricate system integrating various physical and biochemical processes coordinated by the hypothalamus (Gonzalez 2010). Metabolic heat production and external heat sources are equally capable of elevating the core temperature during work in hot environments. However, core temperature elevation can be restricted to a safe and manageable level if heat loss mechanisms (sweating and skin blood flow) can be sustained or supplemented (Caldwel et al. 2011).Two major processes dissipate heat from core body parts to the environment. One is heat loss from the skin surface; another is heat transfer from core body parts to the skin. Since heat loss from the skin is inefficient in hot and humid environments, the contribution of core to skin heat transfer becomes relatively greater than that in neutral environments. The transfer of heat to the skin through the blood circulation is a product of skin blood flow, core-skin temperature gradient and the volume specific heat of blood (Taylor et al. 2008) by Wakabayash (2010).

3.4 Brain

The thermoregulatory responses to exercise and heat stress occur without conscious action by the brain, but this does not mean that brain is not aware of what is occurring or that it is not essential for conservation of function when exposed to theses stresses (Maughan, 2007).

Changes in brain activity with temperature have earlier been observed in humans on the basis of electroencephalographic (EEG) recordings and sensory evoked potentials (Nielson 2003). It is possible to monitor brain function through psychophysiological recording. Traditionally, much of this work has been based on arousal theory. Arousal may be assessed through central nervous system measures (the electroencephalogram or EEG) and autonomic nervous system measures such as increased skin conductance and heart rate (Matthews, 2000).The same author refers that several studies suggested that there is a curvilinear relationship between heat and vigilance, and that several reviewers have suggested that there is an optimum temperature range of around 27º- 32ºC for vigilance. The inverted – U relationship between temperature and vigilance is allusive of the Yerkes – Dodson Law. Decrements in performance at higher temperatures might be attributed to over arousal. However, there are difficulties for such an arousal theory explanation. The subjective effects of heat include anxiety, irritability, fatigue, drowsiness and loss of motivation. With regard to fatigue that can lead to accidents and cause errors. To measure performance three types of fatigue were distinguished: physiological, subjective and objective fatigue. Physiological changes during performance are not directly related to the brain`s consumption of energy during performance (Matthews, 2000).There is a close relationship between physiological and emotional reactions, and there are two traditional approaches to explain this correlation the Centralist (that is to suppose that both types of reaction are expressions of central brain systems - thalamus) and the Peripheralist (more psychological in character) (Matthews, 2000).

According to Ftaiti (2010) the development of fatigue is complex and determined by an intricate interplay between psychological and physiological factors. It was suggested in his study that, exhausting work in the heat induced a change in gross brain activity (alpha/beta ratio) compared to a longer, less thermally demanding exposure. Fatigue in the heat could be attributed to central factors as well as thermal, cardiac and hydro-electrolytic impairment, (Ftaiti, 2010).

The paradox of improving instead of deteriorating the mental performance under certain thermal stress levels is explained by the inverted U-shaped relationship between arousal and performance (Tanaka 2006).

High cerebral temperature may lead to alterations in motor drive that affect the ability to recruit sufficient muscle fibers to meet the demands of exercise. This effect may be mediated, at least in partly, by blood flow changes occurring in response to redistribution of cardiac output due to exercise-heat stress. It is clear that exercise, coupled with heat stress, results in a significant number of metabolic and circulatory perturbations within the brain (Maughan 2007). The changes in whole body fluid balance can directly influence the CNS, and this may potentially play role in the mental and physical performance deterioration observed with dehydration.

Tham (2009) concluded that cooling sensation activates the brain and excites the nervous system controlling thermoregulation and that activation of the sympathetic nervous system elevates mental alertness or arousal, a mental state preferred in performing tasks that require attention, endurance and energies. Tham (2009) asserts in his study that as correlate of catecholamines, salivary alfa-amylase may serve as an indicator of adrenergic activities under various thermal exposures, which could indicate the activation of the nervous system. Gaoua (2011) concludes that heat impairs memory, without change in the process of attention. Deficiencies found in cognitive function with hyperthermia and the beneficial effect of passive cooling of the head, are dependent tasks and suggest that exposure to hot environment is an important variable to consider for cognitive processes. These authors draw attention to the fact that the cooling of the head appears to be more efficient for the cognitive functions that involve the frontal area of the brain.

Sepänem (2006) in studies conducted to determine the performance indicators in offices, in activities such as, for example, word processing, simple calculations (addition and multiplication) and response time for customer call centers concluded that the temperature clearly affects the human response (Sepänen2006). Tham (2009) refers, in turn, the thermal environment in uncomfortable situations, can affect performance in office work. In trying to understand the mechanism of the link between air temperature and mental alertness through the perception and physiological responses, developed a study in this area. In this study, three office environments were simulated subject to the following temperatures 20 ºC, 23 ºC and 26 ºC, and findings related that both thermal comfort and thermal sensation changed significantly over time under all conditions of exposure. Moderate exposure to cold induced activation of the nervous system, demonstrated by the increased level of alpha amylase. Measures of mental performance in the study were obtained from various tests like, for example: arousal/alertness, concentration creativity and reasoning. The relationship between arousal/alertness and work performance is commonly described following the classic Yerkes-Dodson law which dictates that work performance improves with arousal/alertness up to an optimal point beyond which the work performance decreases (an inverted U curvilinear relationship).Association between arousal/alertness and work performance is also governed by the type of tasks under consideration. Tasks/works that emphasize on attention, endurance and energy usually require a higher arousal while those demanding thinking abilities are better performed under lower arousal state. Analyses of salivary biomarker focused on alfa- amylase, a correlate of catecholamines level in plasma secreted by activation of the sympathetic nerves. When released into the blood stream, catecholamines increases heart rate, blood pressure, breathing rate, muscle strength and mental alertness (Tham 2009).

Taking into account that with an uncompensated heat stress and the same core temperature (tc), the absolute heat load may be different among brain areas. It is therefore possible that environmental stress may affect cognitive abilities in different areas of the brain has suggested by Gaoua (2010) that in future rather than to categorize the tasks as “simple” and “complex”, it would be advisable to handle the complexity inside jobs.

4. CONCLUSIONS

Although there is agreement among authors regarding the perceived importance of studying the thermal environment on cognitive response and many studies have been carried out concerning the relationship between high temperatures and cognitive effect in certain professional activities, the results are still inconclusive. This paradox results, occurs by interference from various factors, such as the type of task, characteristics of the worker, the level of motivation (Tanabe et al. 2006), psychological factors and characteristics of buildings, severity of exposure to temperature, complexity and duration of cognitive task (Gaoua, 2010), among others.

However, literature review indicates that the cognitive response is affected by at least two parameters: the internal temperature and dehydration, in addition to other parameters related to psychological factors and the type of task. The type of task is also an important issue whether for the association between arousal/alertness that is commonly described following the classic Yerkes–Dodson law.

The differences in temperature and humidity can cause changes in the performance of workers at various levels, particularly in cognitive aspects, while being harmful to the health of workers. Factors such as internal body temperature and dehydration are highlighted, throughout this research, as key issues in monitoring the state of human beings to high temperatures. This scenario entails concentration problems, increased fatigue, illness, occupational safety and increased rate of risk. Gaoua (2010) found that cognitive function is more sensitive to environmental disturbances, especially thermal, than physiological tolerance and is influenced by changes in skin temperature. When there is significant increase in core temperature, the cognitive aspects can be affected. In order to proceed with further studies, the same author recommends discussion of results concerning exposure to heat, thermal loading and the resulting dynamic range of core temperature.

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Thermal Environment and Productivity in Sedentary Activities. A Short Review

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ABSTRACT
Physical effects caused by thermal environment, that may vary from cold, moderate to more severe conditions, adversely affect health and safety and may also affect productivity and workers' attention. This paper aims to provide a brief review concerning the influence of thermal environment on productivity in sedentary activities, through the presentation of the research lines and relevant studies in this field. The study was conducted through a systematic review, focused on a research question and according to adequate keywords. Based on content analysis of selected literature it appears that differences in temperature and humidity, whatever their source, may cause changes in the performance of workers at various levels, including productivity, while being detrimental to the health and safety of workers. Thermoregulation is an essential parameter, amid the ones requiring monitorization, depending on individual factors. In this study, other two topics are highlighted as fundamental to the study of the effects of thermal environment and productivity: climatic conditions and neutral thermal sensation. Considering the results it was concluded that there are many factors that affect worker productivity, however the environmental conditions have a great significance. The results show that thermal discomfort caused by air temperature is a relevant negative effect on performance. This effect is demonstrable from the changes in behaviour, mood, fatigue, motivation, reaction speed and increased absenteeism. Further studies are needed to clarify the conditions of ideal thermal environment related to high productivity, since the temperature known as the comfort temperature is not directly related to this factor.

KeyWords: Productivity, Thermal environment, Office Workers, Hot.

1. INTRODUCTION

The relationship between thermal environment and productivity as well as its quantification is an increasingly pertinent issue. In order to contribute to a systematization of knowledge in this field, a first analysis, in terms of scientific literature, is presented in this summary.

To a better understanding of the relationship between productivity, performance and activity, it is essential to define these three concepts; Parsons (2003) definitions were selected for this review: "Activity" is whatever people do, to achieve a goal, and may involve physiological or psychological factors. When these factors are carried out successfully, it means that the activity is performed. The term "Performance" when applied solely does not make sense and should always be associated with a task and related purpose, or will be conducting activities to achieve the objective. Finally "Productivity" is usually associated to the objectives of the organization and translates into a value that corresponds to what extent the activities have provided in terms of performance objectives of the system (Parson, 2003**).**

The physical effects caused by hot and humid thermal environment can vary from a mild state, with the sensation of thirst or heat, causing in this case, discomfort or lack of attention affecting the production, up to a more severe condition that can lead to heatstroke, collapse and unconsciousness and even death.

Productivity is one of the most important factors affecting the overall performance of any organization, from small to large companies (Niemela et al., 2002). Heat can cause physiological stress, particularly in people with high levels of physical activity. However, even people with other kind of activities have the same problem due to inherent physiological and individual aspects. For this reason the study of the relationship between thermal environment and productivity is complex because it depends on environmental factors such as: air temperature, air velocity, radiant temperature and relative humidity and individual factors, such as physical activity and clothing, and consequently, do not have the same effect in all persons.

Besides the factors mentioned above, Hole (2009) found a significant correlation between productivity indicators, health and organizational attributes in a study carried out in India. This study showed that companies reporting more organizational problems also have more performance problems (Hole, 2009). Problems that are sometimes related to working conditions, like for instance lack of resources and facilities: machines, manual material handling, workers motivation, training workers, hot work environment, once in this study in India the temperature in the factory could be around 46 *ºC* in the summer months. The other problems in terms of environment were noise and dusty environment. Due to that, managers receive workers' complaints of fatigue, back pain, upper –body and neck pain and hand or arm soreness.

This paper intends to present a short review regarding the influence of thermal environment upon productivity in sedentary activities, through the presentation of the research lines and relevant studies published in this field.

2. MATERIALS AND METHODS

The study was conducted through a systematic review, focused on a research question and according to adequate keywords. Initially the collection of articles it was independently of the year of publication, and in the second phase, priority was given to articles dating back to the last decade. The keywords used were: "Productivity" in the search field Title and "Thermal environment" in the Subject, and 448 results were listed. Of these, 392 were eliminated corresponding to the database Zentralblatt Math, leaving 56 papers in other three databases: Academic Search Complete (1), Current Glad (20) and Web of Science (35). As a criterion of restriction, only articles from the same keywords were analysed, with the addition of one of the following three search terms: Office Workers and the Indoor Environment, refined in the field of research authors. With this refinement left a total of 17 articles, with priority given to those published more recently, in view of the meta-analysis by Pilcher (2002). The selection was based on the information contained in the abstract of each articles.

3. RESULTS.

Extreme environment conditions are common in several industries. Such places include: iron, steel and nonferrous foundries, ceramics operation, glass and calcium carbide manufacturing, mining operating, electrical utilities (particularly in boiler room), farming operations, bakeries, confectioneries, restaurant kitchens, laundries, chemical manufacturing facilities, airport personnel working on hot tarmac, and also is some military and special facilities such as aircrafts and submarines. This subject is vital to a lot of workers especially due to safety and health problems. The adverse conditions that workers are exposed to, affect individual's ability. With so much blood going to the external surface of the body, relatively less goes to the active muscles, the brain, and other internal organs; strength declines; and fatigue occurs, alertness and mental capacity also may be affected, workers who must perform delicate or detailed work may find their accuracy suffering.

Based on the content analysis of selected literature it appears that exposure to different temperatures and levels of humidity, whatever their source, may cause changes in the performance of workers at various levels, including production aspects, while being harmful to health and safety of workers. Costa (2010) asserts that as a result of such exposure are frequent changes in behaviour, mood, increased distractibility, increased physical fatigue, discouragement, loss of speed in performing tasks, reducing the degree of attention and precision as well as increased absenteeism.

Blyissen (2009) refers that productivity depends upon many aspects: well-being, job satisfaction, technical competence, career achievements, home/work interface, relationship with others, personal circumstances, organizational matters, etc., and also environmental factors (indoor and outdoor environment). The same author sustains that productivity is measured in three different ways:

- Objectively: by measuring the speed of working and the accuracy of outputs by designing very controlled experiments with well-focused tests;
- Subjectively: by using self-estimated scales and questionnaires to assess the individual opinions of people concerning their work and environment;
- Combined measures: using some physiological measures such as brain rhythms to see if variations in the patterns of the brain responses correlate to responses assessed by questionnaires.

This research highlights several topics considered by different authors as essential to develop the relation between thermal environment and productivity, such as: individual factors, climatic conditions and neutral thermal sensation.

3.1 Individual factors

People are different and some people are extremely sensitive when exposed to environmental changes, due the individual factors that differ from person to person, namely thermoregulation. For this reason it may, therefore, be difficult to keep all occupants comfortable at the same time in one space. Human thermal sensation is mainly related to the thermal balance of the human body as a whole. This balance is influenced by physical activity and clothing as well as by the environmental parameters, (Fanger, 1986).

Thermoregulation is one the critical parameters when studying human behaviour at high temperatures. Thermoregulation depends on: age, gender, body mass index, body fat rate, surface area, sweating mechanism, hormonal differences, among others, (Falk, 1998).

On the other hand the variables controlled by Nielson (1993), in a study of heat acclimation were: core temperature (esophageal), sweating, oxygen consumption, heart rate, heart rate response, blood flow, leg (Leg blood flow – LBF), forearm blood flow (Forearm blood flow- FBF), skin temperature, plasma volume, blood constituents (Hct, Hb, glucose and lactate concentration, hormonal analysis (catecholamines, adrenaline, etc.).

It was concluded from the article published by Nielson (1993), that heat acclimation may take a different course depending on the type of environment, for instance, hot and dry effects versus hot and humid, as well as exercise. The high core temperature was a critical factor to fatigue caused by heat stress, both before and after acclimation (Nielson et al, 1993). According to the research presented by Ribeiro (2010), the continuous increase in the value of the internal temperature will cause the achievement of a certain critical value and compromised physical performance, which has been referred to as ranging between 39,1 *ºC* and 40,1 *ºC* (rectal temperature), athletes tend to finish the race due the fatigue with rectal temperature at around 40 *ºC*, (Ribeiro, 2010).

In a recent study published by Zhao (2009), statistics analysis using Excel was applied trying to establish the human tolerance time and productivity model in a hot and humid environment. The main objective was to determine the safe working time for workers in a hot and humid environment and also to provide the performance rate of productivity under

these conditions. It was concluded that work done in warm and humidity, for long periods, not only may cause damage to human health and decrease productivity, but also cause accidents. For that purpose, it was analysed the physiological indices of human body and productivity performance in a combination of six different temperatures (30, 32, 34, 36, 38, 40 *ºC*) and four levels of humidity (40%, 60%, 80%, 90%). In this experience some physiological indices such as body temperature, blood pressure and heart rate were tested every 20 minutes. To make the evaluation of productivity (%) it was used the ratio of labour performance in extreme environment to labour performance in comfortable environment at the same time.
Witterseh (2004), also confirms that dangerous behaviour associated to high temperatures has an impact on productivity and may potentiate the accident. For this reason, Kenefick (2007) states that studies of occupational accidents show a lower rate during the winter months than in the summer, when sweat losses would be greatest. It is in warm-hot environments that fluid turnover would be highest and workers most likely to become dehydrated.

3.2 Climatic Changes

With temperatures expected to increase because of climate change, it is essential to study the health outcomes of different conditions of temperature and humidity, once it is an external condition that compulsorily will affect the general population.
With anticipated effects of global warming, the conditions for manual work in many types of industry and in agriculture get worse. Heat stress in work places will increase and affect strain and performance of workers and their productivity, (Holmer 2010).
To maintain productivity during a heat wave, according to Parsons (2009) it is necessary to provide thermal comfort. But, this is not always possible and what happens is that under conditions of high heat the productivity decreases. There are a variety of studies about the effects of heat on manual dexterity and cognitive performance. However the more direct impact factors on productivity are: time off task, caused by the cessation of work or because heat have caused distraction. This applies to people at home, offices and other workplaces. Until this date the relationship between the level of distraction caused by the heat and the level of heat stress is not yet known (Parsons, 2009).
Akimoto (2009), in his study made the measure in summer, autumn, winter of 2005, and summer of 2006. To understand the thermal environment in working zones in an office, various physical factors of thermal environment were measured, such as horizontal temperature and humidity distributions, vertical temperature distribution, airflow speed and radiant temperature. The thermal environment was also measured using a mobile device cart to understand the environment that the workers were exposed to in the task zone. It was found that the rate of hours occupants stay in task zone during working hours depends, on the type of job, and workers are not frequently repeating sit-down and leaving-out, so it is thought that metabolic rate while occupants are seating is almost constant. But while leaving from the seat, both activity level of occupant and exposed thermal environment is greatly different one by one. It was confirmed that an increase in metabolic rate according to worker's behaviour influenced on thermal and comfort sensation, (Akimoto 2009).
According to the same author at the 3rd Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3) that took place in 1997, the Kyoto Protocol was adopted to fight the global climate change. As a measure to achieve this goal, it is recommended by the Japanese Government to set the air temperature in office building to be 28 *ºC* in summer to reduce CO_2 emission. In office buildings, it is important not only to reduce energy consumption but also to establish comfort environment, which may maximize human productivity. (Akimoto, 2009).
According to a study from Tanabe (2007), a survey conducted in a call-center showed the decline in performance in a warmer environment; and it was different among the task types. He showed in their study that the subject feeling more mental fatigue, and more cerebral blood flow was required to maintain the same level of task performance, in a hot condition than at thermal neutral condition. In the same study it was suggested that the benefit by reduction in the running cost and reduction of the CO_2 emission would be minimal compared to the possible cost generated by the performance decrement, (Tanabe et al., 2007).

3.3 Neutral Thermal Sensation

Once the aim of this paper is to make a review concerning the thermal environment and productivity in sedentary activities it is important to have in mind the first considerations about comfort requirements during winter and summer conditions in the activities studied.
According to Fanger (1986) the PMV (Predicted Mean Vote) and the PPD (Predicted Percentage of Dissatisfied) indices express warm and cool discomfort for the body as a whole. Furthermore, from a laboratory test that was carried out in a climatic chamber by Chung (1990) it was found a neutral temperature of 24,9 *ºC* under sedentary activities and with clothing level of 0,6 *clo*.
Thermal dissatisfaction may also be caused, by an unwanted heating or cooling of one particular part of the body (local discomfort). This can be caused by a too high vertical air temperature difference between head and ankles, by a too warm or too cool floor, or by a too high air velocity (draft) or by a too high radiant temperature asymmetry. Limits are listed in the ISO standard for light, mainly sedentary activity during winter (Table 1) and summer (Table 2) conditions. If these limits are met, it is expected that no more than 5 – 10 % of the occupants will feel uncomfortable due the local heating or cooling of the body caused by each of the below–mentioned factors, (Fanger 1986).

Table 1 – Comfort requirements during winter conditions and light, mainly sedentary activity.

Situation	Conditions
Operative Temperature to be between:	20 and 24 *ºC*
Vertical air temperature difference between 1,1 *m* and 0,1 *m* above floor (head and ankle level) to be less than:	3 *ºC*
Surface temperature of the floor to be normally between:	19 and 26 *ºC*
Floor heating systems may be designed for:	29 *ºC*
Mean air velocity to be less than:	0,15 $m.s^{-1}$
Radiant Temperature asymmetry from the windows or other cold vertical surface: Radiant temperature asymmetric (in relation to a small vertical plane 0,6 *m* above the floor) to be less than:	10 *ºC*
Radiant Temperature asymmetry from a warm (heated) ceiling: Radiant temperature asymmetry (in relation to a small horizontal plane 0,6 m above the floor)to be less than:	5 *ºC*

Fanger 1986

Table 2 – Comfort requirements during summer conditions and light, mainly sedentary activity.

Situation	Conditions
Operative Temperature to be between:	23 and 26 *ºC*
Vertical air temperature difference between 1,1 *m* and 0,1 *m* above floor (head and ankle level) to be less than:	3 *ºC*
Mean air velocity to be less than:	0,25 $m.s^{-1}$

Fanger 1986

Tables 1 and 2 show a summary of the temperature limits for winter and summer required to obtain the desired level of comfort.

In the table 3, it is indicated a summary of different studies of thermal comfort in sedentary activities. A neutral thermal sensation is the feeling of neither slightly warm nor slightly cool (Chow et al 2010). Tanabe, carried out a thermal comfort study in Japan with 172 college–age subjects wearing 0,6 *clo* standard clothing, and the neutral temperature was found at 26,3 *ºC* under sedentary activities (Tanabe et al 1987).

Table 3 – Different studies of Thermal Comfort conditions in Sedentary Activities.

Conditions of Thermal Comfort in Sedentary Activities	Country	Authors
26,3 (0,6 *clo*)	Japan	Tanabe et al 1987
26 *ºC* (air velocity 0,4 $m.s^{-1}$)	Brazil	Candido et al 2010
30 *ºC* operative temperature (air velocity 0,9 ms^{-1})	Brazil	Candido et al 2010
26 *ºC* (air velocity 0,2 ms^{-1}); 50 %- 60 % HR	Thailand	Yamtraipat 2005
25,4 *ºC* (neutral temperature for people that have AC acclimatization)	Thailand ,	Yamtraipat 2005
26,3 *ºC* (neutral temperature without AC acclimatization)	Thailand	Yamtrapat 2005
24,9 *ºC* (0,6 *clo*) Climatic Chamber	Hong Kong	Chung 1990
25,4 *ºC* (air velocity at 0,1-0,2 ms^{-1}) 0,55 *clo* metabolic rate *1met* (laboratory)	Hong Kong	Chow 2010

On the other hand in Brazil in a situation of comfort, it was found a temperature of 26 *ºC*, air velocity 0,4 ms^{-1} and 0,9 ms^{-1} was required if operative temperature reached 30 *ºC*,(Candido et al., 2010) and in Thailand it was suggested 26 *ºC*, 50-60 % RH and 0,2 ms^{-1} air velocity to be the thermal comfort standards for air-conditioning design; the neutral temperature for the group of people having AC acclimatization behaviour at home and at work was about 25,4 *ºC*, whereas 26,3 was found for the other group (Yamtraipat, 2005).

More recently by Chow (2010) in a laboratory – based thermal comfort survey was conducted in Hong Kong with around 300 educated Chinese subjects and the result analysis shows that, like in many other Asian cities, the thermal sensation of the Hong Kong people is sensitive to air temperature and speed, but not much humidity. With bodily air speed at 0,1-0,2 ms^{-1}, clothing level 0,55 *clo* and metabolic rate 1 *met*, the neutral temperature was found be around 25,4 *ºC* for sedentary working environment.

In the following overview of different studies, thermal comfort in sedentary activities is referred to and when it was compared with the requirements presented by Fanger, where a slight discrepancy in different temperatures is observed. In additions the average annual temperatures in the studied countries are: Japan (max. temperature 30 *ºC*; min. temperature 1 *ºC*); Hong Kong (max. temperature 34 *ºC*; min. temperature 8 *ºC*); Thailand (max. temperature 33 *ºC*; min. temperature 20 *ºC*) and Brazil (max. temperature aprox. 30 *ºC* and min.20 *ºC*).

4. DISCUSSION

Although the relation between temperature and productivity may vary according to several factors including: individual, climatic changes, neutral thermal sensation, there are other factors such as building characteristics and the type of activity developed that should be taken into consideration.

The relation between productivity and temperature according to research is shown in table 4. Seppänen (2005), inferred through a simple example, that the use of ventilation during the night, improves indoor increasing productivity (Seppänen et al., 2005). However, the same author also mentions the existence of studies that indicate that there is no significant relationship between temperature and productivity when it comes to values within the comfort zone, but when these values ate between 24,8 *ºC* and 26 *ºC*, there a 15 % decrease in productivity. On the other side, in another different environment and activity, in the case of a textile manufacturing plant, it was registered an 8 % reduction in productivity for variations in temperature between 23,9 *ºC* and 32 *ºC* (Seppänen, et al 2005).
When approaching others activities, productivity may exhibit different values. Eston (2005), points out some values in gold mines in South Africa, referring to acclimated workers, (miners accustomed to a new climate or environment), working during three consecutive hours. Such data indicate that from a certain temperature the worker's income is reduced drastically, ranging from 100% yield with a temperature of 28,9 *ºC*, and 25 % yield with a temperature of 37 *ºC* (Eston, 2005).
Although some studies indicated that the best environment for working is the thermally comfortable environment, or the most comfortable temperature yields optimal work performance, the relative humidity also affects productivity. A maximum relative humidity between 50% and 65% is normally provided at the design stage and higher relative humidity affects thermal comfort (Zhao, 2009).

Table 4 – Relation between productivity and temperature according to research

Temperature	Productivity
Around 25 *ºC* (in call center)	Decrease 1,8 % for each *ºC* that increase (1)
Above 25 *ºC* (in call center)	Decrease 2,2 % for each *ºC* that increase (2)
Between 24,8 *ºC* a 26 *ºC*	Decrease 15 % (3)
In a textile manufacturing plant (23,9 *ºC* to 32,2 *ºC*)	Decrease 8 % (4)
Mines in South Africa 28,9 *ºC*	100 % of Productivity (5)
Mines in South Africa 32,8 *ºC*	75 % of Productivity (5)
Mines in South Africa 35,3 *ºC*	50 % of Productivity (5)
Mines in South Africa 36,4 *ºC*	30 % of Productivity (5)
Mines in South Africa 37 *ºC*	25 % of Productivity (5)

(1), (2), (3) e (4) Seppänen et al., 2005 (5) Eston, 2005

5. CONCLUSIONS

Considering the results it was concluded that thermal environment affects the human being, thus causing an impact upon the activity which in turn influences performance and productivity. It was also inferred that there are many factors affecting workers' productivity. However, environmental conditions have a notable significance and may have consequences of various kinds. The results from different papers show that thermal discomfort caused by high air temperature has a negative effect on performance. This effect is evidenced by changes in behaviour, mood, fatigue, motivation, reaction speed, increased absenteeism and stress. The relationship between the level of distraction caused by heat and the thermal stress level is still not yet known. Therefore, further studies are needed to clarify the conditions of ideal thermal environment related to high productivity, since the temperature known as the comfort temperature is not directly related to high productivity, as attested the findings of some authors. For that reason it is advisable to develop further studies using different combinations of relevant factors including physiological factors.

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Cost/Benefit Analysis in Occupational Health and Safety: CBAOHS Model

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ABSTRACT
After performing a risk analysis within Occupational Health and Safety (OHS), the implementation of preventive and corrective measures lacks a proper systematic economic evaluation that allows to compare alternatives and to understand the impact of each measure of them. It is important not only to make a financial evaluation of the measures considering costs and income for the organization resulting from the implementation of identified measures but also to take into account the impact of each measure in society, in other words, to measure the involved externalities (either positive and negative). In this paper, the development of an innovative Cost/Benefit Analysis in Occupational Health and Safety (CBAOHS Model) is proposed. For the development of the model, a survey with a panel of experts based on Delphi methodology has been performed. The methodology of the study is presented, together with a summary of the results of the first round, in which a consensus of the experts has already been reached in 76% of the questions.

Keywords: Cost-Benefit Analysis; Occupational Health and Safety; Delphi Methodology; Risk Analysis.

1. INTRODUCTION

The Occupational Health and Safety (OHS) management system can be regarded as the part of the management system of an organization used to develop and implement the OHS policy and manage the related risks (BS OHSAS 18001:2007; Santos et al., 2008). The OHSAS 18001:2007, developed by the OHSAS Project Group, a consortium of organizations from several countries, defines a set of occupational health and safety management requirements for occupational health and safety management systems. Its purpose is to manage OHS risks through the identification of several elements which include responsibilities, authorities, relationships, functions, activities, processes, practices, procedures and resources. These elements permit to establish OHS policies, plans, programs, and objectives.

Carrying out an occupational risk assessment it is necessary to take into account the associated costs and benefits. However, only a cost-benefit analysis (CBA) can capture all impacts resulting from work accidents and/or from prevention measures regarding OHS. The CBA is used to determine whether a project is feasible, from the standpoint of social welfare, by the sum of the costs and benefits, discounted over time (EVALSED, 2009; Cullis and Jones, 2009). Firstly, from the firm’s perspective, it is necessary to consider costs and revenues which result from the implementation of each particular measure identified in an OHS exercise. Nevertheless, this financial evaluation of the measures is not enough. It is also important to realize the real contribution of each solution to society. Such economic evaluation implies to include the analysis of the related externalities (some positive and other negative to society).

The economic analysis of an OHS policy and OHS measures should be based on cost models where both financial and economic perspectives are taken into account. In this paper, a Cost/Benefit Analysis in Occupational Health and Safety is proposed. The CBAOHS model is a relevant tool for both practitioners and academics as well as for companies and public policy. The impact of work accidents should be fully calculated and the different alternative prevention measures should be adequately compared in order to maximize the adoption and use of OHS management systems. In fact, efficient and effective OHS management systems contribute directly to the competitiveness of the firms which use them but also indirectly to the competiveness of the economy and to the general welfare.

The proposed model was based on the opinion of a panel of experts. For this purpose, the Delphi methodology has been performed. This methodology is briefly presented, together with a summary of the results in which a consensus of the experts has been reached in 76% of the questions after the first round of questions. The CBAOHS model is a multi-step approach to evaluate an OHS policy and related risks from the individual (companies) and the global (stakeholders, state, society) points of view.

This paper is structured as follows. Next section gives an overview of Cost/Benefit Analysis in Occupational Health and Safety, particularly the fundamentals of financial and economic evaluation in this domain. In section three, the Delphi methodology followed is explained and the obtained results are presented in section four. Finally, the last section presents some conclusions and opportunities for further research.

2. COST-BENEFIT ANALYSIS

2.1 Evaluation, risk and cost analysis in OHS

The Occupational Health and Safety (OHS) management system can be regarded as part of the management system of an organization used to develop and implement the OHS policy and manage the related risks (OHSAS 18001:2007). Risk management is considered as including the risk assessment and control, comprising the systematic application of management policies, procedures and work practices to analyse, assess and control risk (Roxo, 2004). Although risk assessment is a legal obligation, in terms of methodology there are no strict rules on how this should be done. In the

opinion of Roxo (2004), risk assessment should include two steps: a) risk analysis, which aims to determine the magnitude of risk and b) risk evaluation, which aims to evaluate the significance of the assumed risk.
If a risk assessment (identification, estimation and evaluation) determines that a specific risk is not acceptable - acceptable risk is a risk that has been reduced to a level that can be tolerated by the organization and taking into account their legal obligations and its own OHS policy according OHSAS 18001 (2007), then it is necessary to proceed to the set of actions to control risk. This refers to processes of decision / action for the management and risk reduction, its implementation and periodic review, by using the results of risk assessment as an input. Typically, organizations make a more or less detailed evaluation of the monetary impact (positive or negative) on the actual organization of each decision/action to implement. Any preventive measure is translated into a cost and the real profitability can only be confirmed through an appropriate cost-benefit analysis. Literature on Occupational Health and Safety presents several approaches that assess the impact of these measures particularly in terms of cost analysis and the level of cost-benefit analysis.
When the result of a project cannot be measured in monetary units, analysts adopt the cost-effectiveness analysis (CEA). The cost-effectiveness analysis is an evaluation technique used to select a project that will bring the lowest production cost of a certain product or choose the project that will lead to maximum production at a given cost. According to EVALSED (2009), the cost-effectiveness analysis (CEA) is a tool that can contribute to an efficient application of resources and investments in sectors where benefits are difficult to assess. This approach is useful to identify and select alternative projects with the same objectives (quantified in physical terms). The CEA can identify an alternative project that for a given level of expected results, minimizes the actual cost or, for a specific cost, maximizes the level of expected results. For example, the evaluator can compare the different projects by means of simple linear relations result/cost. Typically, the assumption is that a benefit or desired result can be achieved through different alternative ways. Thus, in this approach are usually only considered the costs and the cheapest way to get to achieve the desired benefit.

2.2 Financial evaluation

In an OHS risk analysis, a financial assessment of the alternatives can be done if a monetary value can be assigned to all costs and revenues. This analysis is made to determine whether a project is feasible from the standpoint of the company by the sum of the costs and benefits, discounted over time. It is usually based on a feasibility study of the project (technical, financial, legal and organizational) and can be characterized by an initial project and technical identification followed by the financial analysis.
Generally, there is an initial cost and benefits that arise after a long period, making it necessary to update these cash flows using a discount rate appropriate for the company, referring to the present, so that a valid comparison can be obtained. Thus, all costs and benefits are expressed in present value. The present value of all costs and benefits can be combined to produce a net present value (NPV). A positive NPV means that the purposed solution or intervention is beneficial, which means that the income generated outweigh the costs incurred. If there is uncertainty about the level of costs and benefits, one or both terms may be weighted according to their probabilities. This analysis can be expressed quantitatively as a net present value (NPV), an internal rate of return (IRR), a payback period or as the ratio between the present value of benefits and the present value of costs.
The financial analysis is used to determine if the project is feasible from the standpoint of the company by the sum of the costs and benefits, discounted over time. The financial analysis is the departure point for a subsequent economic analysis. It provides all the needed data in terms of inputs, outputs, their relative prices and how these are distributed predictably over time. Thus, the financial analysis is usually performed using measures such as the net present value, the internal rate of return and the payback period.

2.3 Economic evaluation

The CBA usually accompanies a feasibility study (technical, financial, legal, organizational) of the project and is its final synthesis. According to EVALSED (2009) CBA is characterized by five main stages: 1) project identification, technical analysis and demand, 2) financial analysis, 3) correction of tax effects, 4) calculation of positive and negative externalities, 5) market prices to shadow prices and 6) calculating the economic profitability of the project.
The financial analysis from the viewpoint of the private investor includes some items, such as income taxes, which do not represent a social benefit or a cost but a transfer from one social group to another. There are other examples of tax effects in the case of subsidies, social contributions considered in the cost of manpower and the effects of taxes on prices of inputs and outputs. In assessing the "appropriateness", the public operator also takes into account the externalities generated by the project. In a cost-benefit analysis (CBA), the present value of all costs and benefits for all stakeholders can be combined to produce the economic net present value (NPV). Furthermore, a CBA should take into account the costs throughout the life cycle of the subject under study, involving both economic costs and "accountable" benefits, but also the impacts that are not "accountable", known in the literature as externalities.
According to Cullis and Jones (2009), externalities consist of social costs or benefits that manifest themselves beyond the realm of the project and influence the welfare of third parties without any monetary compensation. Van Beukering et al. (1998) consider that an externality occurs when an economic decision has an impact on the welfare of another economic agent not directly involved in the process, resulting from the fact that the possibility of impact has not been properly

addressed at the planning stage. In general, an externality is present when the welfare function of some economic agent (utility or profit) includes real variables whose values are chosen directly by others, without special attention to the effect on the welfare of the agent that they affect. Where the project needs or deserves an evaluation by a public entity, the externalities generated are taken into consideration. However, the evaluation of projects of a private nature does not consider the effects on third parties arising from associated externalities. Indeed, the externalities generated by a project are in many cases difficult to quantify. This is the case, for example, of calculations related to the “value” of human life.
According to Cullis and Jones (2009), externalities may be positive (external benefits) or negative (external costs) and occur both at production or consumption. The concept of externality can and should be applied to the area of OHS, namely through the implementation of a cost-benefit analysis. When an organization performs a risk analysis within its OHS management system, several steps are suggested to solve the identified risk situations. Usually the organization makes a detailed analysis of the monetary impact (positive or negative) for the organization of each considered measure. However, it is also important to perform an analysis of the impact of each measure for the society, i.e., to measure the involved externalities. The measures taken by an organization in terms of risk prevention may have an indirect positive effect (positive externality) for the society, while no action, due to the costs for the organization, may have significant negative effect for the society (negative externality). It follows that these effects should be duly considered in decision making.
Thus cost-benefit analysis should take into account the costs throughout the life cycle of the subject under study, involving both economic costs and benefits "accountable" and the impacts are not "accountable", known in literature as externalities (Queiroz, 1999).

3. RESEARCH METHODOLOGY

3.1 Principles of Delphi methodology

Although there is some published work in this specific domain, the subject of CBA including externalities in OHS appears to have been insufficiently addressed in the literature (Ramos et al., 2011a). Thus, a proper model and a well-defined set of procedures are needed.
This project aims at discussing the use of the cost-benefit analysis within the OHS domain. With this purpose, a qualitative exploratory study is was undertaken proposed, using the application of the Delphi methodology (Ramos et al., 2011b). In this study it is intended in order to get some input from an expert panel by conducting a series of questionnaires in order to determine the most important factors to consider in the cost-benefit analysis on OHS.
Thus, the a selected group of experts is was asked about future events in successive rounds anonymous and with maximum autonomy of the participants, with the goal of reaching consensus (Linstone and Turrof 1975; Godet, 1993; Landeta, 1999; Vergara, 2005). In this type of research, traditional mail was normally used, but nowadays Internet is increasingly used for this purpose (Giovinazzo and Fischmann, 2001). In this research method the results depend strongly on the quality of the questionnaire and selection of experts (Godet, 1993).
Although the method foresees several successive rounds of questionnaires, it can often be limited to two rounds without affecting the quality of the results, as it has already been demonstrated in many studies (Vergara, 2005).
The successive questionnaires are were used to reduce the “interquartile interval”, a measure of the deviation of the opinion of an expert from the opinion of the whole (median). The aim of the first questionnaire was then to calculate this deviation. If more than one or more rounds are required, a greater consensus is to be expected on each issue (Godet, 1993; Landeta, 1999). According to Skulmoski et al. (2007), the process can be considered as concluded when the answers are near the consensus, according to appropriate statistical methods.

3.2 Questionnaire

The questionnaire has been developed with the purpose of apply it to a panel of experts with different backgrounds. It was expected that with three rounds it may be possible to obtain important conclusions and to have a better understanding of the importance of the application of the cost-benefit analysis in the OHS domain.
The questionnaire has a total of 51 questions, grouped in five sections:

1. Occupational Risk Assessment (12 questions)
2. Costs and Benefits Analysis of Occupational Risks (10 questions)
3. Financial Assessment (from the company’s perspective) (6 questions)
4. Economic Evaluation (for the society) (12 questions)
5. Externalities (11 questions)

For each question, the expert could choose the answer in a scale 1-5 (1=very low, 2=low, 3=medium, 4=high, 5=very high); the possibility of answering “no opinion” was also possible available. The variables studied are discrete, categorical and qualitative of ordinal type. In each section there was also a question about the degree of familiarity of the expert with section (with three options. low, intermediate, high). The detailed structure of the questionnaire has been presented in a previous publication (Ramos et al, 2001a).
The questionnaire has been prepared based in Adobe Acrobat Reader and sent by email to each expert. After filling the questionnaire, the expert just had to click on the button “Submit Form” and the questionnaire was immediately

transmitted electronically. The questionnaire has been previously validated with three experts before being sent to all members of the expert panel.

3.3 Expert panel

An initial expert panel has been established, which included a total of 29 experts that have were initially contacted, including 13 Academics, 8 OHS Professionals/Technicians and 8 OHS Consultants/Auditors. From the initial 29 experts, 23 of these experts have confirmed their interest to participate in the study. The first Delphi round started in September 2011.

3.4 Methodology for the treatment of the answers

For all the 51 questions, the following statistical parameters have been calculated: mean, median and inter-quartile range.
The IQR - interquartile range is a measure of dispersion respective to the median and is based on the average of 50% of observations. Thus, an IQR less than 1 means that more than 50% of all opinions fall at a certain point on the scale (von der Gracht and Darkow, 2010).
According to Bryman and Cramer (1993) the consensus is indicated by the distance between the first and third quartile and the median value; these units of measurement are more robust and less sensitive to isolated cases and applicable in the case of ordinal variables such as our questionnaire.
The median indicates the degree of support group for each factor; if it is high, we can conclude that there is a high level of support from the group.
The presentation of the quartiles allows an assessment of the degree of convergence of the answers. The quartiles are used to help measuring the variability or dispersion of the observed data. The first quartile is a variable value such that the number of observations for lower values is 25% and upper 75%, i.e., the first inter-quartile (Q1) refers to 25% agreement between the experts and the third quartile (Q3) refers to 75% agreement (Astigarraga, 2005 and Santos, 2010).
The inter-quartile range (IQR) is the difference between the 3rd and 1st quartile in which lie 50% of core values. The higher the IQR, the greater the dispersion in the data. Thus, a small IQR indicates a small variation in the responses of members of the panel, which shows that they have reached consensus (Bryman and Cramer, 1993).
An IQR of zero indicates a perfect consensus among panel members.
There are many criteria to establish the moment they reached a consensus (Fink et al., 1984). We have adopted in our study as criteria of consensus the IQR≤1.
The second round has been launched in November 2011. The questionnaire sent to the experts included the treated results of the first round. In this second round, the “zone of agreement” has been indicated with a red rectangle, considering the median value of the responses of the panel with a deviation of plus or minus one level; the answer given by the corresponding expert has been also presented. Figure 1 shows an extract of a concrete second round questionnaire.

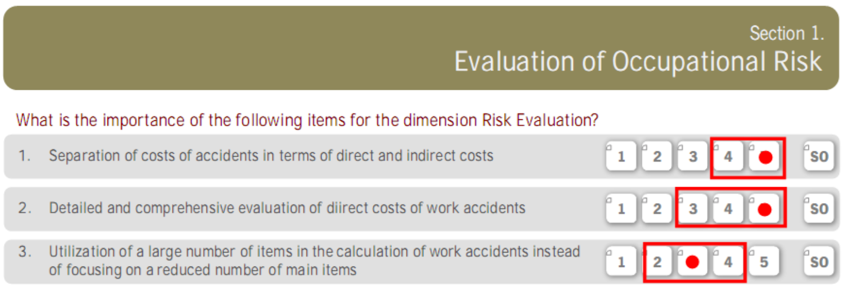

Figure 1 - Extract of the questionnaire used for the second round.

The experts have been invited to indicate their agreement or disagreement respect to the median answer. The following alternatives are possible for each expert:

a) keep the original answer
b) re-evaluate the initial answer and change it.

In case the final answer of the expert is outside the consensus, he/she has been asked to briefly indicate the principal reason(s) that led him/her to keep this response, by using the box for this purpose text available at the end of the questionnaire.
The same methodology will be followed when the second round is concluded. Then it will be decided if a third round is still needed.
The opinions of the expert panel will clarify what issues are important to consider in the development and application of the cost-benefit analysis in the OHS domain. In fact, the implementation of corrective and preventive actions under OHS requires a proper and systematic economic evaluation, in order to compare alternatives and understand the impact of each of them. For this, it is important to consider not only the costs and benefits for the organization but also the so-called externalities, which correspond to the impact of each measure in the whole society.

4. RESULTS

Out of the 29 experts contacted, 23 have accepted to participate in the study. Each of them received a questionnaire sent by a personalised email. 20 have sent a validated questionnaire; the other 3 have been excluded due to lack of answer after several reminders.

Figure 2 presents 3 examples of results obtained in three typical situations.

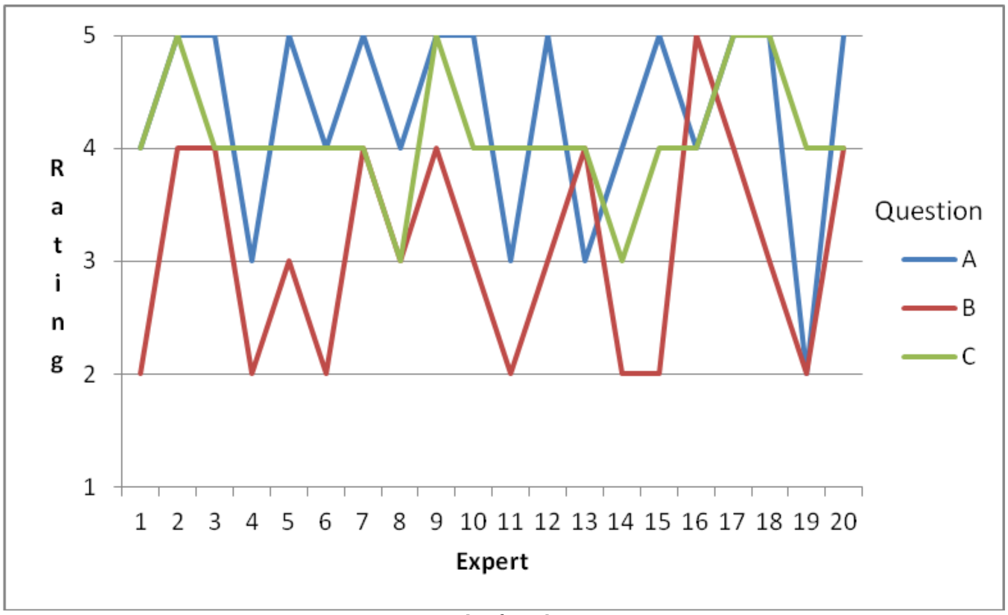

Figure 2 - Example of results in 3 questions:
Question A: IQR = 1, accepted consensus – Mean 4.3, Median = 5
Question B: IQR = 2, low consensus – Mean 3.1, Median = 3
Question C: IQR = 0, high consensus – Mean 4.1, Median = 4

In the example of figure 2, according to the methodology IQR≤1, we can conclude that a consensus has been obtained in questions A and C but not in question B.

The global treatment of the results has lead to the following:

Number of questions with IQR≤1: 39 (including 5 questions with IQR = 0)

Only the remaining 12 questions had an IQR >1. A higher consensus is expected after the second round.

The results of the second round are still being collected and processed when this manuscript has been prepared. The need of a third round will then be decided.

After the final round, the results obtained will be weighed. A weight will be applied to each answer, taking into account the degree of familiarity of each expert with the corresponding topic. To a low familiarity corresponds a weight of 1 for all the questions of the corresponding section, for a medium familiarity a weight 2 and for a high familiarity a weight 3. The median and IQR have been calculated accordingly.

Table 1 presents the questions in which the expert panel found that were extremely important (median equals to 4,5 or 5) with IQR=1 and those that the expert panel found that they were important (rating 4 but with very high consensus (IQR=0). These results are an important basis for the development of the Cost / Benefit analysis model.

Table 1 – List of questions with higher consensus

Section	IQR = 1 Median = 4,5 or 5	IQR = 0 Median = 4
1. Occupational Risk Assessment	questions 1, 2 and 9	question 10
2. Costs and Benefits Analysis of Occupational Risks	questions 1, 2 and 7	question 9
3. Financial Assessment	-	-
4. Economic Evaluation	question 1	questions 8 and 9
5. Externalities	questions 1, 5 and 6	question 8

Following the results from the Delphi study, a model (CBAOHS model) may be proposed for the application of CBA in OHS. The model will give special emphasis to the topics that have been considered as priority by the expert panel.

The scheme presented in Figure 3 summarizes the CBAOHS model to be developed.

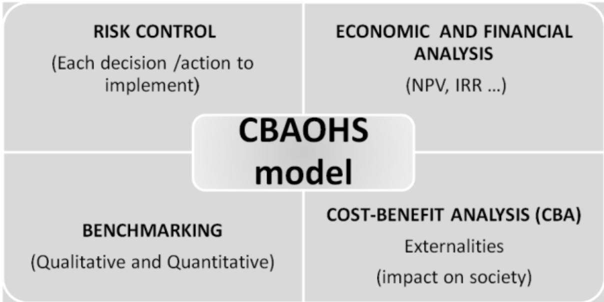

Figure 3 –Scheme of the CBAOHS model.

This model will permit to perform economic evaluations of risks and prevention initiatives from both the company and society perspectives and will be tested with data from two case studies. A hospital and a construction company have already been contacted for this purpose.

5. CONCLUSIONS

Given the apparent lack of studies on the use of cost-benefit analysis related to OHS, in this paper it is proposed an exploratory qualitative study applying the Delphi methodology, in order to develop a model for Cost/Benefit Analysis in Occupational Health and Safety. This methodology allows the assessment of the views of experts, by conducting a questionnaire on the subject, where the final results are processed from the consensus generated by the group. Accordingly, a questionnaire has been developed and sent to a panel of experts. After the first round, a large consensus has already been reached. It is expected that after the planned three rounds it will be possible to obtain some important conclusions and a better understanding of the importance of the application of the cost-benefit analysis in the OHS domain.

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Integration of the Occupational Health and Safety Management System with the Quality Management System and Environmental Management System - from the Theory to the Action

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ABSTRACT
The aim of the work was to conceive an integrated model among various systems, of which highlights, Occupational Health and Safety Management System according OHSAS 18001/NP 4397, Quality Management Systems according ISO 9001 and Environmental Management Systems according ISO 14001. The model was designed at Itron Portugal and 160 employees were surveyed. The rate response was equal to 86%. The model was conceived and implemented. Among the main findings we highlight: the elimination of conflicts between individual systems; the integrated management of sustainability components in a global market; the improvement of partnerships with suppliers of goods and services; dialogue with the main stakeholders and commitment to their ongoing satisfaction and increased contribution to the company's competitiveness.

Keywords: OHSAS 18001; Occupational Health and Safety Management System (OHSMS); Integrated Management Systems (IMS).

1. INTRODUCTION

More than ever, today, is in question the business sustainability of the organizations and the focus should be placed far much more than financial results. These results will not verify if that focus does not prioritize also, the satisfaction , balanced, integrated and growing of the customers and others relevant Stakeholders, that are clearly and objectively the employees for example (Rebelo, 2011). Hence, human resources are the most valuable resource of any company or country, but not always the most valued. Thus, the greatest asset of any organization, any region or any country, are people with their know-how (Santos, 2002). As such, it is important to know that to help organizations tackling occupational safety and health challenges continuously and improving control on factors influencing health and safety. Safety management systems (SMSs) have recently experienced an increasing diffusion between companies (Bottani, 2009), but the major shortcoming with most of safety culture models is the lack of their integration into general models of organizational culture (Choudhry, 2007). Hence, to achieve excellence in prevention, safety must be integrated into all the organisation's decisions and actions, and the prevention must be more organisational and strategic than material, given the important role that the human component plays in the causal chain of workplace accidents (Fernández-Muñiz, 2009). In this context of real and new paradigms of management – the Global Quality Management – it imposes to seek permanent the Business Excellence. Hence, in a not distant past, some companies in Portugal and other countries, although in a small percentage, began to integrate their management systems, the quality management system (QMS), the environmental management system and the Occupational Health and Safety Management System (OHSMS). For this purpose, conceived integrated procedures in order to make the integration of two systems (Quality, Environment or Safety) and whenever possible, the three systems (Quality, Environment and Safety) according Santos (2011). It reveals the growing interest that has been demonstrated by organizations in the adoption of a normative reference OHSAS 18001/ NP 4397, ISO 9001 and ISO 14001. On the other hand, the integration of management systems, supported by those normative references in a single system, taking into account the correspondence ant the level of compatibility between them and potential tangible and intangible gains resulting from this integration will be an added value that organizations do not can bleach (Rebelo, 2011). On other hand, regulations based on ISO 9000 have been created to guide companies in developing systems for management and prevention of worker risks. Annex A and B of ISO 9001–2000 gives various clauses and sub-clauses related to the necessary elements of this standard (Vinodkumar, 2011). Within this, certified management systems are increasingly used by enterprises to document and develop conformance in a variety of different areas. Within the past decade, the application of certification has spread from documenting quality standards to additional areas, including the management of occupational health and safety (OHS) (Granerud, 2011). Thus, according Fernández-Muñiz, (2007) several fields are showing increasing interest in safety culture as a means of reducing accidents in the workplace. The literature shows that safety culture is a multidimensional concept. Hence, nowadays, companies that search greater profitability and better organization implement the quality systems, aiming at a reduction of defective products and lost time, searching for the loyalty of customers and searching for excellence. The progressive implementation of ideas and techniques related with the quality management is one of the clearest demonstrations of organisational innovation in the industry in the last decades. From the standpoint of the risk prevention literature, it has been argued that the use of advanced quality management systems help reduce accident rates because quality management methods are based on the principle of prevention rather than corrective actions. Hence, the concept of an OHSMS has become common over the past 20 years

(Robson, 2007). The people that work in safety management and at the same time, are members of quality teams, assure that quality management has a great relationship with risk management.

2. MATERIALS AND METHOD

The work was developed in business environment, the Itron – Portugal that over the years has been adopting, in whole or in part, gradually and individualized standards or specifications of different Management Systems, relevant to the OHSAS 18001/NP 4397 (Safety and Health Management Systems), ISO 9001 (Quality Management Systems), ISO 14001 (Environmental Management Systems) and ISO 17025 Laboratory Accreditation.

While it is imperative to assess the perception of employees of the Company on the structuring, implementation and evaluation of the integration model and its validation in a real work environment, it was developed an internal research through a questionnaire. The total population was 160 employees which are the organization structure of the different branches and levels. The responses rate was 86%. In the data collection, analyses and presentation were considered the guidelines of NP 4463:2009.

We considered four questions: Question 1 – Importance of the twelve factors identified as motivation for the implementation of the Integrated Management Systems (Quality , Environment and Safety) IMS- QES; Question 2 – Influence of Stakeholders identified nine shares on the performance and evolution of IMS-QES; Question 3 – Main difficulties in the context of the development and implementation model. It were identified seven potential difficulties for which the respondents chosen the main. Question 4 – Potential benefits with the implementation of IMS-QES. Eleven potentials benefits were identified for which the respondent chosen the main.

The objective of this work is to contribute to the integration of the Occupational Health and Safety Management System with the Quality Management System and Environmental Management System in a real work environment.

3. RESULTS AND DISCUSSION

From the statistical analyses, resulting from the responses of the survey, it shown a set of conclusions by itself revealing: the importance in the present and the future, all the various “motivating factors” that evaluated and alone justify and validate the model of implementation of the Integration of the Occupational Health and Safety Management System (OHSMS) with the Quality Management Systems (QMS) and Environmental Management Systems (EMS) in the company, either in the internal aspects such as: rationalization and optimization of resources, reduction of costs and bureaucracy. And also in the external aspects, such as: increasing competitiveness, to satisfy the growing demands of customers and others stakeholders. It also was identified a number of difficulties, as well as a range of potential benefits, shown in the fig.1(Rebelo, 2011) from that highlight: The elimination of conflicts between individual systems; The integrated management of sustainability components in a global market, where quality no longer makes a competitive difference and is now just a starting point for a business; The improvement of partnerships with suppliers of goods and services; Dialogue with the main Stakeholders and commitment to their ongoing satisfaction and increased contribution to the company's competitiveness; Common management policy, objectives, targets and KPIs - Key Process Indicators related to QES performance; The creation of added value for the business through the elimination of waste, especially that of bureaucracy associated with independent management systems and their certifications, including the laboratories and MID; Improvement to the company's internal and external image and to its credibility in QES areas, specifically in relationships with Clients, Official Entities and other Stakeholders; Improvements to the coordinated and integrated management of risks to the safety of people and property, the environment and the quality of products from "cradle to grave"; A reduction in the number of internal and/or external audits and audits of suppliers and the consequential amount of time taken and associated costs; Greater valuation and motivation of Employees as a result of the expansion of their skill base, actions and responsibilities, with their resulting empowerment; The integrated management of ustainability components.

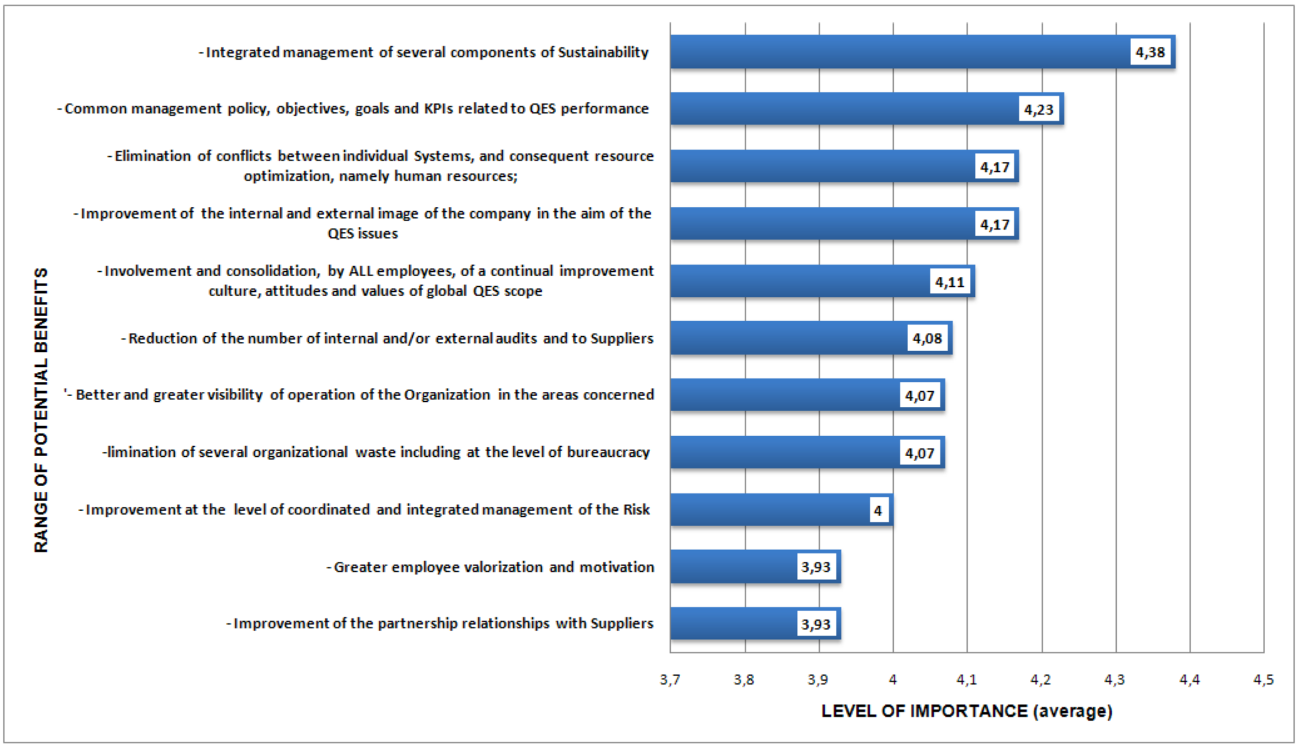

Figure 1 *– Main benefits resulting from the implementation of an IMS – QES*

3.1 - Integration and operation of IMS-QES - approach to structuring to the Integrated Management System Model.

The standards NP EN ISO 9000:2005, ISO 9004:2011, NP EN ISO 9001:2008, NP EN ISO 14001:2004, OHSAS 18001:2007 / NP 4397: 2008, among others, and the identification of common areas and requirements versus correspondences between them allowed to structure from the existing individual systems, a model of integration management of the Occupational Health and Safety Management System (OHSMS) with QMS and EMS. This integration gives a true usefulness and added value to the company`s business, more easy manageable and securely enhancer the improvement of conditions in the company in terms of management, the prevention component of OHSMS. Furthermore, according to table 1, it is still possible to establish a correspondence between the legal requirements of OHSMS and regulatory requirements, as the examples (not exhaustive) which gives an even greater consistency to that integration.

The survey results, by itself, justify, validate and prioritize enormously the structure of the model IMS-QES, as recommended which has Itron implementation Company in Portugal at Vila Nova de Famalicão as shown in fig.3.

Table 1 *- Correspondence between Portuguese legal requirements in the aim of OH&S and requirements of the NP 4397:2008*

LEGAL REQUIREMENTS Portuguese law nº 102/2009 of 10th September	**REQUIREMENTS OF THE** NP 4397:2008
- Scope	4.3.2 – Legal and others requirements
- Risk assessment of susceptible harmful effects on the genetic heritage	4.3.1 – Hazard identification, risk assessment and determining controls
- Records, archiving and conservation of the documents	4.5.4 – Control of records
- General obligations of the Employer - Emplloye obligations	4.1 - General requirements 4.4.1 – Resources, roles, responsibility, accountability and authority
- Analyze of accidents and Occupational diseases	4.5.3 – Incident investigation, nonconformity, corrective action and preventive action
- Coordenation of internal safety inspections	4.5.5 – Internal audit
- Safety of the machinery and work equipments	4.4.6 – Operational control
- First aid, fire fighting and evacuation of the Workers	4.4.7 – Emergency preparedness and response

3.2 - Similarities between the Management System standards which enhance the integration - Matrix of compatibility of the requirements and of support to the integration

One of the activities that forms part of the scope and objectives of this study to which we have paid particular attention is the compatibility of the requirements of the standards, in context and framework of the characterization of the company's situation, backed up by an analysis of these standards. This compatibility represents, at our understanding, the starting point for consequents activities of integration, simplification and optimization, to achieve a level of the strictly necessary and consequently the three subsystems - QMS, EMS, and OHSMS are integrated to the maximum extent possible.

Table 2 - Matrix of compatibility of the standards requirements and of support to the integration of the Sub-systems

PHASE I - PLAN	ISO 9001	ISO 14001	OHSAS 18001
1 - INTEGRATED MANAGEMENT POLICY			
1.1 - Management commitment Continuos improvement	5.1 5.3 8.5.1	4.2	4.2
2 - PLANNING			
2.1- Identification of : product requirements, aspects, impacts, hazards and risks and their assessment	5.2 7.2.1 7.2.2	4.3.1	4.3.1
2.2 - Identification, access to and updating		4.3.2	4.3.2

PHASE II - DO	ISO 9001	ISO 14001	OHSAS 18001
3 - IMPLEMENTATION AND OPERATION			
3.1 - Resources, organizational structure, roles, responsibilities and authority	5.1 5.5.1 5.5.2 6.1 6.3	4.4.1	4.4.1
3.2 - Training, awareness, competence and qualifications	6.2.1 6.2.2	4.4.2	4.4.2
3.3 - Communication, participation and consultation of the Stakeholders	5.5.3 7.2.3	4.4.3	4.4.3
3.4 - QES Management System documentation	4.2.1	4.4.4	4.4.4

PHASE III - CHECK	ISO 9001	ISO 14001	OHSAS 18001
4 - CHECKING AND CORRECTION			
4.1 - Performance monitoring and measurement of processes and products	7.6 8.1 8.2.3 8.2.4 8.4	4.5.1	4.5.1
4.2 - Evaluation of compliance	8.2.3 8.2.4	4.5.2	4.5.2
4.3 - Incident investigation	---	---	4.5.3.1
4.4 - Non-conformities; corrections; corrective and preventive actions Control of nonconforming products	8.3 8.4 8.5.2 8.5.3	4.5.3	4.5.3.2

of legal requirements and other requirements of Stakeholders			
2.3 - Definition of objectives, targets and Programmesof QES management and improvement	5.4.1 5.4.2 8.5.1	4.3.3	4.3.3
2.4 - Definition of the plans of response to emergency situations	8.3	4.4.7	4.4.7

3.5 - Control of documents	4.2.3	4.4.5	4.4.5
3.6 - Product realization Operational control	7.1 to 7.5.5	4.4.6	4.4.6
3.7 - Operationalisation of contingency plans.	8.3	4.4.7	4.4.7

4.5 - Records Control	4.2.4	4.5.4	4.5.4
4.6 - Combined Internal QES Audits	8.2.2	4.5.5	4.5.5
5 - MANAGEMENT REVIEW			
PHASE IV - ACT			
5.1 - Critical analysis and combined QES Management System review	5.1 5.6.1 5.6.2 5.6.3 8.5.1	4.6	4.6

CONTINUAL IMPROVEMENT OF THE IMS_QES

The ISO defines as principles of Quality Management: Customer focus; leadership; involvement of people; process approach; system approach to management; continual improvement; factual approach to decision making and mutually beneficial supplier relationships. According to the ISO Guide 72:2001 (ISO Guide, 2011), anyone drafting these and other management standards must take into account that the corresponding management systems must consider the following phases of the PDCA cycle - *Plan, Do, Check, Act*: Policies and principles; planning; implementation and operation ; performance assessment. Within this framework, taking into account the structuring of standards - management responsibility/planning; resource management; product realization/operational control and measurement, analysis and improvement, on the matrix of the table 2 (Rebelo, 2011) we have shown the requirements of the ISO 9001, ISO 14001 and OHSAS 18001 (NP 4397:2008), as well as we have established correspondences, made them compatible with each other and associated with the phases of the PDCA methodology - “Plan-Do-Check-Act”. With this matrix, we aim to orientate and align the organizational structure of the company in the same direction, while at the same time creating a structured and useful work referential to support an effective alignment and correspondence of the Sub-Management Systems of Quality, Environment and Safety with consequent compatibilities between each other, for consequent implementation of the IMS-QES. From this matrix we can also, at the same time, to made a correspondence with the Deming Cycle, in this circumstance for the Integrated Management System, as well as a set of stages (1.1; 2.1...2.4; 3.1...3.7; 4.1...4.6 and 5.1) associated with each other these phases of the PDCA cycle.

3.3 - Model of development of the IMS-QES

The continuous improvement of the global performance of a Company shall be an objective always present in the development of the IMS. The Company should therefore potentiate for each stage: Plan, Do, Check, Act, a careful and methodical analysis of the differences that effectively can be observed in terms of standards requirements under clauses equivalent involved and for each phase and each stage of development of the SIG-QES, according to the model of Fig. 3 (Rebelo, 2011) to ensure its compliance and evidence of it, in full conformity.

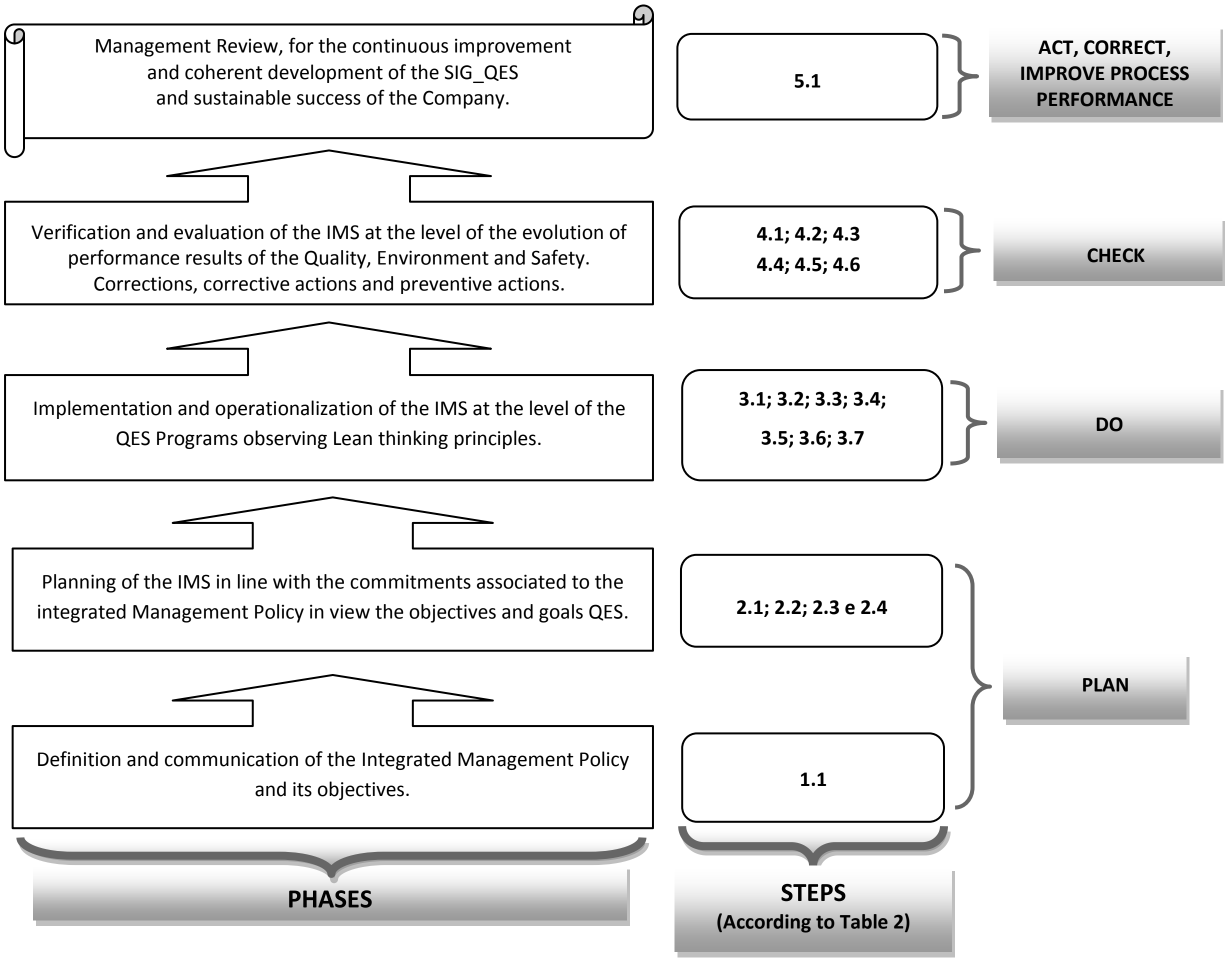

Figure 3: Model of development of the IMS-QES

First of all, the definition, approval and communication of the Integrated Management Policy, a common requirement to the different normative references, which must take into account and be consistent with the Mission and Vision of the Company, these supported on a strategy and specific objectives which in turn , support the implementation of that policy and its consequent effectiveness.

The planning of activities in the aim of the Integrated Management System - Phase I (Plan) - is perhaps the most important. In fact, a neglected planning will lead to inefficiencies that can be translated into potential deviations to the objectives. It is therefore fundamental to invest resources and expertise at this stage, via a thorough and careful work, in order to respond effectively to all requirements arising from the involved standards and others applicable requirements in this phase of the planning of the IMS.

Following is the Implementation and Operation - "Do", the Company should, in this Phase II - Do - promote, the "Make / Do" in coherence with the pre-planned. Corresponds mainly to clauses: 7 - Product Realization, of ISO 9001 - and 4.4 - Implementation and operation of the NP 4397 and ISO 14001 and in the case of ISO 9001 should be considered associated with the product realization, other complementary clauses, particularly in context of resource allocation (6.1, 6.2, 6.3, 6.4) and management commitment (5.1, 5.5.1).

In the Phase III - Check, we identified six steps (4.1 to 4.6) designed to meet the requirements of clauses: 8 - Measurement, analysis and improvement of ISO 9001, 4.5 - Checking of the ISO 14001 and OHSAS 18001/NP 4397. With the exception of step 4.3 - Investigation of incidents resulting from a specific sub-section, the 4.5.3.1 - Incident investigation, the OHSAS 18001/NP 4397 has no correspondence in the ISO 9001 and ISO 14001.

At the end, in the Phase IV - Act, we identified the step 5.1 - Critical analysis and review of the Management System, which refers to the requirements of clauses: 5.6 - Management review of the ISO 9001 and 4.6 - Management review of the ISO 14001 and OHSAS 18001/NP 4397.

The Management review process can be done in an integrated manner. It requires, in itself, a very careful preparation face, particularly, to the level of various information that supports the inputs, as is schematized in Figure 4 (Rebelo, 2011).

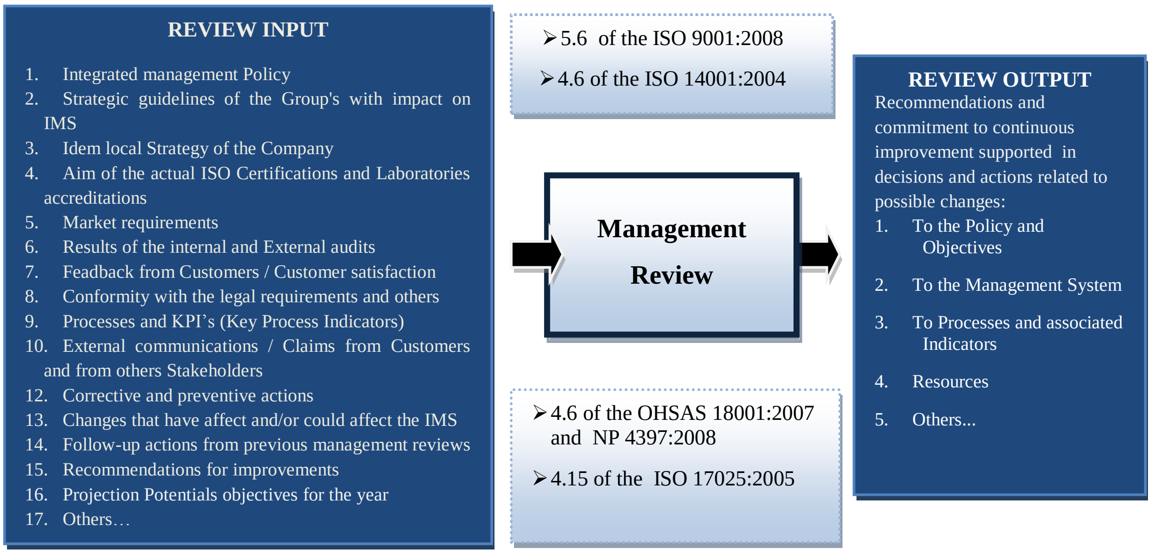

Figure 4 - IMS_QES - Management Review - Standards, inputs and outputs

4. CONCLUSIONS

The continuous improvement of the global performance of organizations must be always a present goal in a perspective of sustainability. The development Model of the integration of the Management System of Safety and Health at Work with the Quality Management Systems and Environmental Management at the Company should therefore to potentiate, for each phase: Plan, Do, Check, Act, a careful and methodical analysis of the differences that effectively are observed at the level of normative requirements under the equivalent clauses and for each step of their development as the advocated model of integration.

The compatibilization of the normative requirements supported by an analysis of similarities, of the normative referentials of Management Systems, which promotes the integration and it's formatting on a Matrix of compatibilization of the requirements and of support to the integration of the referential - NP EN ISO 9001:2008, OHSAS 18001:2007 / NP 4397:2008 and NP EN ISO14001:2004, establishing correspondences, matching them with each other and associate them, according to ISO Guide 72:2001, the following phases of the methodology *PDCA - Plan, Do, Check, Act*: Policy and principles; Planning, Implementation and Operation, Performance Evaluation, Improvement, Management Review, is one of the activities that in the aim and objectives of the integration model was given special attention in context of characterization and framework of the situation in the Company. That compatibilization constitutes, the starting point for subsequent activities of integration, simplification and optimization, to a level of the strictly necessary and consequent integration maximized as desired of the three subsystems - the Management of Occupational Health and Safety, Management of Quality and the Environmental Management, in context of strong competitiveness.

The integration of the OH&S Management System with the Management Systems of Quality and Environment represent added value both in the present and, fundamentally, for the future, not only for the Company, as well as for a whole range of Stakeholders. Are examples, also highlighted by the survey respondents: the elimination of conflicts between individual systems with optimization of Resources; the improvement at the level of the Coordinated and Integrated Management of the Risk associated to the Safety of the Persons and Company Assets, Environment and Quality of the Products; the reduction of the number of internal and/or external audits and audits to Suppliers and spent time versus associated costs; the creation of added value for the business through the elimination of several types of waste.

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Analysis of the relation between the implementation of the directive yard and the accidents in the construction

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ABSTRACT
This study was based on the analysis of work accidents at the Portuguese construction sector and also on the implementation of Safety and Health Plans at construction works. The data/information achieved for this analysis was obtained from the accidents inquiries of the authorities for the working conditions in Portugal and from the analysis of the implementation of Safety and Health Plans at construction works. This information was the starting point of a database created to know and understand the cause of accidents. When knowing the cause of accidents, it is possible to deeply investigate the impact of the transposition of the directive yards in our nation. This is crucial to reduce accidents at work. With the conclusion of this study we aim to check in which way Safety and Health Plans are being implemented and taken into consideration by the security coordinators.

Keywords: Work Accidents in Construction, Safety and Health Plan, Coordinator.

1. INTRODUCTION

This study was based on the analysis of serious and deadly work accidents in the construction sector as well as on the implementation of Safety Plans at construction sites. The Portuguese Authority for Work Conditions and a large construction company were the basis for the collection of data. The fundamental goal is to check in which way the implementation in Portugal of the Council Directive for Construction Sites performs an important impact in reducing work accidents. Through the analysis of inquiries about work accidents in the construction area, we aimed to check whether Safety and Health Plans are being fulfilled and adapted to each specific and singular work. Another feature of this study consists in evaluating, at site, in each way the Safety and Health Plan is being implemented and checking which are the most common mistakes that occur. This was accomplished by defining the variables that characterize accidents and by creating a database and an analysis model. Regarding the variables' statistic study, the start was a descriptive analysis, followed by a bivariate analysis that consists in the application of hypothesis tests to understand the dependence that exists between the variables that originate accidents. This analysis allows the achievement of information about the compliance of the Portuguese decree-law number 273/2003, of 29 October [1], which is the transposition to the Portuguese legislative framework of the Council Directive 92/57/CEE, of 24 June. These indicators are related to the probability of the occurrence of work accidents in the construction area. This study aims to check the impact of the implementation of the Council Directive for Construction Sites in diminishing accidents.

2. METHODOLOGY

This work aims to study, analyse and characterize work accidents in the Portuguese construction sector and to check how Safety and Health Plans are implemented at site. Seven hundred and nine accidents were studied, four hundred and nineteen of them were deadly and two hundred and ninety caused serious injuries. The studied accidents refer to inquiries of the Portuguese Authority for Work Conditions in the construction area. Companies are obliged to report to them both deadly and serious accidents to this Authority, according to the article 24 of the decree-law 273/2003, of 29 October [1]. They have to report the accident in the shortest period, never exceeding 24 hours. After being notified, the Authority places an investigation at site and conducts an independent inquiry in order to determine the causes.

The gathering of information provided by this organism was quite detailed and time-consuming. [2]. However, these inquiries provided important information, which allowed the creation of the database and the respective variables. A statistical analysis was essential to this study (statistical inference). The goal is to test hypothesis in a way to verify whether the sample data is compatible or not with particular populations. An analysis model based on the elaboration of a set of questions was created, in order to study the relation of the two by two variables (bivariate statistics), In this case, we aimed to evaluate in which way safety plans have contributed to diminishing accidents and if the plans are being correctly implemented. The starting questions are in each way the implementation of safety and health plans influence accidents. On the other hand, a specific construction site was studied to verify how the safety and health plan was being implemented and which were the most frequent non compliances at safety level.

These inquiries have created a database, as well as an analysis model with several questions that were necessary. The database is composed by variables or factors that somehow have influenced the occurrence of accidents. These variables are, in general, qualitative, leading to the application of the independence Chi-square test, based on contingency tables to study the dependence of two by two variables. The starting question to check how variables affect the occurrence of accidents is: in which measure safety and health plans and safety personnel at work site are

relevant to diminishing accidents? The dependent variables analysed were: Hour, Day, Season, Material factor, Consequence, Profession, Age, Equipment's failure, Administrative region, Nationality, Collective protection equipment, Transgression of preventive measures, Work organization, Type of employer, Job situation, Task, Subtask, Type of Work Site, Type of Work, Work time.
One of the first analyses performed was the variables' descriptive analysis. The statistic analysis was performed through a statistical commercial programme designated SPSS. When applying the independence Chi-square test, based in contingency tables, their applicability conditions were taken into account.

3. RESULTS

3.1. ANALYSIS OF THE FULFILMENT OF THE COUNCIL DIRECTIVE BASES

Since the implementation of the decree law 155/95 of 1 July, presently repealed by the decree law 273/2003 of 29 October, a Safety and Health Plan is obligatory for each and every construction site. The first decree law was in vigour at the time of the studied accidents. It is important to verify if this document existed to check if the law was fulfilled.
When an accident occurs, it is crucial to see if the construction site had a safety and health plan implemented. If so, it is necessary to analyse if the content refers to the work site in cause. In the majority of cases, the Safety and Health Plan is not executed, representing a total of 60,4% of accidents. There are also cases where there is omission of the analysed elements, which means for sure that such document did not exist. So, it's possible to say that 66,6% of accidents happen in construction sites without a Safety and Health Plan.
However, we have to highlight the fact that in the cases in which a Safety and Health Plan does exist, there were accidents in 33,4% of construction sites. In 8,5% of these works, this document was never implemented, in 8,0% it did not refer to the work in cause, being a mere adaptation to fulfil the legislation in vigour. Only in 16,9% of works, the Safety and Health Plan was correctly elaborated and implemented. The existence of this document is crucial as well as its adaptation and implementation, in order to be considered a good project and fundamental in managing safety.

Table 1- Distribution of accidents according to the existence of a Safety and Health Plan [2]

Safety and Health Plan	**N**	**%**
Unknown	44	6,2
Exists	120	16,9
Exists, but not fulfilled	60	8,5
Exists, but not adapted to the work	57	8,0
Inexistent	428	60,4
Total	709	100,0

Other situation to analise is the existence of safety staff. According to the legislation in vigour, at the date of the accident, all construction sites should have a safety and health coordinator, named by the Owner [1]. The contractor should have safety and health technicians in its staff. Analising Table 2, one can understand that only 14,7% of the studied accidents have safety coordinators. In only 3,8% of the accidents there is the presence of the contractor' safety technicians. In 61,2% of the cases, safety staff does not exist. There are 13,1% unknown cases to join the cases where there is no official involvement of staff, what totalizes 74,3%.

Table 2- Distribution of accidents according to the existence of safety staff [2]

Safety Staff	**N**	**%**
Unknown	93	13,1
Safety Coordinator	104	14,7
Person in charge (safety)	51	7,2
Inexistent	434	61,2
Safety technician	27	3,8
Total	709	100,0

3.2. REGISTER OF NON-COMPLIANCES AND PREVENTIVE ACTIONS

Non-compliances appear when a determined task presents risk of accident. Consequently, there is interest in studying in what way the safety plan was being implemented in a specific construction. This is registered as a non compliance and not as an inspection and prevention register when, according to the safety and health coordinator, there is a serious non compliance situation. In the studied case, the safety and health coordinator has stipulated, with the owner's consent, the retention of 0,5% of the monthly value of performed works, for each unresolved non compliance. [3].This retention is done for different periods according to the number of non compliances to be solved. As the register of non compliances is the proceeding that reports more risks at site regarding safety issues, a more profound study is important. There was the register of two hundred and ten non compliances during the months in which the construction site was analysed. Through the analysis of the non compliances existent at site, one can say that there was some difficulty in implementing the Safety and Health Plan in some of its points, as shown in Table 3. We highlight that all these procedures were predicted in the Safety and Health Plan but they were not followed.

Table 3- Most frequent non compliances by ascending order [3]

Description of the most frequent non compliances	N.º of times these NC happened
Incomplete work platforms	16
Access ladder with no safety conditions	15
Miss of safety railings	15
Inadequate load lift devices	8
Workers with no individual protection equipment	7
Inadequate auxiliar lifting support	5
Incorrect movement of hanging loads	5
Missing of signalization	5
Missing of security sound signalization for equipments' backwards movements	7
Rebars for splicing with no protection	***4***
Incorrect material storage	4
No safety access conditions to cranes	4
Wires and cables at risk of cut and smash	4
Open power supply cabin	4

The most long-lasting non compliances (around a year) refer to work platforms, access ladders with no safety conditions, lack of register of inspection and prevention relative to the construction processes and construction site equipments. Regarding the incorrect handling of hang loads, there is no control of the entrance of people in the construction site, incorrect manoeuvre of load removal equipments, passage of workers in dangerous areas (landslide). These situations were not resolved at date and are lasting for 57 days.

3.3. IMPACT OF THE COUNCIL DIRECTIVE

To check in what measure the implementation of the directive regarding construction sites has influenced the diminishing of accidents, there was the study of the relation between the variables. Next, it's presented an example of the performed analysis, seeking to understand if there is or not a relation between the existence of the Safety and Health Plan and the existence of safety staff. Through the application of the independence test Chi-square we obtain $\chi2$ (4) = 193,492, p = 0,000. The existence of the Safety and Health Plan depends on the existence of safety personnel. Analysing Table 4, we verify that when there is a safety coordinator, there are more accidents when there is a Safety and Health Plan. When there is a safety technician there are more accidents when there is not a Safety and Health Plan. On the other hand, when there is no safety staff, there are more accidents when a Safety and Health Plan does not exist.

Table 4- Contingency Table with the Safety and Health Plan and the safety staff by column [2]

Safety and Health Plan	Safety staff			Total
	Safety Coordinator	Safety Technician	Inexistent	
Exists	57 54,8%	16 20,5%	47 8,9%	120 16,9%
Only to comply with the legislation	30 28,8%	25 32,1%	62 11,8%	117 16,5%
Inexistent	17 16,3%	37 47,4%	418 79,3%	472 66,6%
Total	104 100%	78 100%	527 100%	709 100%

Table 5- Contingency Table with the Safety and Health Plan and the safety staff by line [2]

Safety and Health Plan	Safety staff			Total
	Safety Coordinator	Safety Technician	Inexistent	
Exists	57 47,5%	16 13,3%	47 39,2%	120 100,0%
Only to comply with the legislation	30 25,6%	25 21,4%	62 53,0%	117 100,0%
Inexistent	17 3,6%	37 7,8%	418 88,6%	472 100,0%
Total	104 14,7%	78 100%	527 100%	709 100%

Analysing by line (Table 5), we verify that when there is a Safety and Health Plan, there are more accidents when a safety coordinator exists. If the Safety and Health Plan is only to comply with the legislation there is no safety staff. When there is no Safety and Health Plan, accidents represent 88,6% of the cases where there is no safety staff. Through the crossing of the two by two variables (independence test of Chi-square), was created a dependence matrix. For an easier interpretation, taking in account the level of confidence obtained, there is the attribution of numbers from 0 to 5, according to the accidents level of probability. Table 6 presents the relation existent between the test's trust level, that allows us to evaluate the dependence of variables to which it is given a probability degree to occurring an accident [2].

Table 6- Probability Scale of construction accidents [2]

Type of Probability	Scale	Level of trust (Lt)
Very low probability	0	Ltc< 80%
Very low probability	1	80% ≤ Ltc < 85%
Low probability	2	85% ≤ Ltc < 90%
Medium probability	3	90% ≤ Ltc < 95%
High probability	4	95% ≤ Ltc < 99%
Very high probability	5	99% ≤ Ltc ≤ 99,9999%

The importance of the Safety and Health Plan is here highlighted through the analysis of this occurrence probability matrix. There is a strong relation between almost all the variables that feature the accident, with exception of hour, season, day, equipments malfunction and worker's service time. The following table presents the relation between the test's trust level, allowing us to evaluate the dependence of the variables by linking to a probability degree of the accident's occurrence [2].

Table 7- Matrix referent to the implementation of Safety and Health Plans [2]

Variables	Safety and Health Plan (risk probability)
Material factor	5
Consequence	5
Profession	5
Age	5
Company's dimension	5
Region	5
Nationality	5
Collective protection equipment	4
Preventive measure	5
Work organization	Not applicable
Employee	5
Job status	4
Task	5
Sub-task	5
Type of Site	5
Type of Work	5

For each situation where it's obtained a 4 or 5 probability of occurring an accident, taking in concern the trust level, precautions to have to avoid accidents are associated to each crossing with variables dependence. These answers are obtained through the analysis of contingency tables and call our attention to the most dangerous combinations. To avoid accidents, the responsible for the construction, the contractor, their technicians, quality control personnel and safety coordination team should pay attention whenever these variables of high probability level get in touch and should have in attention the referred precautions.

4. CONCLUSIONS

After analysing 709 work accidents in construction sites, there are some conclusions regarding potentially relevant risk indicators. Analysing the behaviour of the association of variables two by two, applying the Chi-Square test, for a trust level of 95%, we came to the precautions to take in order to avoid accidents. We aim to create a useful work tool, for both the contractors and their technicians and supervising and safety coordination teams. The absence of a safety coordinator and an adequate safety plan are two of the great misses noticed. In only 20% of the construction sites, the safety plan is rigorously adequate. In 117 cases, it exists only to comply with the legislation, not being implemented, and in the remaining 402 it is inexistent. To improve the efficiency of safety plans, we should have into consideration the precautions obtained for the situations where there is high or very high probability of accidents, extracted from the contingency tables. On the other side, the safety plan should be seen as an important specialty project. It was also seen that many accidents happened because of the collapse of provisional structures. Consequently, it is recommended that the calculus of provisional structures starts being obligatorily performed during the Project phase, accompanied by a responsibility term signed by the technician.

To strengthen this combination of two by two variables, there was the choice of dependent variables to allow the explanation of the themes related to the accidents, in order to apply multivaried methods. In this case, there was the use of multiple correspondences analysis (ACM), which allows depicting sceneries of the most frequent situations, trough the association of the strongest between the multiple variables. Through an accurate analysis of ACM there is the attempt to identify the accident type's profiles, which are represented by a circle, in which are presented the categories of the variables with strong associations [4].

Evaluating the company's profile through an ACM it is possible to define four groups. In a first group, one of the strongest associations is when there is a safety plan. This safety plan is not implemented at site when there is a safety technician at work. Another strong association refers to the group where there are the accidents occurring in small and medium companies, where these are most frequent due to the use of collective work, of bad work organization and of sub-contracted companies. A third group shows that the strongest association happens at micro companies where there is neither a Safety and Health Plan nor any type of safety staff. It is most frequent in individual work, with permanent workers and when the employer is the contractor. The fourth group represents the most frequent accidents at big companies. In these cases, these are more frequent when there is a safety coordinator and a Safety and Health Plan and due to a good work organization.

It was verified that the main reason why it is difficult to implement a safety and health plan is because the contractor and owner understand safety issues as a cost and not as a benefit. Trough an investigation work [5], we can prove otherwise, as follows.

Table 8- Relation of expected costs [5]

From the point of view	Economical advantages
Contractor	3
Insurance company	21
Social	5

After the analysis of all the non compliances, through the detailed record of data and the plan of non compliances, through the Gant's diagram, where in the spatial line it is possible to see the duration of non compliances, their interconnection and their date of closure and reopening, which sometimes is very short, there are interesting conclusion to take. From observing the Gant's diagram, it is evident the time needed to place the safety anomalies and the short time to break safety rules. Another aspect is the fact of the closure of some non compliances being dependent from other ones. All this can be due to a lack of policy, engagement and organization in terms of safety, on the side of the employer. If the employer does not bear in mind the implementation of safety measures for the good development of construction, it will be so hard to demonstrate otherwise.

Through the most frequent non compliances, and the number of times they repeat themselves, we are able to get a glimpse of the probability of occurrence in other construction sites, given the repetition in first place. Regarding the non compliances of the Safety and Health Plan, there is the use of incomplete work platforms, access ladders with no safety conditions, missing of railings while formworking, in scaffolding, negatives, etc. This can cause the increase of the risk of falling from heights. Other common mistakes are related with crane operations, incorrect loads' lift, which can cause the fall of materials. It is fundamental to see the safety plan as a specialty project to fulfill, adequate and adapted to the construction sites and correctly implemented.

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Behavioural compliance with emergency exit signs - Pilot test in Virtual Reality

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ABSTRACT
Being able to understand and predict human behaviour is quite important, either for the design or the redesign of new environments. In this context, the objective of this pilot study was to assess the influence of some environmental variables (i.e., corridors' width, light positioning, and the amount of concurrent visual information), as well as some signs' design variables (i.e., static vs. dynamic) on the behavioural compliance with exit signs. For this, a virtual environment, composed by a set of fifteen T-shaped corridors, resulting from the combination of the variables in study, was used as experimental scenario. Sixteen university students have participated in this pilot study, and their task was to leave the virtual building, as fast as they could, due to a potentially hazardous emergency situation (i.e., a fire). A constant stimulus method was used to present the stimuli, and a two-forced choice method was used to gather the participants' choices regarding the path they prefer to follow in order to reach the exit. The results reveal higher compliance rates with the dynamic signs than with the static counterparts. An influence of the concurrent visual information, posted on the environment, was also shown, with higher compliance being attained in conditions with less visual pollution.

Keywords: Behavioural Compliance, Virtual Reality, Decision-taking, Emergency egress.

1. INTRODUCTION

Although in the well-accepted *safety hierarchy*, or *hazard control hierarchy* (Sanders & McCormick, 1993) the warnings (including a myriad of safety-related signs) are considered the last line of defence against hazards (mainly due to their considerable potential for failure), they are fundamental because they can help to avoid the occurrence of accidents, injuries, and material losses (Duarte & Rebelo, 2007). Nevertheless, ultimately, the importance of the warnings/signs depends on their capacity to influence the human behaviour (Wogalter, 2006). Therefore, poorly designed warnings, or warnings being misused, could result in serious problems, possibly jeopardizing people's life, as well as resulting in economic losses.

Besides the warnings/signs' design factors (e.g., colour, size, format) other extrinsic aspects, the non-design factors (e.g., target audience and situational factors), can strongly affect their effectiveness (e.g., Laughery, 2006). Location or placement of a warning could be considered either a design or a non-design factor depending on the circumstances. A different type of factors, to some extent related with the previous factors, are the characteristics of the task's environment, which can also be seen as constraints on the design factors. For example, the colour contrast (e.g., Young, 1991), the illumination level (e.g., Dahlstedt & Svenson, 1977) or the amount of visual clutter in the vicinity (e.g., Godfrey et al., 1991) can affect whether the warning will be successful or not. Therefore, a well-designed warning/sign could be ineffective if placed in an environment that strongly compromises its ability to attract attention or that is giving clues to the users that are conflicting with the warnings' instructions.

The above-mentioned characteristics of the environment should than be considered when designing or displaying environmental signs, such as the exit signs, so that they can be effective even in situations in which people naturally tend to act contrarily to the instructions being given by the signs. For this study, and regarding to the task's environment, we emphasize its physical characteristics (e.g., dimensions, illumination level, presence of obstacles to locomotion, visual pollution), which can influence the users' decisions when they need to choose between alternative paths to move in both daily (Duarte, Vilar, Rebelo, Teles, & Almeida, 2011) and emergency situations (Vilar, Rebelo, Noriega, & Teixeira, 2011).

In this context, the main objective of this pilot study was to assess the ability of the exit signs to promote compliance (i.e., if participants follow the direction being indicated by the exit sign) even when they are posted in environments that, in result of its features, tend to induce people to follow a direction that is opposite to the one indicated by the sign (Vilar et al., 2011), or can compromise the signs' ability to elicit a switch of attention to it. Two types of exit signs were considered for this study (i.e., static vs. dynamic), always posted on T-shaped intersections. The environment's variables being studied are related with the visual pollution level (i.e., clean vs. cluttered), the illumination level (i.e., brighter vs. darker), and corridor's width (i.e., larger vs. narrow).

The main hypotheses defined were: a) the rate of behavioural compliance is higher for the dynamic exit signs, on both clean and cluttered environments and, b) the routes choice is coherent with the directional indication given by the exit signs instead of with the clues given by the environment (i.e., illumination, and corridors wideness.)

Researching behavioural effects is difficult to carry out, mostly due to concerns for safety, ethics, and high costs. For experimental studies involving hazardous events, such as the one used in this study (i.e., an emergency egress due to a fire), the major constraint is that researchers cannot deliberately expose participants to real hazards while conducting a

research. Furthermore, a realistic scenario that appears risky but that actually has no risk is expensive to conduct in terms of money, time, and effort. However, Virtual Reality (VR) can be, as defended by Duarte, Rebelo, and Wogalter (2010), a viable alternative technique to investigate warning effectiveness, particularly behavioural compliance. Other studies have also used VR to study exit signs' effectiveness (e.g., Gamberini, Cottone, Spagnolli, Varotto, & Mantovani, 2003; Mantovani, Gamberini, Martinelli, & Varotto, 2001; Tang, Wu, & Lin, 2009).
"VR is about simulating reality (…) The main goal of VR is to create in the user the illusion of being in an environment that can be perceived as a believable place with enough interactivity to perform specific tasks in an efficient and comfortable way" (Gutiérrez, Vexo, & Thalmann, 2008, p. 2). Therefore, VR can provide researchers with virtual environments (VEs) to be experienced by the research participants, which are tree-dimensional worlds containing virtual objects and animated entities to which it is possible to interact with. This can be done with a relatively low monetary cost and in a short time. Additionally, numerous variables can be manipulated rigorously, within a highly controlled context as in conventional laboratory research.

2. METHODOLOGY

A Virtual Reality (VR)-based methodology was adopted for this pilot study. Thus, a set of virtual indoor corridors was projected using a stereoscopic projector and shutter glasses. The stimuli sequence was presented using a constant stimulus method combined with a two-forced choice method in order to collect the participants' responses. The participants' decision about which path to follow at the intersections, was the study´s main focus.

2.1 The Virtual Environment (VE)

Three virtual environments (VEs) were created to resemble T-shaped intersections: a) left corridor with 3.5 m vs. right corridor with 2.0 m, both with the same bright; b) left corridor with 4.0 m vs. right corridor with 2.0 m, with bright on the narrowest corridor; c) left corridor with 4.0 m vs. right corridor with 2.0 m, with bright on the widest corridor.
All VEs were developed as 2D plans using software AutoCAD 2008® and exported to 3D Studio Max® in order to model the 3D environments. In this phase some elements – such as colours on walls and floor, ceiling mouldings, wainscoting and baseboards – were inserted in the corridors to increase their realism. The modelled environments were then exported using plug-in called OgreMax 1.6.23, to be used by the software ErgoVR (Teixeira, Rebelo, & Filgueiras, 2010).

2.2 Experimental Setting

A LightspeedDepthQ3D video projector and a MacNaughtonInc'sAPG6000 active glasses comprised the VR system used for the experimental tests. A Logitech®Attack™ 3 joystick was used as an input device, in order to collect the participants' answers. Participants were asked to navigate through the corridor and to choose, between two alternative paths (i.e., left vs. right), the one that they would follow to find the building exit.
The projected image size was 1.72 m (horizontal) by 0.95 m (vertical) with an aspect ratio of 16:9. The observation distance (i.e., the distance between the observers' eyes and the screen) was 1.50 m, resulting in a 35.2º of vertical field-of-view (FOV) and 59.7º of horizontal FOV. All participants remained standing during the experimental session, at the same location (marked on the floor) to ensure the same observation distance.

2.3 Design of the experiment

The experiment used a within-subjects design in order to assess the influence of the independent variables – the type of the signs (i.e., static vs. dynamic), the environmental conditions (i.e., clean vs. cluttered; brighter vs. darker; larger vs. narrow) – on the path's selection, by participants within a simulated emergency egress. The participants were assigned to a setting offering two alternative paths (i.e., to turn left or right) in a T-shaped corridor. The signs used for this experiment (see Figure 1) were always pointing to the opposite direction to the one that was the most chosen in a previous study by Vilar et al. (2011).
Participants were unaware of the real objective of the experiment and were asked to act in a realistic/natural manner in order to evaluate a new system for VR simulation. They were told that they should choose one of the available paths, as fast as possible, since they were in an emergency situation.

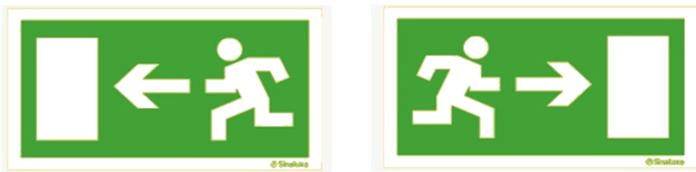

Fig. 1 – The exit signs used in this experiment.

A total of 15 experimental conditions (stimuli) resulted from the combination of 3 types of lighting placement (all corridors with the same bright; a wider and brighter vs. narrower and darker corridor; a narrower and brighter vs. a darker and wider corridor) x 2 environmental conditions (clean vs. cluttered, which included decorative elements as paintings on the wall and machines) x 2 sign condition (static vs. dynamic), plus 3 neutral conditions, characterized by clean corridors, without exit signs, having each one of the three types of lighting. Figure 2 depicts the three lighting conditions used.

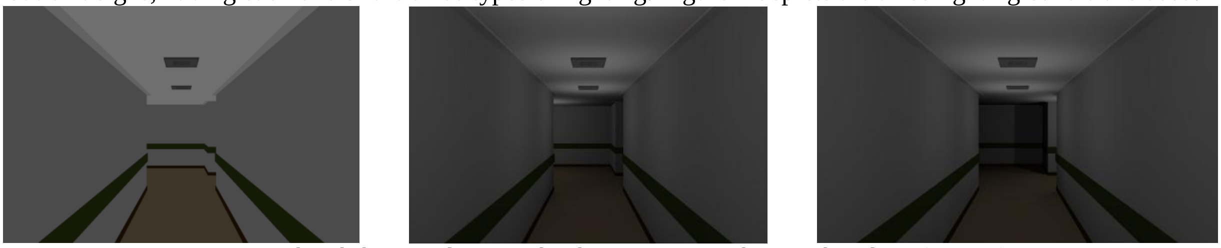

Fig. 2 – Three lighting conditions used in this experiment, in the neutral condition (no-signs).

The exit signs' static version (i.e., printed on a support) and dynamic version (i.e., a backlit printed) were posted on the corridors, as can be seen in Figure 3, in the conditions of clean environment and cluttered environment (together with other competitive visual information) shown in Figure 4.

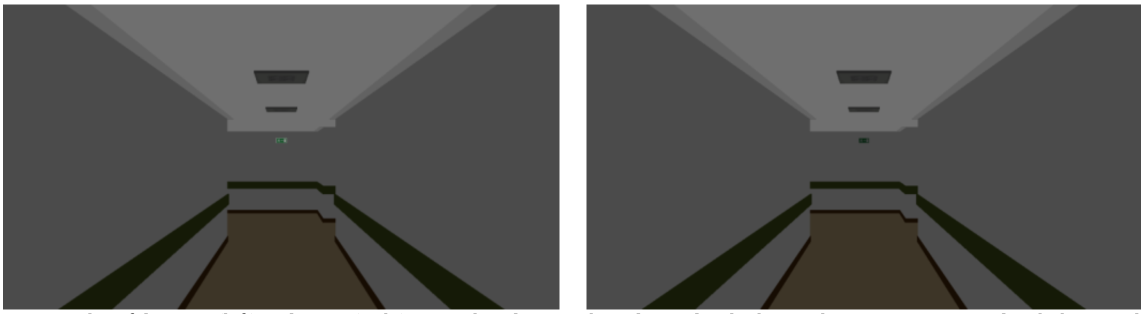

Fig. 3 – Examples of dynamic (left) and static (right) signs placed in a T-shaped corridor, both in a clean environment and with the same bright.

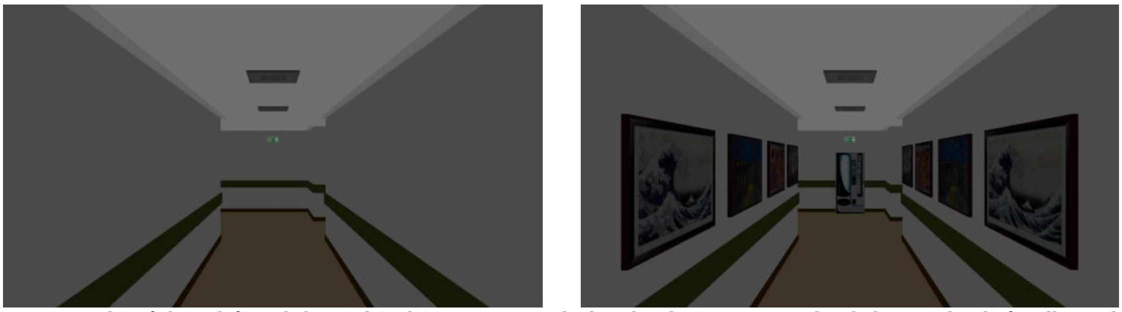

Fig. 4 – Examples of clean (left) and cluttered (right) environments, both with a dynamic sign, and with the same bright for all corridors.

The 15 experimental conditions were repeated 4 times, resulting in 60 stimuli that were organized in two sequences, according to the method of constant stimuli, separated by a break time. The first sequence was randomly generated and the second one was the inverse of the first. The fact of having two sequences is intended to diminish the continuous exposure time of the participants to the VR, as a preventive action to avoid the occurrence of simulator sickness. To exclude an eventual sequence effect, each half of the sample was assigned in first place to one of the sequences. These two sequences were the same for all participants.

The presentation of the stimulus had a maximum duration of 7000 ms and, when it is shown, the participants had to use a joystick to navigate along the corridors in order to follow the path they would choose if they were in an emergency egress. The stimulus automatically changed as soon as the choice was made (i.e., when crossing an invisible trigger placed on the floor at the beginning of the left/right corridors) or when reaching the time limit of 7000 ms of exposure without having made any choice. The path chose by the participants was automatically recorded by the ErgoVR system (Teixeira et al., 2010). An inter-stimulus interval was inserted, consisting in a gray screen with the image of a black cube in the centre, and its displaying time ranged from 800 to 1000 ms.

2.4 Participants

The sample for this pilot study comprised sixteen volunteers, all graduate or under graduate students, aged from 18 to 23 (average = 20.2, SD = 1.652) and equally distributed by gender. All participants declared, through a questionnaire, to have right hand as dominant, had normal sight or had corrective lenses, and no colour vision deficiencies. Complementarily, the colour blindness was screened by the Ishihara Test (Ishihara, 1988). They also reported no physical or mental conditions that would prevent them from participating in a VR simulation.

2.5 Procedure

The experimental session started with the participant's reception, followed by the filling of the informed consent form and the verification of the exclusion criterion using Ishihara's test. Afterwards, there was a training session conceived to explain the procedures and to homogenize the participants' performance regarding the use of the device required to select the paths (i.e., joystick), as well as to get the participants acquainted with the amount of time available to make a choice. It was also highlighted that they could quit the experiment at anytime without any consequences or prejudice of any kind. A ten-repetition sequence has been defined for the training session, and a participant was considered apt to initiate the experiment after successfully completing ten choices within the time previously specified.

After the training session the participants were informed that they were on an emergency situation and that they should leave the building as soon as possible. In order to perform such task, they should choose, using the joystick, which corridors they would follow to exit from the building.

Participants were alternatively assigned firstly to the first sequence, followed by the second sequence, or the inverse order. After concluding the first sequence, the participants took a five minutes break before initiating the second sequence. The test ended when the participants had made all their choices, or when they expressed will to give up.

3. RESULTS AND DISCUSSION

A total of 960 route choices, made by 16 participants, were analysed for this pilot study. All statistical analysis were performed using the software SPSS (v19, IBM® SPSS Statistics) and considering an error probability type I (α) of 0.05. The summary statistics for the individual choices are presented on Table 1.

Table 1 – Individuals choices

Corridor type	Experimental condition	% Left (n)	% Right (n)
Left corridor with 3.5 m vs. Right corridor with 2.0 m, both with the same bright.	Neutral	65.62 (42)	34.38 (22)
	Static sign. Clean. Pointing to the right	15.87 (10)	84.13 (53)
	Dynamic sign. Clean. Pointing to the right	6.25 (4)	93.75 (60)
	Static sign. Cluttered. Pointing to the right	15.87 (10)	84.13 (53)
	Dynamic sign. Cluttered. Pointing to the right	3.12 (2)	96.88 (62)
Left corridor with 4.0 m vs. Right corridor with 2.0 m, with bright on the narrowest corridor.	Neutral	34.38 (22)	65.62 (42)
	Static sign. Clean. Pointing to the left	85.71 (54)	14.29 (9)
	Dynamic sign. Clean. Pointing to the left	90.62 (58)	9.38 (6)
	Static sign. Cluttered. Pointing to the left	78.12 (50)	21.88 (14)
	Dynamic sign. Cluttered. Pointing to the left	89.06(57)	10.94 (7)
Left corridor with 4.0 m vs. Right corridor with 2.0 m, with bright on the widest corridor.	Neutral	78.12 (50)	21.88 (14)
	Static sign. Clean. Pointing to the right	12.5(8)	87.5(56)
	Dynamic sign. Clean. Pointing to the right	10.94(7)	89.06(57)
	Static sign. Cluttered. Pointing to the right	14.06(9)	85,94 (55)
	Dynamic sign. Cluttered. Pointing to the right	10.94 (7)	89.06(57)

Table 2 – Rates of higher compliance with directional signs.

Corridor type/ Experimental condition	Neutral	Static sign		Dynamic sign	
		Clean	Cluttered	Clean	Cluttered
a) Left corridor with 3.5 m *vs.* Right corridor with 2.0 m, both with the same bright.	65.62%	84.13%	84.13%	93.75%	96.88%
b) Left corridor with 4.0 m *vs.* Right corridor with 2.0 m, with bright on the narrowest corridor.	65.62%	85.71%	78.12%	90.62%	89.06%
c) Left corridor with 4.0 m *vs.* Right corridor with 2.0 m, with bright on the widest corridor.	78.12%	87.5%	85.94%	89.06%	89.06%

As shown on Table 2, the results attained suggest that the dynamic exit signs promoted higher behavioural compliance rates than the static ones. This result is consistent with others reported in the literature (e.g., Duarte, Rebelo, Teles, & Wogalter, 2010).

For the intersection composed by a left corridor with 3.5 m vs. right corridor with 2.0 m, both with the same bright, the dynamic exit signs presented a rate of 93.75%, which is higher than the rate attained by the static ones (84.13%) in a clean environment. A similar pattern is verified for the cluttered environment, in which the compliance rate of the dynamic exit signs was higher (96.88%) than the one of the static signs (84.13%).

For the intersection composed by a left corridor with 4.0 m vs. right corridor with 2.0 m, with bright on the narrowest corridor, the dynamic exit signs presented a higher rate of compliance (90.63%) than the static signs (85.71%) in a clean environment. For the cluttered environment, the dynamic exit signs promoted, again, a higher rate of compliance (89.06%) compared to the static ones (78.13%).

For the intersection composed by left corridor with 4.0 m vs. right corridor with 2.0 m, with bright on the widest corridor, the dynamic exit signs presented a higher rate of compliance (89.06%) than the static signs (87.5%), in a clean environment. When considering the cluttered environment, the dynamic exit signs presented a higher rate of compliance (89.06%) compared to the static ones (85.94%).

For the intersection composed by left corridor with 3.5 m vs. right corridor with 2.0 m, both with the same bright, the average presented by both signs, in both environments, was 89.95%. For the intersection composed by left corridor with 4.0 m vs. right corridor with 2.0 m, with bright on the narrowest corridor, the average presented by both signs, in both environments, was 86.6%. Finally, for the intersection composed by left corridor with 4.0 m vs. right corridor with 2.0 m, with bright on the widest corridor, the average presented by both signs, in both environments, was 88.61%.

In spite of the reduced difference between the percentages of left/right choices, it is important to stress that such difference increases when the environment is cluttered. Additionally, the compliance rate is always higher with the dynamic exit sign in use. Therefore, the results suggest that the signs' conspicuity is an important aspect to be considered when the background environment has a high quantity of concurrent visual information. Furthermore, the data also suggests that the dynamic exit signs are more influent on the routes decision than the bright and wideness of the corridors. To find out if the choices were done randomly, the non-parametric Wilcoxon Signed Ranks test was applied comparing the percentage of choices, of both signs, to 50% (the 50% represents a choice due to chance). The test's results (*p-value* $<$0.001, one-tailed), attained for both signs, show that the choices were deliberated.

Knowing that the choices were deliberated, it was important to see if the difference between the percentages of choices for both signs (i.e., static and dynamic) was statistically significant. The results of the Wilcoxon Signed Ranks test show that there is no statistically significant difference between the percentages of choices attained by the two types of signs (*p-value* = 0.064).

As stated above, the higher differences between static and dynamic signs, on compliance, were achieved on cluttered environments. Thus, to check if such a difference was statistically significant a non-parametric Wilcoxon Signed Ranks test was performed. The results reveal that there is no statistically significant difference between the rates of compliance for both signs in cluttered environment (*p-value*=0.059).

4. CONCLUSION

Considering the objective of this pilot study, an experimental test was performed to verify to which extent the behavioural compliance with exit signs is affected by the characteristics of the environment, particularly when such features tend induce people to follow directions opposite to the ones indicated by the signs.

The attained data suggest that people tend to follow the exit signs' directives, with dynamic solutions presenting higher rates of behavioural compliance than static counterparts. Also, the influence of the dynamic signs was increased by the visual pollution, indicating that the visual salience of the signs can be an important characteristic when they are posted on environments with plenty of competitive visual information.

It is important to emphasize that, due to the reduced sample, these results are considered as preliminary and cannot be generalized. A learning effect should also be underlined on this type of methodological approach and it must be considered in future studies, as well as the use of a more ecological approach. The next steps of this study are to enlarge the sample and to modify the static and dynamic signs, in order to investigate more effective ways to direct people to emergency exits.

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A compared study of the required autoprotection measures in buildings with distinct features

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ABSTRACT
In Portugal, after an extended period of legal production in terms of fire safety, sometimes dubious in application, a new Legal Framework governing the provision of Fire Safety in Buildings (RJSCIE) was regulated in 2008. The current RJSCIE, applicable to all types of buildings, brings significant changes to the responsibilities, functions and fire safety management, which have implications on existing facilities in terms of implementation of the so called autoprotection measures, from the date of its publication. To evaluate and understand the impact these changes will have in organizations, a comparative study was conducted within four contact centres belonging to the same company. Although belonging to the same dominant building use-type classification, the four facilities are distinct from one another. Nevertheless they were all classified in the same risk category, and therefore the same autoprotection measures were applied. Among those measures, emergency drills were set out and its evaluation accomplished by external observers. Several incorrect behaviours were observed, highlighting the need to reinforce training both in terms of periodicity and contents. These results are related to the human factor and its unpredictability in emergency situations in which inadequate responses may produce dramatic consequences.

Keywords: Fire safety; Emergency; Autoprotection measures; Safety plan; Emergency drills.

1. INTRODUCTION

The primary goal of fire safety regulations in buildings, implemented in most countries, is the protection of people and the reduction of losses related with fire (Croce et al., 2008). In Portugal, fire safety regulations have evolved along with the technological processes of building construction. Increasingly, fire safety concerns are less related with fire protection and more often concerned with fire prevention and its management throughout a facility’s lifetime.

The current Portuguese legal framework governing the provision of fire safety in buildings (RJSCIE) illustrates this form of approach by including, for the first time, the concept of autoprotection measures in its principles. These measures are based on the human resources’ management and its own safety, as well as on the safety related equipment and systems within a facility. In this way, whenever necessary, fire safety equipments will be properly used by those who occupy the amenities which, in most cases, are employees of the companies who exploit the building’s facilities.

This work reflects how the obligation to implement autoprotection measures may modify the existing safety culture in companies. Through a comparative study in four establishments belonging to the same entity, all classified as use-type III - "office buildings", similarities and differences in terms of implemented autoprotection measures were identified and analysed according to the Portuguese legal framework governing the provision of fire safety in buildings.

2. METHODOLOGY

The current study began with an initial literature review, followed by the analysis of the Portuguese legal requirements regarding fire safety in buildings. Afterwards, the approach to be used in this study was defined and resulted in the following stages:

- Preparing and conducting safety fire audits in the four establishments of the same entity (complemented by meetings with the safety management staff in all facilities);
- Collecting and reviewing the necessary data for the preparation of the autoprotection measures for the four establishments;
- Developing and implementing the appropriate autoprotection measures:
- Defining, preparing and elaborating documentation;
- Defining, preparing and developing training sessions;
- Validating the required autoprotection measures by conducting emergency drills.

Table 1 summarizes the several stages of the followed methodology and specifies the developed instruments.

Table 1 – Methodology.

Stage	Instrument	Purpose of the used instrument
Facility audit	Production of an audit report.	Identification of legal obligations (OL) and technical recommendations (RT) in accordance with the Portuguese fire safety legal framework.
Meetings with the safety management staff	Production of meeting reports.	Collection of data about the organization (number of employees, working hours, etc.), existence of safety procedures, previous emergency training of the employees.
Definition and implementation of autoprotection measures	Preparation of the legally required documentation, safety records, prevention plan, emergency procedures and definition and implementation of emergency training sessions.	Preparation and creation of legally enforceable documents, development, definition and preparation of emergency training sessions.
Validation of the autoprotection measures implemented in each establishment	Definition of the emergency drills' scenario, preparation and development of the drill and production of the correspondent report	Validation of the autoprotection measures, issuance of findings and any recommendations to be implemented as a complement to the applicable autoprotection measures.

For each company's subsidiary, an audit plan was established, where the following aspects were taken in account:
• Defining the facilities areas and spaces to audit;
• Data and location of the audit;
• Audit purpose and scope;
• Worker in charge of the audited area;
• Audit schedule;
• Description of the facility's type and occupied fractions, location, geographical implantation, building accessibility and environmental characterization;
• Identification of possible emergency and evacuation plans.
Each safety audit allowed the collection of the following information concerning all facilities:
• Description of the facility;
• Characterization of the outdoor conditions shared by different facilities within the same building;
• Assessment of fire behaviour of materials, their isolation properties and level of protection they provide;
• Assessment of the general evacuation conditions;
• Evaluation of the general technical installations provided in the building;
• General conditions of the existing safety equipment and systems;
• Building use-type specific conditions.
Based on the results obtained from the audits and from the information gathered in the work meetings it was set to produce the following documentation:
• Safety records;
• Prevention plan;
• Emergency procedures;
• Training sessions in matters of emergency organization;
• Emergency drills.

2.1. Safety records
Safety records consist of a set of documents that relate to indicators of relevant events, reports of previous fire events, safety equipments and the facilities themselves.

2.2. Prevention plan
The prevention plan brings together all the information related to the characterization of the buildings in a safety perspective. Therefore, it includes facility plans, scaled between 1:100 and 1:200, with unambiguous representations of:
• Risk classification and maximum probable number of occupants for each site, according to the legal framework;
• Horizontal and vertical evacuation routes, including any common communications pathways;

Location of all devices and equipment associated with fire safety.
Finally, it also comprises information related to prevention procedures regarding:
- Use of the spaces within the facility;
- Use of technical facilities and equipment;
- Existing safety systems.

2.3. Emergency procedures
Information concerning emergency procedures reflects procedures for alarm, alert, evacuation, use of 1st order means of intervention and aid of 2nd order means of intervention, once they arrive. These procedures describe the set of behaviours to be adopted when an emergency occurs. That is, how an emergency should be reported to all employees in the facility and how they should organize themselves and act if necessary to abandon the premises. If possible, some of them should have developed skills to assist in extinguishing fire and transmitting the adequate information to external aiding entities such as fire fighters and paramedics.

2.4. Training sessions in matters of emergency organization
Two groups of audience were set for training sessions on emergency organization. The first group comprised employees that are regularly in the building, but do not have any assigned mission within the safety team. Nevertheless, they should know how to act and be aware of the appropriate behaviour to adopt in an emergency situation. On the other hand, there is the group of employees assuming particular functions on the evacuation course and/or the fire extinguishing process. For each group a specific and distinct training was set up.

2.5. Emergency drills
The emergency drills in all four establishments followed the same scenario and the same sequence of events, with only minor adjustments due to the specific configuration and layout of the facilities.
This approach assured that, although geographically distant and sharing some of the coordinating elements, there was no information passage between facilities regarding the scenario to simulate. Since this was the first emergency simulation, its occurrence was communicated to all the elements that were part of the safety team in all establishments.
The simulation scenario includes a set of data and information necessary for the preparation and implementation of the emergency drill. It is a document systematizing the purpose of the drill, describing how it will be held, who will be involved and what emergency scenario will be.
The defined exercise aimed to test the mechanism set out in the autoprotection measures and check the level of readiness of the facility occupants in response to an emergency situation. On the other hand, depending on the findings obtained after its completion, it makes it possible to program new actions, including other drills, and to determine the lacking means and resources.

3. RESULTS
All created instruments delivered important results for the implementation of the required autoprotection measures in each establishment of the company.

3.1. Preparation of audits, audits and meetings for validation of the gathered data
The result of this stage produced a report that identifies the fundamental aspects of fire safety, for each audited facility. This information allowed a thorough and insightful survey for each of the facilities that describe aspects of fire safety. On the other hand, it revealed the difficulties that could arise from the implementation of the autoprotection measures.

3.2. Characterization of the establishments
The results show that although the buildings have distinct characteristics, from the view point of fire safety they also presented some aspects in common.
Table 2 presents the data elements, the criteria and the different features with direct implication in the definition of the autoprotection measures for the 4 facilities.

Table 2 – Establishment classification criteria

Installation classification criteria with implications in the definition of autoprotection measures	**Building 1**	**Building 2**	**Building 3**	**Building 4**
Building's type of use classification	Use - Type III "Administrative"	Use - Type III "Administrative"	Use - Type III "Administrative"	Use - Type III "Administrative"
Building's height	≤ 28 m	≤ 28 m	≤ 9 m	≤ 9 m
Local risk types	Yes, local risk types A, B and C.	Yes, local risk types A, B and C.	Yes, local risk types A, B and C.	Yes, local risk types A, B and C.
Maximum persons in the facility	548	259	451	399
Building type of use	Exclusive use	Exclusive use	Exclusive use	Mixed use
Risk category	2nd Category of Risk - Moderate fire Risk	2nd Category of Risk - Moderate fire Risk	2nd Category of Risk - Moderate fire Risk	2nd Category of Risk - Moderate fire Risk

3.3. Produced documentation

The prepared and produced documentation tried, not only to meet the legal requirements raised in legislative provisions, but also to draw up documents that could be easily handled, understood and interpreted by employees with functions in the safety team that have reduced or even no knowledge on these matters. In this sense, the following documentation was prepared for each of the establishments:

- Security records;
- Prevention plan;
- Procedures in case of emergency.

3.4. Results of fire safety training

The defined training sessions were of a short duration period. Therefore, from a pedagogical point of view, it wasn't meaningful to proceed to its evaluation at the end of each session. The evaluation of the provided knowledge in these actions as well as for the specific training set of sessions was globally evaluated within the drill performed in each establishment.

3.5. Drill's outcome

The results obtained in the drills were grouped into two types of information:

- Quantifiable data;
- Data describing the principal evidence for each establishment, based on an evaluation grid of desired and inadequate behaviours.

This appraisal tool was set to guide the observers[1] during the assessment of the drill, for the desired and expected behaviours that the elements of the safety staff of each establishment should adopt, during five significant drill events, as listed below:

- Event 1: Fire identified through the Automatic Fire Detection System (AFDS) – The alarm rings;
- Event 2: Evacuation;
- Event 3: Identifying a fire victim;
- Event 4: Call of the 2nd means of intervention;
- Event 5: The post - emergency.

4. DISCUSSION

The main differences found between the results obtained for the four establishments concerned the undertaken training sessions and the drills' evaluation.

The way safety teams responded to the drill in each facility allowed us to identify gaps and difficulties in implementing the autoprotection measures.

Different evacuation times were registered. This difference had to do with the difficulty of simulating an emergency and the way several team elements interact with themselves. Plus, different safety team elements are not equally aware of

[1] Observers – external elements whose function is to observe and record the behaviours that occur during a drill.

what an emergency is and do not manage the resources and means at their disposal in the same manner. On the other hand, there were also registered differences in the way they put into practice the emergency behaviours they learned in the training sessions. The total number of workers in the facility and the building's height were also relevant.

Prior to the implementation of the autoprotection measures, two of the establishments already had had emergency training for the implementation of an emergency plan. It was then expected to easy the implementation of the current autoprotection measures, resulting, for instance, in a shorter evacuation time compared to the other establishments. This did not happen.

Once the training sessions' content was the same for all establishments and the results of the drills were different, occurring situations in which the non-realization of the expected and adequate behaviour conditioned the actions of other elements of the safety teams, the need to enhance the undertaken actions of general and specific training should be reconsidered.

In the developed study, the implemented autoprotection measures were the same for all establishments.

For the autoprotection measures to be implemented in the four sites, the same principles of organization and management of both documents and human resources was followed, i.e., the necessary documentation for each establishment, was set up following the same logic, the same structure and principle development. The same was true in terms of human resources, i.e., the definition of the adequate employee's profile so that he could integrate the safety team in an emergency situation.

Previous implementation of emergency plans and training sessions in two facilities did not produce better results in drill's which imposes a review of the role that training can have and play in the implementation of autoprotection measures.

On the other hand, checking over disruptive behaviours, both in the meeting point and sometimes in the return of unauthorized employees to their workplace during a drill, meet the two types of behaviour described by Kobes et al. (2010) and support the idea of the authors with respect to the set of critical factors that determine the performance and behaviour of individuals in case of fire. One of these aspects is clearly linked to the human factor. This observation reinforces the need to pursue further studies in fire safety based on the research of human behaviour and its unpredictability, verified and taken in such circumstances and in a general way also linked to other kinds of emergency situations.

The facilities under evaluation, regarding the characteristics of the performed activity, primarily based on its human resources character, in its form of organization and management (high number of employees, flexible working hours, shift work, rotating jobs and high turnover), reveal a different need to carry out training actions on emergency and conduct emergency drills. This need reflects the recommendations resulting from the conducted study, i.e. the training actions on emergency and the emergency drills should be defined with a different periodicity, in legal terms.

5. CONCLUSION

The present study describes and presents a possible implementation methodology for the required autoprotection measures in accordance with the current Portuguese legal regulation for buildings fire safety. The followed methodology served its purposes, permitting the implementation of the required autoprotection measures for four establishments with the same classification of use-type.

The conducted study showed that, in accordance with these requirements, the company's human resources will have a key role in how to manage emergencies, since they play a part in and are the first to intervene in the facilities, in case of a possible incident situation.

By the specific assignment of responsibilities and functions in case of emergencies, the company's employees are aware of and familiar with the correct behaviour to adopt in emergency scenarios. However, only the passage of time, the need for further training activities, drills, audits and inspections of the facilities will tell if the implemented measures, are always known, and are adapted and kept updated. Only then it will be possible to realize if the autoprotection measures are important or not and whether they are part of their internal safety culture or not.

It is difficult to assess the impact of autoprotection measures based on a study that takes place at an early stage of the implementation of the legal required autoprotection measures. Validating its true impact involves regular monitoring of the progress that these measures have on the premises and it is necessary to perform studies with a broader temporal scope.

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LEAN Principles Applied to the Safety Management in the Construction Sector

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ABSTRACT
Nowadays the great exigencies of competitiveness imposed to companies lead them to achieve its resources optimization. According to Lean Production perspective the products have to be produced to give the maximum value to clients. Lean Construction is the application of Lean principles to the construction sector. This sector has special characteristics, but with the Lean principles implementation can progress to new philosophies that answer to its particularities. The main aim of Lean is to eliminate economic losses that also include indirect losses as administrative costs, production losses, the lack of workers motivation and the low health and safety conditions. So, the results to be achieved by Lean Construction also include eliminating waste that arises from occupational accidents. Some of the Lean Production concepts and methods, as Last Planner, implemented in production planning, may also be applied in the health and safety management and planning. This work introduces the fundamental principles and concepts relative to Lean Construction and applies them to the health and safety (H&S) management of a construction project. The analysis of the no concluded H&S planned activities were made through the Last Planner System. The Percentage Plan Complete index – PPC were used to measure the activities performance. An exploratory application of the methodology was made to a case study. It is showed the improvement that can be achieved through the implementation of the Lean Construction principles in the health and safety management in the construction sector. The main goal of this work is to optimize the health and safety management systems using some tools which aim is the implementation of Lean principles in the construction projects.

Keywords: Lean Construction; Planning; Production; Safety Management.

1. INTRODUCTION

The actual enterprises competiveness exigencies lead them to optimize its resources. According to Lean perspective the products are produced with the aim to give the maximum value to clients, promoting the maximum production with the least consumption of material, workforce, time and space and satisfying the clients' requirements (Womack and Jones, 2003). The production systems are designed to achieve the aims of its clients and producers. This one's as the owner of the production systems should have uniform goals to maximize value and minimize waste, keeping the required quality level and keeping the system open to the changing and to the continuous improvement (Ballard et al., 2001).

The construction sector has several specific characteristics such as immobility of the final product, long life cycle, great capital involved and singularity of objects that are developed in a specific institutional, economic and social context. This sector also has great fragmentation, great variety of enterprises with different dimension and specialization and very casual work (Vrijhoef and Koskela, 2005).

So, the Lean philosophy has been incorporated with aspects such as the constructive processes, the management of the conversation and the continuous learning throughout life and the application of Lean Production philosophy to the construction was launched by Koskela (1992). His work especially led to the consideration of the construction management community of the exchanges aspects between time, cost and quality that were improperly established. In addition, it stressed the importance of the flow of the production process, as well as the conversion of inputs into the finished product (outputs). All these aspects are important elements for the creation of value over the life cycle of the project.

The five major lean principles that are identified to be applicable in the construction industry are: customer focus, culture/people, workplace standardization, waste elimination, continuous improvement/built-in quality (Salem and Zimmer, 2005).

The constructive process itself is a type of production which performs project management and as the Lean Production System, Lean Construction focuses on delivering value viably and quickly for the customer and stimulates the conviction in relations of exchange between time, cost and quality (Peneirol, 2007). The main goal of Lean is to eliminate economic losses that also include indirect losses, as administrative costs, production losses, the lack of workers motivation and the low health and safety conditions. It is essential to create a culture of engaged employees and working toward safety that can only be achieved when there is a high degree of trust in the business (Hafey, 2010).

So, the results to be achieved by Lean Construction also include eliminating waste that arises from occupational accidents (Abdelhamid et al., 2003). According to Saurin et al. (2001) some Lean Production concepts and methods implemented in the production planning, as Last Planner, can be also applied in the health and safety planning and management. Mitropoulos et al. (2007) studied in what extent Lean practices contribute to the reduction of occupational accidents in construction and concluded that the reduction of uncertainty of errors (and consequently of rework) and the congregation of the capabilities needed for tasks, reduce the likelihood of accidents increasing productivity. Furst (2010) show that applying Lean Six Sigma thinking to safety has great possibility and potential to drive safety performance integrating safety procedures into internal processes.

This work introduces the fundamental principles and concepts relating to Lean Construction and applies them to the health and safety management in a construction project.
For the implementation of Lean principles was applied the Last Planner System to perform an analysis of the causes of non-completion of planned activities, and the Percentage Plan Complete index – PPC, a performance monitoring index, both adjusted to health and safety management at work.
It is also underlined the improvement that can be achieved through the implementation of the Lean principles in the construction sector through the production and health and safety integrated management.
The main goal of this paper is to optimize the management systems of health and safety through the application of some tools that aim to implement Lean principles in construction projects.

2. DEVELOPED MODEL

2.1. Background

A Construction Project management consists on the planning of all activities from the design phase to the final product customer delivery. This involve the coordination and monitoring of all its phases to satisfy all the functional, cost and time requirements and the applicable legal, quality and health and safety requests (Harris and McCaffer, 2006).
So, planning is a management process that includes the establishment of objectives and the determination of the indispensable procedures to achieve those goals. It contributes to the work conduction within the parameters laid down, being also essential to define the criteria for monitoring the established goals (Ballard, 2000).
During the design phase the principal activities are planned in a general way and in detail during the execution phase.

2.2. Last Planner System

The construction sector has a high diversity of products and processes with varying durations, failed deliveries, among other problems. The Last Planner System is a project management method developed to face the situations encountered in the control and execution of the construction activities and has been developed since 1992. The method has arisen inductively through a series of industrial experiments (Ballard and Howell, 1997).
In the construction industry the variability decrease and its harmful effects can be controlled through the Last Planner System presented as a planning and production control tool. This planning tool is widely used to stabilize the construction production (Soares et al. 2002).
A Last Planner important resource is the control and measurement of the performed tasks. This control is done by the Percentage Plan Complete index – PPC which shows, in percentage, the amount of tasks performed according to the planned (Ballard, 2000). The PPC index ensures the knowledge of possible planning irregularities in the short-term identifying immediately the delay, allowing the planning redo and recovery.
As Construction is a sector with multiple tasks to be carried out at the same time it is indispensable to develop different plans in three distinct time levels: the short, medium and long term.
The long-term planning is the first phase of planning at the strategic level. Its main outcome is the global plan (master plan) and at this level the principal production processes are defined and planned. In conjunction with the budget data it is defined a flow of expenditure which must be compatible with the feasibility study carried out during the strategic planning of the construction project (Formoso, 2002). The production planning and controlling process facilitates the Lean Production principles implementation that tend to reduce activities such as handling, inspection and waits, as well as those activities that consume time but do not generate final customer value. The information contained in the long-term planning will be disseminated to those involved in the work implementation and the deadlines set in are essential for the preparation of the medium-term plan. This planning reflects the effective delays between the planned and the executed. Another important decision, related to this level of planning, deal with the work strategy development. Through this planning is established the program for the different activities eliminating potential points of collision that may exist between teams and promoting the improvement of material and workforce flows (Kurek, 2005).
The medium-term planning is a second strategic planning level which makes the linkage between the master plan and the daily plans. At this level the planning tends to be mobile and for this reason called look ahead planning. The processes defined in the master plan are now detailed and segmented in groups that shall be performed in accordance with the established (Formoso, 2002). The typical medium-term plan has a horizon of four weeks counted from the second week because the first one corresponds to the horizon implicit by the short-term plan (Bernardes, 2003).
Each activity of that plan will be subjected to a constraints analysis and from it are produced the resources plans and programme, the stocks verification and projects analysis. The responsibility for achieving this level of planning is addressed to the work site direction.
The short-term planning has the role of directly guide the carrying out of the site work. In general is held in weekly cycles, being characterized by the allocation of physical resources (manpower, equipment and tools) to the activities programmed in the medium-term plan, as well as the splitting of these activities into smaller packages, called tasks. In rapid works or with a high uncertainty associated with the production process (for example rehabilitations) the short-term planning cycle can be daily (Formoso, 2002). So, the planning horizon is the week and it details the daily tasks to run. Another source of information is the short-term plan of the last week because the part of activities that have not been

performed in the previous week should enter in the following short-term plan. The problems that occurred in the previous period are evaluated and the necessary measures to solve them are taken. It is then carried out the sizing of work teams, the adjustments in the tasks sequence and the verification of the resources availability. The responsibility for achieving this level of planning is addressed to the work site direction in conjunction with the chiefs of the work teams.

During the course of the site work, weekly meetings are held for discussion and work control. These will serve to analyze the contract, to make amendments or new definitions of the project, to address concerns about safety, environment and quality of work, to analyze relevant questions about the construction site, the monitoring of the work, to analyze activities foreseen in the work plan, the materials quality and discuss technical aspects. Planning assumes primacy in all meetings and it is in this context that activities to be running in the short term are analyzed. It should be noted that the excellence of production is to achieve the end product with the highest quality and without occupational accidents. So, it is suggested as improvement of the safety management system, a weekly control map that provides the work to the following week. In the planning meetings will be discussed and analyzed, for each activity, the project definitions, the dependencies between activities, the preparatory work to be carried out, the safety measures to be implemented, the training and information to be given for everyone concerned. A week map control is being completed that includes the detection of constraints found in the zone of "checking of risks in the activity start up".

Another important indicator in the construction work flow control is the PPC – Percentage Plan Complete index which considers the completion of an activity only when is completely performed. The indicator confronts the work done with the work planned for this week indicating if the fluidity of work and the resources available are well allocated to the activities. It is considered that as higher is the PPC higher is the productivity and fewer are the unpredictability of this week.

2.3. Week control map model

Figure 1 depict the week control map model developed that combines the planning factors of the production tasks with the safety measures and specifications that have to be implemented in an integrated way.

The section of production (Figure 1) analyzes the forward tasks which conclusion is required to allow the beginning of the next week tasks without any restriction. It is verified the existence of the needed material to carry out the task, as well as the manpower and equipments, the physical space where these activities will flow and in some cases it is advisable the design verification (details of execution, errors and omissions). It is also verified the existence of constraints which can disrupt the success of the activity and also the need for special resources.

The section of safety corresponds to the confirmation that all the safety requirements needed to the task execution were implemented. To each work activity it is verified if:

- It is provided in the health and safety plan;
- Its risk assessment was done;
- The correspondent safety procedure was approved;
- The individual safety equipment is available;
- The collective safety equipment is implemented;
- The specific health and safety training was given to all the participants at work.

After this section in Figure 1 the next one regards the risk assessment of the activity beginning that includes the risks control with an adequate safety level and the identification of the risks that did not achieve a good safety level. The control field is a visual indicator assigned with the following code of colours:

- Green - the activity has no risks associated with its beginning;
- Yellow - the activity has risks that can be eliminated/controlled before its beginning;
- Red - The activity start cannot be allowed because there are not present all the safety conditions required.

The week control map must be completed from up to down and from left to right and only the fields that are not conform have to be signalized, avoiding overload the map with unnecessary information. With this map is intended to protect the weekly workflow ensuring quality of execution and high safety levels.

To get the feedback of each activity the map has a control section that allows measuring the evolution of planning and pointing out the reasons for the no conclusion of the work activities. This information may be very useful to improve the production flow in the course of the work or in future construction works.

To achieve a positive control of the week it must be checked the percentage of work done for the activity concerned, and shall only be assigned Yes in the field “conclude” if the percentage of work realized is greater than or equal to the estimated for the week. For the negative case are described briefly the reasons for the no completion of the work. If the activity passes to the next week is rescheduled on the next column.

Related with the week activities performance another important index is the PPC – Percentage Plan Complete that is obtained by the expression (1):

$$\text{PPC} = \frac{\text{Number of activities concluded}}{\text{Number of activities planed}} \times 100 \quad (1)$$

This indicator is linked with the percentage of work done for each activity concerned and as said, the activity conclusion is only considered when the activity is completely finished. So, the options “almost” or “90% done” are considered as not completed. This index confronts the work done with the work provided for the week indicating whether the fluidity of work and the resources available are well allocated to the activities. As higher is the PPC higher is the productivity and fewer are the unpredictability of this week.

Enterprise simbol	Document number	Name of the construction project	Date: __/__/__
	Week control map		
Part of the construction:			PPC %
Local:			
Week Number:	Week: __/__/__ a __/__/__		

Description of the activity to conclude in the week					Planning - startup activity risk checking																							Control			
					Work to do							Production								Safety						Assessment		Conclude?			Reschedule
Week number	Nº	Activities	Execution responsible	Localization	2ª	3ª	4ª	5ª	6ª	S	D	Forward activity number	Materials	Work force	Equipments	Design	Space	Constraints	Recursos especiais	The activity exists in the safety plan	Risk assessment done	Safety procedure approved	Professional training	Individual safety Equipment	Colective safety measures	Control	Type of Risks	Yes	No	Why not?	Week number
	1																														
	2																														
	3																														
	4																														
	5																														
	6																														
	7																														
	8																														
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	20																														

Figure 1 – Week control map (adapted from Mendonça, 2009)

According to the proposed model, aiming an integrated management of production and safety, the week control map highlight the conditions that have to be effectively granted to allow the beginning of the planned production activities. All of the indicated factors are analyzed before the start of the work activities to identify which one constrain the beginning of the activities because is missing the corresponding resources.

3. CONCLUSIONS

This work highlights the advantages of the implementation of an integrated method of planning and monitoring the construction health and safety by applying innovative methodologies and principles that contribute to the reduction of uncertainties contained by the production and health and safety.

The developed model was based on Lean principles implemented through tools and methodologies of Last Planner System. With the proposed model was implemented an integrated system of planning and monitoring the safety at work.

The application of the Last Planner had as main impact the possibility of prevision of the activities that can effectively be carried out in each week, through the conditions established on the construction site. It also contributes to the analysis and registration of the reasons for not completing the planned activities and uses a production performance index, the PPC. The values of this index draw the attention to the existence of problems that can be solved in real time, preventing their repetition, decreasing the occurrence of failures, increasing productivity, the quality of the work done and the implemented safety levels.

It also highlights the fact that the improvements obtained by applying the proposed model does not require any financial effort of the construction enterprises because in order to attain the objectives of the model it is enough the commitment and training of all the participants in the implementation of Lean principles.

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Noise Levels in Hospital Environment – The Case of Intensive Care Units

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ABSTRACT
The high noise levels found in hospitals, particularly in intensive care units can cause physiological and psychological disorders in health professionals and patients. Taking into account the absence of national guidelines for the control of this agent in hospitals, a study was carried out in a hospital which had as main objectives to evaluate the sound pressure levels at intensive care units and analyse the perception of health professionals. The measurements of the equivalent continuous A-weighted sound pressure level and C-weighted peak sound pressure level, took into account the layout of units and the location of the main sources of noise. In order to prioritise interventions in different units, the Ergonomic Workplace Analysis methodology, adapted by Miguel *et al.* (2010), was applied. Finally, it was applied a questionnaire, that allowed the characterisation of the health professionals and assessment of noise perception in this type of units. In general, the values of equivalent continuous A-weighted sound pressure level vary between 48.9 dB (A) and 67.1 dB (A). These results are higher than the limit recommended by international organisations and may have been influenced by the equipment and the conversation between the health professionals team. The daily personal exposure values ranged from 57.8 dB (A) and 67.1 dB (A) and the values of C-weighted peak sound pressure level ranged from 106.5 dB (C) to 118.5 dB (C). According to the applied methodology all units were classified at risk level 2, except one unit that was classified as risk level 3. Environmental and structural corrective actions were proposed. As regards perception, health professionals identified noise as a disturbing agent and the great majority identified the equipment as the most annoying noise source. The implementation of noise control actions may require a previous study of technical and economic practicability.

Keywords: Noise; hospital; intensive care units.

1. INTRODUCTION

The importance of noise in health facilities has been recognised as an important determinant of well-being and comfort of patients and health care professionals. The hospitals have different sources of noise. Examples can be given for equipment with alarms, tasks developed by health professionals, moving and speaking patients and visitors, among others (Short *et al*., 2011). These institutions have in general surfaces - walls, ceilings and floors - which reflect sound and cause long reverberation times that promote echoes, blending and overlapping of sounds and worse the problem of noise (Pope, 2010). According to Busch-Vishniac *et al*. (2005), data collected in several hospitals over the past 45 years indicate an increasing trend in noise levels in hospitals during the daytime and evening. The World Health Organization (WHO) (1999) has established noise limit values for hospitals (L_{Aeq}) of 40dB (A) during daytime and 35 dB (A) at night). Other organisations like the United States Environmental Protection Agency (USEPA) and the Brazilian Association of Technical Standards (ABNT) proposed limits of 45 dB (A) for daytime and 35 dB (A) for night. However, numerous studies have shown that sound pressure levels in hospitals are higher than those recommended, particularly in intensive care units (ICU), ranging L_{Aeq} between 55 dB (A) and 70 dB (A), with maximum values that vary between 80 dB (A) and 120 dB (A) (Pugh, 2007). The UCI are places that have much high-tech equipment, used to serve a population segment of high risk. In these units, health professionals develop delicate tasks that require high concentration levels. According to Mahmood *et al*. (2011), the work done in a hospital environment is physically and psychologically intense and can cause burnout, stress and fatigue, which can result in errors. Juang *et al.* (2010), studied the health professionals perceptions and found that "the conversation between visits and patients" as the main source of noise in hospitals. Portuguese legislation regarding the exposure of workers to risks arising from noise consists of the Decree-Law No. 182/2006 of 6 September, which transposes the Directive No. 2003/10/EC of the European Parliament and the Council. This law establishes exposure limit values in relation to daily personal exposure – $L_{EX,8h}$ - and sound pressure level peak – $_{LC,peak}$. For $L_{EX,8h}$ exposure limit value is 87 dB (A) and the $L_{C,peak}$ is 140 dB (C). However, for $L_{EX,8h}$ above 80 dB (A) or $L_{C,peak}$ greater than 135 dB (C), admits that there is risk of hearing damage (Miguel et al., 2010). In hospitals, daily personal exposure to noise levels, are generally below the levels recommended by national legislation. However, extra-auditory effects may occur, as above mentioned, which may enhance the occurrence of errors and work accidents in such institutions. Considering the lack of national guidelines for the control of this agent in a hospital, it was followed the methodology developed by the Finnish Institute of Occupational Health, called the Ergonomic Workplace Analysis. This is a tool that allows a true assessment of the work situation and aims to promote jobs and health insurance, based on labour physiology, occupational biomechanics, psychology, information, occupational hygiene and a model of organisation of sociotechnical work (Costa, 2004). According to Miguel *et al*. (2010), the recommendations of the EWA method can be applied to risk assessment associated with the occupational environment. In this case, only three risk levels and correspondent priority intervention levels are considered. Noise is a physical agent in the occupational environment that can be analysed from the adaptation of the EWA methodology. Regarding this agent, the methodology takes into account the need for verbal communication between workers at work and if the task requires concentration or not to assess the risk level. Thus, recognising the negative impacts of noise in hospitals, the main objective of this study was to assess quantitatively the noise in the UCI and apply semi-quantitative method based on the EWA recommendations for the determination of intervention priorities and establishment of corrective and / or preventive actions.

2. MATERIALS AND METHOD

This study was performed in a hospital unit located in Porto, in eight ICU. The choice of the sample is explained mainly by the fact that these units have a large variety of equipment, a low turnover of professionals and tasks requiring concentration and increased responsibility. The designation of the ICU is presented in Table 1.

Table 1 - Identification and characterisation of ICU

ICU	*General characterisation*
Paediatrics	8 beds, 1 isolation room, 1 work bench, 1 sink, 1 storage room.
Infectious Diseases	6 beds, 1 work bench, 2 sinks, 1 storage room.
Neonatology	18 incubators; 2 work benches; 2 sinks; 1 isolation room; 1 waste storage room; 1 storage room; 1 meeting room.
Cardiology	8 beds, 1 work bench, 1 storage room.
General	10 beds, 2 workbenches, 2 sinks
Urgency	14 beds, 1 isolation room, 2 workbenches, 2 washbasins.
Emergency	5 beds, a work bench, 1 storage room.
Neurocritical	8 beds, 2 workbenches.

The methodology was based on four approaches:

- Application of a checklist for the characterisation of ICU conditions;
- Measurements of equivalent continuous A-weighted sound pressure level (L_{Aeq}) and C-weighted peak sound pressure level ($L_{C,peak}$);
- Application of the EWA methodology adapted by Miguel *et al.* (2010) for the determination risk level and priority intervention;
- Application of a questionnaire to analyse workers' noise perception at the workplace.

2.1. Characterisation of the structural conditions of the ICU

For the characterisation of structural conditions, it was developed a checklist that included main analysis topics, like: general installation conditions, type of tasks or activities and main sources of noise.

2.2. Evaluation of occupational exposure to noise

Initially, sampling points were determined, taking into account the layout of the ICU and location of the main sources of noise (number and type of equipment, number of occupants). L_{Aeq} and $L_{C,peak}$ measurements were made in the proximity of noise sources (at the bedside of patients) and at the centre of the units, with the microphone positioned, approximately, at worker ear level. Measurements were made during normal work hours, 8:30 am to 4:00 pm in order to obtain representative values of workers' exposure. Morning and afternoon measurements lasted 30 minutes (in the centre of the unit) and 20 minutes (at the bedside of patients). The equipment used in the measurements were the integrating sound level meter Brüel & Kjær and the 01 dB sound level meter Model Solo-Premium. In the analysis and interpretation of results were used reference values given in Table 2:

Table 2 – Recommended Values

Organization	*Reference*	*Recommended Value (L_{Aeq})*
United States Environmental Protection Agency (US-EPA)	EPA Noise Levels affecting Health and Welfare, 1974	45 dB (A) day 35 dB (A) night
World Heath Organisation (WHO)	Guidelines for Community Noise, 1999	40 dB (A) day 35 dB (A) night
Brazilian Association of Technical Standards (ABNT)	NBR 10152 - Acoustics - Loud levels for acoustical comfort	45 dB (A) day 35 dB (A) night

2.3. Application of the EWA methodology

The analysis and interpretation of $L_{EX,8h}$ results obtained in the ICU were made by applying the recommendations of EWA methodology adapted by Miguel *et al*. (2010), that considers the risk levels presented in Table 3 and the recommended values shown in Table 4.

Table 3 – Level of risk associated with occupational environment and priority intervention

Risk Index	*Priority Intervention*
1	Acting is not a priority
2	Acting in the short term
3	Acting very urgent, requiring immediate action

Table 4 – Level of risk associated with noise levels ($L_{EX,\,8h}$), according to the type of work

	Work that requires no verbal communication	*Work that requires verbal communication*	*Work that requires concentration*
1	< 65 dB (A)	< 50 dB (A)	< 45 dB (A)
2	65 – 80 dB (A)	50 – 70 dB (A)	45 – 65 dB (A)
3	> 80 dB (A)	> 70 dB (A)	> 65 dB (A)

2.4. Development and application of a questionnaire

To analyse the noise perception of workers in their workplaces, it was developed and applied a questionnaire, in order to characterise work conditions, comfort and the main noise sources.

2.5. Statistical analysis

The processing and data analysis involved descriptive statistics, with analysis of L_{Aeq}, $L_{EX,8h}$ and $L_{C,peak}$ values. In the data processing Microsoft Excel software was used.

3. RESULTS AND DISCUSSION

3.1. Analysis of the results obtained for the L_{Aeq} in the ICU

Figure 1 shows the results obtained for the values of L_{Aeq} dB (A) from the evaluated ICU.

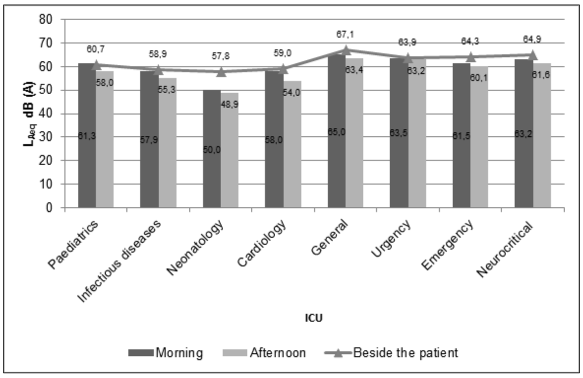

Figure 1 Values of L_{Aeq} dB (A) obtained from the ICU

Figure 1 shows the values of L_{Aeq} dB (A) obtained in the ICU ranged from 57.8 dB (A) to 67.1 dB (A) at the bedside of the patient and between 50.0 dB (A) and 65.0 dB (A) in the centre of the units. These values are above those recommended by U.S. EPA, WHO and ABNT and similar to those obtained by several authors in the same type of units (Christensen, 2005; Chen *et al*. 2009; Neto *et al*., 2010, Short *et al*. 2011). It is important to note that during the measurements, different operational equipment, including alarms, monitors, ventilators, infusion pumps and nebulizers were operating. According to Pugh (2007), some of the specified equipment, such as the alarms of the monitors can reach sound pressure levels of 79 dB (A) at ICU. The conversation between the health professionals team at ICU was also identified as a possible source of noise and interferes with the results. Comparing the results, it was found that the morning L_{Aeq} dB (A) values were higher than the afternoon ones, which may be related to the fact that during this period, medical examinations and hygiene of patients were more intense.

Figure 2 presents the results for the $L_{EX,\,8h}$ dB (A) and $L_{C,peak}$ dB (C) values, which were analysed by applying the EWA methodology.

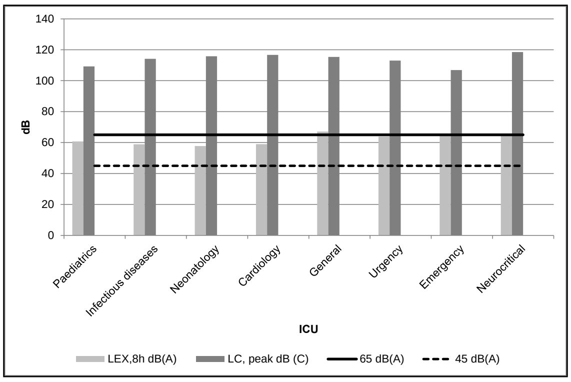

Figure 2: Values of $L_{EX,\,8h}$ dB (A) and $L_{C,peak}$ dB (C) obtained from the ICU

As mentioned above, the Decree-Law No. 182/2006 of 6 September, which establishes the limits for daily personal exposure to noise, is not suitable for the hospital environment. In fact, the results presented in Figure 2 revealed that none of the ICU had noise values above the action levels recommended by Portuguese law. The $L_{EX,\,8h}$ values obtained ranged between 57.8 dB (A) and 67.1 dB (A). The $L_{C,peak}$ values ranged between 106.5 dB (C) and 118,5 dB (C). These values are considered high, taking into consideration the requirements for the hospital environment. However, as Ryerd *et al.* (2007) report, these values are relative to isolated events and would require a deeper analysis of the distribution of these values over a working day or a week.

The work at ICU requires high concentration, given the responsibility that the health professional have in treating patients and, in most cases, save their lives. Thus, regarding the application of the EWA methodology adapted by Miguel *et al.* (2010), the type of work in these units was classified as "work that requires concentration" (Table 4). Thus, taking into account the values obtained from $L_{EX,\,8h}$, it was assigned to all ICU risk level 2 ($L_{EX,\,8h}$ ranging from 45dB (A) to 65 dB (A)), except for the ICU General, to which the risk level 3 ($L_{EX,\,8h}$ > 65 dB (a)) was assigned. During the measurements, the ICU General had a total occupancy of beds, which was not observed in the remaining units.

The intervention priorities indicate that it is necessary to implement corrective actions in the short term, and in the specific case of the ICU General those actions should be immediate. According to the literature review carried out by Ulrich and Zimring (2004), environmental or structural interventions have better results in reducing noise levels than interventions on occupants' behaviour. However, environmental or structural interventions involve, in most cases, high economic costs, which make difficult their implementation. Nevertheless, some corrective actions may be indicated:

- Changing acoustic conditions through the application of sound absorption panels on walls, ceilings and floors, improve speech intelligibility and reduce the reverberation time (Hagerman *et al*. 2005; Hignett and Lu, 2010);
- Create single rooms, in order to reduce the number of people present in the units and reduce the noise levels produced by conversation (Bailey and Timmons, 2005).

The creation of educational programs to raise the awareness among the professionals about the noise problem in hospitals and its impact on health and well-being of occupants seems to be crucial for the behavioural change. For equipment, it would be important to reduce the volume of alarms ensuring that they are disabled as soon as possible.

3.2. Analysis of questionnaire administration

In the present study included 33 valid questionnaires which responded mostly women (88%) aged between 26 and 31 years. The men who responded to the questionnaire represent only 12% aged between 28 and 46 years. The questionnaire was answered by twenty-three nurses, four doctors and six operational assistants. Figures 3 and 4 shows the responses obtained for the question "How do you rate the noise in your workplace?" and the statement "In relation to noise, think that this environment is ..." respectively.

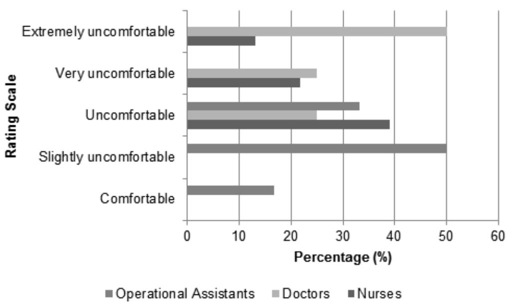

Figure 3: Classification of the work environment

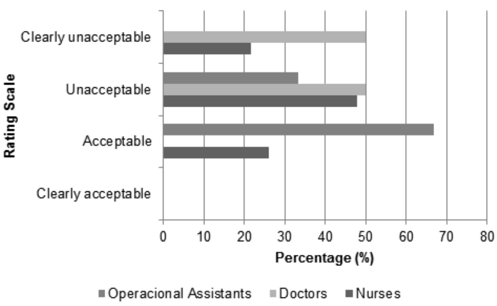

Figure 4: Perception of comfort in the workplace

As the Figure 3 shows, for the question "How do you rate the noise in your workplace?", 26.1% of nurses rated the noise as "Acceptable" on their workplace, 47.8 % as "unacceptable" and 21.7% as "clearly unacceptable". For the doctors, 50% rated the noise in their work environment as "unacceptable" and 50% as "clearly unacceptable". A percentage of 66.7% of operational assistants considered noise "Acceptable" and 33.3% considered it "unacceptable" in the workplace. None of the respondents rated the work environment as "clearly acceptable". The perception of comfort in relation to the work environment was assessed using the statement "In relation to noise, you think that this environment is ...” The Figure 4 shows that, in general, the nurses considered the work environment "Uncomfortable" (39.1%), doctors considered it "extremely uncomfortable" (50%) and operational assistants perceiving it as "slightly uncomfortable" (50%). These results demonstrated that, in fact, noise is identified by professionals as a disturbing agent and had a negative impact on the environment. The same was found in a study by Gurs and Carayon (2009) about barriers to work performance in ICU. This study showed that nurses indicate noise, overcrowding and lack of space in the ICU as the main obstacles to work performance.
Figure 5 presents the sources of noise that most disturb the health professionals in the ICU.

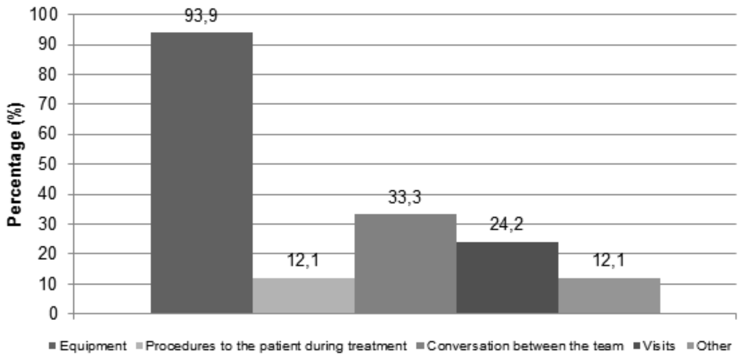

Figure 5: Sources of noise identified by health professionals

Figure 5 shows that 93.9% of health professionals reported that "equipment" are one of the most annoying noise sources. The "Conversation between the team" was reported by 33.3% of professionals and "visits" by 24.2%.
It is emphasised that the professionals have identified other sources of noise (12.1%), for example, the large number of other health professionals who undertake medical services at ICU. These results are similar to those obtained by Ryerd *et al*. (2007), where the alarms were identified as the main cause of negative reactions by nurses and their replacement by visual alarms was indicated as a viable solution.
For the question "In what shift, noise can cause greater discomfort?" it was found that the majority of respondents (90.1%) considered the morning shift as the most uncomfortable. These results are consistent with the L_{Aeq} dB (A) values obtained, because during the morning noise levels were higher than in the afternoon.

4. CONCLUSIONS

The noise in ICU is recognised by many researchers as an agent with negative implications on health and well-being of patients and health professionals. The results of this study showed that none of the ICU complies with the L_{Aeq} dB (A) values recommended by international organisations. The main noise sources identified were the alarms of the monitors and also the conversation between the health professionals’ teams. In addition, the layout and acoustics of these units are not adequate, which also promotes the increase of noise levels. The application of EWA methodology adapted by Miguel *et al*. (2010) represented a gain, given the absence of national guidelines for occupational exposure to noise in a hospital environment, to prioritise the intervention, taking into account the type of work. The application of questionnaires demonstrated that health professionals perceive the noise as a disturbing agent in workplace. The combination of environmental and structural interventions and the creation of educational programs would substantially improve the working environment of health care professionals in these units. However, due to the high costs associated with these interventions and taking into account the main noise sources identified, it would be essential to raise awareness among health professionals. As future work it is proposed to extend the study to more ICU located in different hospitals at national level in order to develop methodologies for control of this agent in a hospital environment.

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Use of Geoestatistics for Spatial Characterization of Thermal and Acoustic Environment for Building Sheds in Broilers

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ABSTRACT

The workers in the poultry sector are exposed to a number of risk factors in the execution of their activities, including exposure to dust, harmful gases, excessive noise and heat stress, and is subject to biological, chemical, physical, mechanical ergonomic, social and accidents. This research aimed to evaluate the environmental variables and specialize, air temperature, relative humidity and noise level inside a warehouse business with tunnel ventilation system equipped with negative pressure exhaust fans and evaporative cooling, for the production of chickens for court. Despite the high level of technology used in this production system, including automated control of environmental variables, the action is still irreplaceable the worker performing tasks inside the shed, such as the removal of dead birds and conducting preventive maintenance and corrective in drinkers, feeders and automatic misting system. Maps of spatial distribution of the aforementioned environmental variables were generated inside the shed, using the method of kriging. Based on the results, it can be concluded that workers in general, were not subjected to unhealthy environmental conditions even in the hottest times of day. The spatial distribution of variables related to the production environment provides to obtain more detailed information about the studied system.

Keywords: Poultry, Production, Distribution Space.

1. INTRODUCTION

The importance of research that seek optimization and adaptation to environmental well-being and comfort of workers involved in the authoring environment and poultry production has been discussed over time, however the interaction of various environmental factors, such as thermal factors and the level of noise to which these workers have been exposed, have not been thoroughly evaluated.

According to Santos et al. (2010), the Brazilian poultry industry is an important activity for agribusiness in the country and, although the use of technology in this activity involves the replacement of human labor by automating tasks, the use of human labor is still significant.

The poultry industry has been considered one of the most important and efficient activities of Brazilian agriculture, leading Brazil to assume, since 2004, as the largest exporter of chicken meat, and finished 2009 with a mark of 3.6 million tons shipped to more than 150 countries. As for chicken production, Brazil is currently the second position with a production of 10,900 tons. Generating more than 4.5 million direct and indirect employments and responding to 1.5% of GDP-Gross Domestic Product (UBA, 2010).

According to Carvalho (2009) Brazil's poultry plants have generally low thermal insulation, especially in coverage, and natural ventilation is still the most commonly used to minimize high temperatures in aviaries, although this research has been done to tunnel type sheds with negative pressure, using exhaust fans.

The configuration of the building causes the internal environmental conditions become very vulnerable to external variations in temperature. In addition, workers are exposed to problems stemming from dust, gases and physical overload coming from the various work activities. These problems can be reduced or even eliminated from the application of good ergonomics and safety, which has contributed notably through interventions and projects to improve, in an integrated safety, comfort, welfare and effectiveness of human activities in the urban sector, and may be extended to the rural sector, even this sector significantly different in character, such as workers' education levels, socioeconomic, cultural, and anthropological (Alencar et al, 2006).

In the industrial production systems are more rigid and the jobs are more defined. In contrast, the traditional agricultural labor workers are not employed in a specific task or set forth precisely the worker performs several tasks, and must organize their time so that at achieving all of themThe Brazilian agricultural activity has a large number of accidents due to lack of information and risk perception by employees and employers, and a less accurate registration system of rural accidents (Carvalho et al., 2008).

The poultry industry in southern Brazil has been a constant theme of research in the areas of Ergonomics, Health and Safety at Work, however, few studies in this area have been directed to the poultry industry in the Northeast. For this type of activity there are regional factors that differentiate by region, for example, climatic, technological and organizational.

Although there are these differentiating factors it appears that implementation of this activity whatever the region, have in the supply chain aspects related to ergonomics and hygiene, health and safety that need to be improved. The workers in the poultry sector are exposed to a number of risk factors in the execution of their tasks.

A concept well explored in poultry, and other animal production systems, is that in the absence of comfort and well being, the animal does not produce consistent with its potential. This concept should also be widely used for humans. Since worker productivity is directly related to farm productivity and profit of the producer.

The workers in the poultry sector in any region is exposed to a number of risk factors in the execution of their activities, including exposure to dust, harmful gases, excessive noise and heat stress, and is subject to biological, chemical, physical, mechanical, ergonomic, social and accidents. In the Agreste region of Paraíba, Northeast Brazil, where human activity is still present in some tasks due to the level of technology prevalent in some building sheds for broiler, it is estimated that these risks are higher and exert influence on the welfare of workers, affecting productivity through increased absenteeism and lack of motivation to perform tasks.

Therefore, it is very important to qualify and quantify this environment of worker exposure to risks, better understanding the relationship between the types of facilities, the level of technology adopted and the inadequate conditions in conjunction with inappropriate acts, present in various positions of work. The spatial distribution of environmental variables enables thermal and acoustic understand the relationship between these factors of production environment and its spatial variation (Tadayuki et al., 2011).

Geostatistic is a statistical tool that allows the interpretation of results based on the structure of their natural variability. In the case of natural phenomena should check the spatial dependence of the variable under study, before the choice of statistical methods of data analysis (Miragliotta, 2006).

By the above, this article aims to evaluate the specialization of thermal and acoustic variables in a shed for the production of commercial broilers.

The research aims to contribute to the strengthening of the scenario of occupational hygiene, safety and health of workers in the poultry production sector, ensuring the efficiency of individuals, preventing them from occupational diseases, environmental comfort and evaluating the risks inherent in the creative industry of broilers, by proposing improvements in working conditions.

2. MATERIALS AND METHOD

The experiment was conducted in a commercial farm for broilers in the municipality of Guarabira - PB, Brazil, located at latitude 06 ° 54'07 .5 "S and longitude 035 ° 27'02 .6".

Data collection was made during the period 08 October and November 20, 2010, The Shed, oriented east-west, illustrated in your outdoor area in Figure 1 (a) and on the north side (b) has 150 m long, 15 m wide, 3.45 m -ceilinged, tiled roof of fibro cement, chicken litter of sugar cane bagasse, side curtains and liners yellow plastic tarp, as can be seen in the image of its 3D model in Figure 2.

The system Cooling thermal design environment used is the negative pressure tunnel type, with side curtains open until the 12th day of life of birds and closed the 13th through the end of the lot, approximately 42 days.

The ventilation system consists of hoods 10, 08 being on the west face of the shed, associated with a misting system.

The variables that make up the thermal environment, air temperature, Tar (°C), relative humidity, RH (%) were collected simultaneously through Psychrometer-anemometer portable instrument manufacturer's AN-4870 ICEL, illustrated in Figure 3 (a), with its technical specifications shown in Table 1, as well as the noise level (dB) was collected by using a decibel meter Thermo-Hygro-light meter,portable, model maker Instrutherm THDL-400, illustrated in Figure 3 (b), whose technical characteristics are shown in Table 2.

Measurements were made inside the shed three times a week on alternate days for a complete batch, in others words, for 42 days in the period of greatest heat stress, from 12 to 16 h at 100 points allocated inside the shed, and 1.0 m height from the floor, equivalent to the center of mass of the worker, except for the noise, which was collected at the time of the worker's hearing center, approximately 1.5 m above the floor.

Figure 1-Exterior of the house to create commercial broilers (a) North Face side of the shed (b)

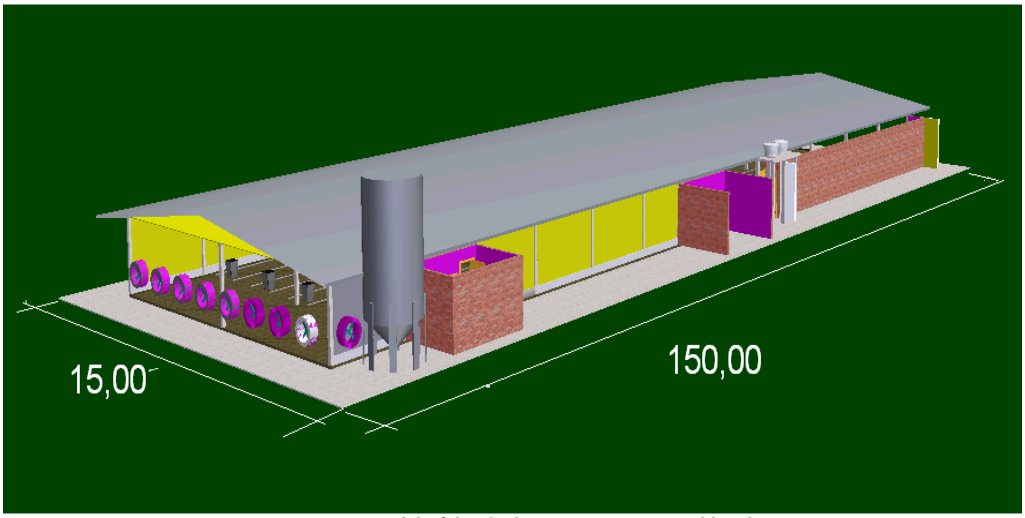

Figure 2 - 3D model of the shed to create commercial broilers

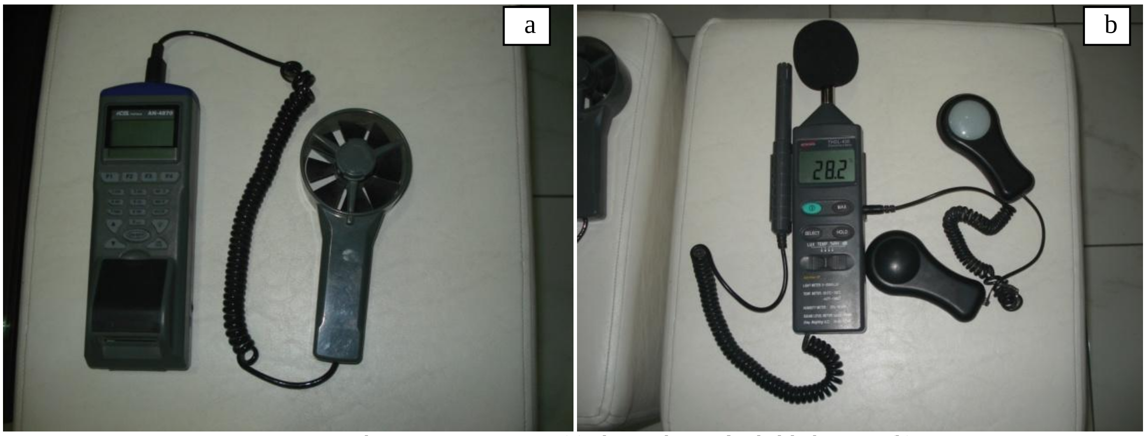

Figure 3 - Psychrometer-anemometer (a) Thermo-hygro-decibel-light meter (b)

Table 1 - Specifications of portable anemometer Psychrometer-AN-4870 ICEL Manufacturer

Values	Range	Resolution	Accuracy
Temperature (°C)	0 a 70	0,1	±0,6
Relative Humidity (%)	0 a 100	0,1	±3,0
Air Velocity (m/s)	0 a 35	0,1	±3,0

Table 2 - Technical Specifications of the Thermo-hygro-decibel-THDL-400 lux meter manufacturer Instrutherm

Values	Range	Resolution	Accuracy
Sound pressure dB(A)	35 – 130	0,1	±3,5
brightness (Lux)	0-20.000	0,1	±5,0

In the figure 4 can be seen the points of measurements inside the shed, which were collected with a distribution of a regular or homogeneous, and the spacing of 3.75 m across the width and 7.89 m along its length.

Data were collected systematically moving to head west to the east, as opposed to air flow through the ventilation system during the period specified. After positioning at each point 10 s were expected to stabilize the movements of birds and made the simultaneous collection of Tar (° C), RH (%) and noise (dB).

Geostatistics was used to construct maps of spatial distribution of variables, from which it viewed the positions that are experiencing the most difficult conditions of the worker to remain inside the shed, depending on the thermal stress occurred.

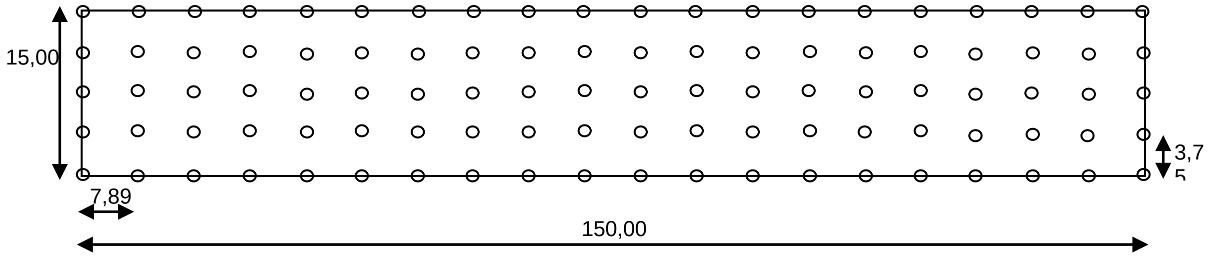

Figure 4 - Points of collection of environmental variables inside the shed, magnitudes in meters

To describe the environmental variables, Tar (°C), RH (%) and noise level (dB) was used geostatistics, a technique based on the theory of regionalized variables (Goovaerts, 2001).

The spatial dependence was analyzed by semi-variogram settings (VIEIRA, 2000), based on the assumption of stationarity (intrinsic hypothesis), which is estimated by equation 01:

$$\mathrm{Y(h)} = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} [z(xi) - z(xi + h)]^2 \qquad \text{Eq.01}$$

Where: N (h) - number of experimental data pairs separated by a distance h;
Z (xi) - value determined at each read point,
Z (xi + h) - measured value at a point, over a distance h.

Thus, the coefficients of the theoretical model for semivariogram(nugget effect, C0; level, C0 + C1; range, A).

Were tested semivariagramas type spherical, exponential, linear, linear and Gaussian level (Souza et al., 2004), adjusted by the program GS +.

The choice of mathematical models was performed by observing the correlation coefficient obtained by cross-validation technique. This technique consists in removing individually each measured point of the study area, its value is estimated via kriging as though it never existed.

Later, using the program SURFER, such models were used to obtain maps of kriging, spatial inference method which estimates unsampled data points from the sampled points.

Statistical analysis was performed using the comparative study of the means (Tukey test, p-value ≤ 0.05) values of environmental variables measured by handheld devices, the points collected.

To compose the distribution map of the hypothetical behavior of the variables for the same time, since the samples could only be performed sequentially, we used the averages of each variable in the critical period from 12:00 to 16:00 h.

The mean value found for Tar (°C) was adopted as the initial value found in the most critical in the distribution map of Tar differences (°C).

And from this point, we traced the Tar (°C) of contiguous positions, calculated by numerical differences, resulting in a hypothetical distribution map of Tar (°C). The same was done for RH (%) and noise (dB).

3. RESULTS AND DISCUSSION

In Figure 5, can be seen the distribution of temperature or the air inside the shed. There is a temperature range of approximately 6 ° C, with a lower temperature in the back of the shed located on the east side, just at the entrance of air, by the panel of evaporative cooling systems.

The maximum temperatures observed are considered unhealthy for the NR-15.

On average, the RH values remained within the range considered to be of comfort to workers who are exercising management activities within the shed, between 70 and 80%, as can be seen in Figure 6, which not characterized as unhealthy environment, according to Standard NR-15 which deals with "Unhealthy Activities and Operations."

However, minimum and maximum values indicated that, at certain times of day and in certain parts of the shed, RH levels were observed above and below the range of comfort with respect to the external environment, it is observed that the RH had values below the median the installation.

In turn, the median values were 68.7 dBA noise, and externally to the shed of 64.2 dBA, as can be seen in Figure 7. Being the highest values found closer to the fans.

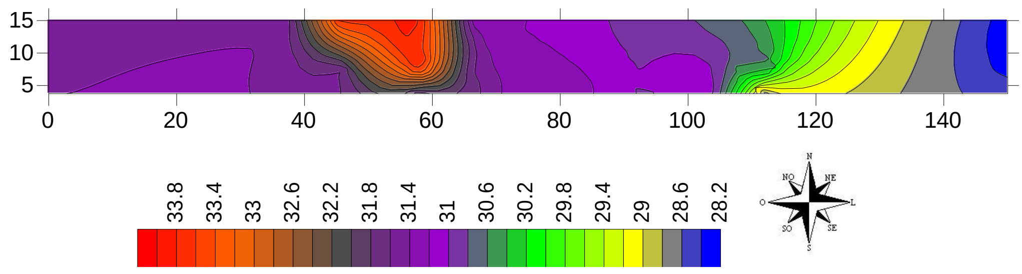

Figure 5 - Spatial distribution of the variable air temperature, Tar (°C) within a commercial warehouse production of broilers

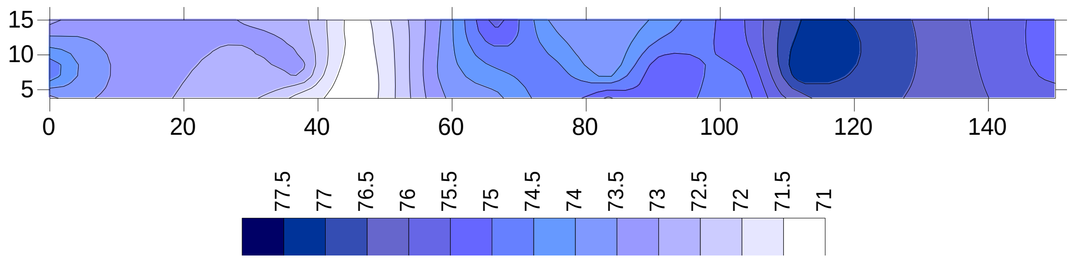

Figure 6 - Spatial distribution of the variable relative humidity, RH (%) within a commercial warehouse production of broilers

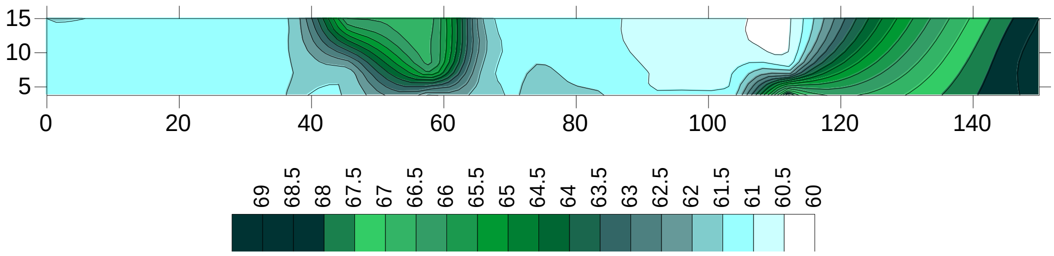

Figure 7 - Spatial distribution of the variable noise (dB) within a commercial warehouse production of broilers

4. CONCLUSIONS

Even in the hottest times of day, between 12 and 16h, and especially close to 14h, there was that much of the shed was in a state of thermal comfort, with no need to use cooling device, since RH is comfortable with values, according to NR 15. Although some results indicate that there is no spatial dependence, we chose to generate the maps in order to better visualize the environmental condition during the activities performed inside the shed in the production, which can be seen in some time, workers were subject to homogeneous environmental conditions.

5. ACKNOWLEDGMENTS

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Use of ICT on Offices: Impact on Task Characteristics and Workers' Health

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ABSTRACT
This article presents the results of a study on the working conditions of 50 office workers, in the Municipal Water and Sanitation (SMAS) from Oeiras and Amadora. The aim of this study was to analyze the working conditions of these professionals and relates them with musculoskeletal, visual and psychosocial complaints.
Through observations and interviews, we collected information on working conditions and the nature of the complaints reported by the workers. We made a descriptive analysis of the characteristics of equipment, identified constraints and complaints (relative and absolute frequencies). Later we used the chi-square (χ2) to determine statistically significant associations between constraints and / or characteristics of the work equipment and the complaints.
In a musculoskeletal level we observed significant associations between the location of the work equipment (eg screen), the adoption of awkward posture and musculoskeletal complaints. It was also found associations with organizational constraints such as workers perception of their work and breaks.
In a visual level, it was found that the equipment height such as keyboard, mouse and screen show significant associations with complaints such as eyestrain, irritability and red eyes. We still find an association between repetitive work and fatigue which highlight the importance of breaks to reduce the incidence of musculoskeletal and visual complaints.
Finally, in a psychosocial level, there were associations between organizational constraints such as repetitive work and not be able to choose times for pauses with complaints such as stress, dissatisfaction and difficulty falling asleep.
The results show that there are several significant associations between working conditions in an office environment and health complaints, thus highlighting the importance of the working analysis to protect the health and safety of workers. Given these results, it is possible to define strategies in order to intervene at an early stage of pathologies, thus preventing their occurrence.

Keywords: Office workers; Information and Comunication Technologies ; Health Symptoms; Occupational Risk Factors.

1. INTRODUCTION

The improvement of working conditions turns out to be an increasingly important issue. The introduction of Information and Communication Technologies (ICT) has introduced significant changes in working methods, including the possibility to perform many tasks quickly and easily, collecting and sharing information beyond time and space barriers, among others. However, we have also witnessed the development of new constraints that jeopardize the health and safety of workers. The ergonomic approach allows the analysis and evaluation of these new forms of work by identifying and reducing / eliminating the hazards and risks. Thus, it is intended to avoid consequences for the health and safety of workers and enhance their efficiency.
This article aims to present results of the analysis to different situations of administrative work with use of computer (white-collar workers) and seeks to highlight the relationship between complaints (musculoskeletal, visual and psychosocial) reported by the operators and working conditions (materials, lighting and organizational). The study was conducted in Municipal Water and Sanitation (SMAS) from Oeiras and Amadora.

2. METHODOLOGY

It was analyzed 18 workplaces located in different facilities of SMAS. The target population (n = 50) was composed by 29 employees of the female gender (58%) and 21 males (42%), with an average age of 41.32 ± 10.0 years old and in the function of 8.4 ± 8.2 years. This employes carry out its activity in the office environment, using the computer.
In order to do a screening of risk factors to which these workers are exposed, we used the results of INSAT survey (Barros-Duarte & Cunha, 2010), applied to SMAS workers (n = 351) in 2010. After that, we carried out observations of work activities and registered workers verbalizations. To assess the mechanical exposure related to upper-limbs we applied the method RULA (McAtamney & Corlett, 1993). We considered three postures, "interacting with the keyboard”," interacting with the mouse" and "reading paper documents". We carried out further evaluation of environmental parameters (lighting) with a digital light meter, model LX-1010B. Finally, we performed a descriptive statistical analysis (absolute and relative frequencies) of the data collected (characteristics of equipment, identified constraints and complaints) and applied the chi-square test (χ^2) to determine statistically significant associations between constraints and / or characteristics of the work equipment and the complaints. In this study, we have the health complaints (musculoskeletal, visual and psychosocial) as dependent variables, and the constraints and characteristics of equipment as independent variables.

3. PREVIOUS SCREENING OF RISK FACTORS

The results of INSAT showed that white-collar workers, given the nature of their activity, are exposed to various constraints including long-time sitting (66.1%), perform repetitive movements, especially at the upper limb (41.1%), adopting awkward postures (20.8%) and working permanently in the computer (79.7%). Exposure to these and other constraints, leads some workers considering their work monotonous (16.7%). However, this view is not widespread, as 82.8% consider their work varied and 60.4% creative. The fact of doing several things at once (71.9%) and having to rush (62.5%) reveals the process of subjection to an intensification of work. For this intensification contributes also the dependence on colleagues (27.6%) and direct requests of customers (33.9%). These results suggested a more detailed work analysis around three axes: (1) the analysis of musculoskeletal complaints related to prolonged sitting posture and performing repetitive movements derived from the need of using computer, (2) the analysis of visual complaints related with environmental conditions (lighting) and frequent use of the computer, and (3) the analysis of psychosocial complaints related to the work organization in an office environment.

4. RISK FACTORS AND COMPLAINTS RELATED TO WORK

4.1. Musculoskeletal complaints, interaction with work equipment and workstation disposition

During the analysis *in loco* we realized a registration of health symptoms reported by workers. At musculoskeletal level were recorded 140 complaints, being the cervical spine (27.9%), shoulder (19.3%) and lumbar spine (15%) the most affected regions.

Through field observations, was observed the adoption of awkward postures at these and other body parts. As such, we proceeded to the application of RULA in order to evaluate postures in tree actions often realized by workers "interact with the keyboard" "interact with the mouse" (taking into account that 88% of workers referred work with computer as the most commonly performed task) and "read paper documents" (considered by 56% of workers as the second most commonly performed task). The results reveal that there is no value within the range considered "acceptable", with the intervals "further investigation" and "investigate further and change soon" covering the largest percentage of results. In the interaction with the keyboard, 70% of workers had values in the range 3 or 4 (investigate further), 24% in the range of 5 or 6 (investigate further and change soon) and 6% of workers obtained the maximum value, 7 - investigate and change immediately. In the interaction with the mouse 58% of workers had values in the range 3 and 4, 34% between 5 and 6, and 8% of workers have obtained the maximum value. For the reading of paper documents, to 61.1% of workers were obtained values between 3 and 4, for the remaining 38.9% values of 5 and 6. These results show that the postures adopted by workers in the most frequently performed tasks are not appropriate, which can explain the complaints presented in chart 1.

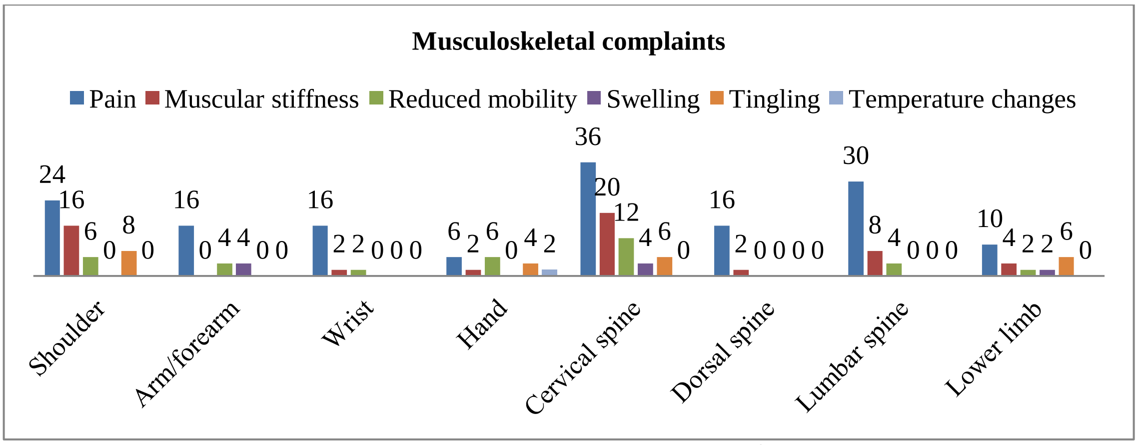

Chart 1 – Musculoskeletal complaints (n=50) (relative frequencies)

At cervical spine level the most referred symptoms are pain (36%), muscle stiffness (20%) and reduced mobility (12%). For the shoulder, the workers have a higher percentage of complaints of pain (24%), muscle stiffness (16%) and tingling (8%) in the case of the lumbar spine it was pain (30%), muscle stiffness (8%) and reduced mobility (4%).

The adoption of awkward posture may be due to several factors such as the inadequacy of equipment, lack of equipment, lack of information, among others. Through observation it was found that the adoption of awkward postures when interacting with certain equipment was associated with their features and / or disposal.

We found that 36% of the display screens do not allow height adjustment, which limits the possibility of adjusting the height to fit the workers needs. Of the 50 workers, only 18% had the screen at the recommended height – equal to or slightly below eye level (Occupation Safety and Health Administration, 2009; Durante, Filacchione & Gullo, 2006; Worksafe, 2010; European Agency for Safety and Health at Work, 2007). In turn, 26% of workers do not have the screen in front as recommended (Occupational Health Clinics for Ontario Workers Inc., 2008, Durante, Filacchione & Gullo,

2006; WorkSafe, 2010), which leads the worker to perform the rotation of the head - to view information on the screen. In addition, the screen location in relation to light sources at 68% of the cases is not adequate (perpendicular to the light sources) (Portaria nº. 989/93 de 6 de Outubro, European Agency for Safety and Health at Work, 2007), that contributes to the occurrence of reflections on the screen which in turn can lead to the adoption of awkward postures in order to view the information on the screen (Chandra et al., 2009). The results obtained in the chi-square agree with the ones mentioned before. We found statistically significant association ($p \leq .005$) between the location of the screen against the light sources and stiffness and swelling in the cervical spine (respectively, $\chi 2$ = 4,503, p =. 034 and $\chi 2$ = 4,427, p =. 035), between (non)existence of reflections on the screen and stiffness ($\chi 2$ = 8,257, p =. 004) and reduced mobility ($\chi 2$ = 8,257, p =. 004) and between the screen height and stiffness ($\chi 2$ = 5,357, p =. 021).
In turn, some features of the chair itself can be related to the complaints referred in the cervical spine. The lack of lumbar support or support for the arms can contribute to the adoption of awkward posture due to lack of support in the spine and upper limbs, causing the worker to support the forearms and / or wrists on the work surface flexing the spine. In the chi-square were obtained associations between the (non) existence of support for the lumbar spine and stiffness in the cervical spine ($\chi 2$ = 3,926, p =. 048) and height adjustment of the armrests support with reduced mobility (respectively, $\chi 2$ = 8,442, p =. 004 and $\chi 2$ = 12,121, p =. 000). It should be noted that organizational constraints such as the workers perception of their work and breaks during work were also associated with cervical complaints. Psychologically demanding work was associated with pain in the cervical spine ($\chi 2$ = 4,432, p =. 035) and breaks throughout the workday with muscle stiffness, swelling and reduced mobility (respectively, $\chi 2$ = 4,633, p = .031, $\chi 2$ = 6,805, p =. 009 and $\chi 2$ = 6,657, p =. 010). For breaks, it was found that only 2% of workers perform regular breaks, which may prevent the worker recovery, thus contributing to the occurrence of complaints. On the other hand, the workers perception about their work and their skills, compared to the demands of this activity, can lead to an accumulation of tension, in turn contributing to complaints in the cervical spine. These results emphasize the interaction of different kinds of hazards that may contribute to the occurrence of these complaints.
At shoulder level, awkward posture were observed mainly in the range of certain equipment, such as the button to change the costumers number, since, contrary to what is referred to by some authors (During, Filacchione & Gullo, 2006), the equipment that is used often is not an easy reach away, forcing the worker to adopt awkward postures in order to interact with it. By chi-square was obtained association between able (or not) to easily access the equipment workers need and shoulder pain ($\chi 2$ = 8,134, p =. 004). In turn, the fact that 60% of the seats have no armrests adjustable in height, makes it difficult to fit the same workers, so there is support in the arms for example for workers 5 and 95 percentile, which may contribute for the occurrence of complaints at the shoulder. The (in) existence of armrests adjustable in height was significantly associated with reduced mobility in the shoulder ($\chi 2$ = 5,764, p =. 017). From the comments it was found that only 14% of workers change the hand that uses the mouse. The performance of repetitive movements involving the upper limb, associated with the adoption of awkward posture at the same level and overload of upper limb dominant since the majority of workers does not change the hand that uses the mouse, may explain the occurrence of symptoms at shoulder level. We found a significant association of the hand on the switch that uses the mouse and stiffness in the shoulder ($\chi 2$ = 4,368, p =. 037) that can be related to the pressure on the use of a mouse (Chandra et al., 2009). As has been demonstrated earlier, some organizational constraints mainly related breaks, may contribute to the occurrence of complaints due to the fact that in most cases, regular breaks are not made. This constraint was associated with shoulder pain ($\chi 2$ = 5,852, p =. 016) and mobility ($\chi 2$ = 10,106, p =. 001).
Similar to what occurred to the cervical spine, the adoption of awkward postures at lumbar spine appears to be related to the location of certain equipment such as display screen, keyboard and mouse. 52% of workers have a chair with lumbar support which helps maintain the natural curvature of the lumbar spine. However, only 22% of the supports are adjustable in height which limits the ability to adapt to the workers needs, which may not have the desired effect or may even contribute to the complaints at the lumbar spine. Using the chi-square, we obtained association between (non)existence of lumbar support and pain and in the same region (χ^2 = 6.731; p=.009).
The location of the screen against the light sources and therefore the existence of reflexes, can lead in some cases to awkward postures in order to be able to view the information provided on the screen (Marmaras & Nathanael, 2006 *in* Margaritis & Marmaras, 2007), which can contribute to the reference to complaints in the spine. Using the chi-square associations were found between these issues and reduced mobility in the lumbar spine (both $\chi 2$ = 4,427, p =. 035) and also between the location of the screen against the employee and the same complaint ($\chi 2$ = 5,929; p =. 015), which may be related to the rotation not only at the cervical spine but also at the lumbar spine to face the screen. It was also found that 86% of workers have the work surface above the recommended height – equal to or slightly below elbow height in a sitting position (WorkSafe, 2010), which causes the workers to perform a spinal flexion. Whereas only 2% of workers held regular breaks and that this is a repetitive activity, there is the possibility of complaints to the lumbar spine. Answers to the question considers the repetitive work, correlates with the stiffness of the lumbar spine ($\chi 2$ = 7,729, p =. 005). In turn, the height of work surface, keyboard and mouse are associated with reduced mobility (respectively, $\chi 2$ = 12,798, p =. 000, $\chi 2$ = 12,798, p =. 000 and $\chi 2$ = 10,938, p =. 001).
In summary, the results show that white-collar workers are exposed to constraints that may contribute to the development of the musculoskeletal complaints mentioned above.

4.2. Visual complaints, lighting conditions and workstation disposition
It was reported 104 visual complaints, whose distribution can be seen in chart 2

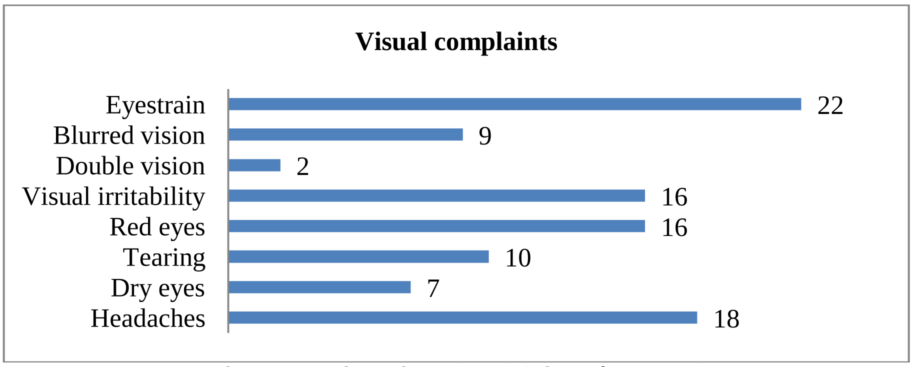

Chart 2 - Visual complaints (n=50) (relative frequencies)

The most frequently visual complaints are eyestrain (22.1%), headache (18.3%), irritability (burning eyes) and red eyes, (both with 16.3%).
According to Veitch (2008 *in* Pais, 2011), lighting conditions affect workers perception and feeling of visual discomfort, expressed through signs and symptoms of eyestrain, blurred vision, irritability, headache, muscle pain, stress and concentration problems. Taking into account the lighting conditions, the location of the workstation and screen, the existence of glare on the screen or directly on worker may contribute to the onset of health symptoms not only visual but also physical and psychosocial it was characterized the existing lighting conditions and the location of workstations and display screen.
With regard to lighting conditions, we carried out three measurements of illuminance conditions in each workplace (approximately at the beginning, middle and end of the workday). In these measurements, more than half of workstations had lower levels than the recommended (between 500 and 750 lux) in accordance with the standard ISO8995: 2002 (*in* Pais, 2011). However, the chi-square did not detect any association between levels of lighting and visual complaints.
In terms of the location of workstations and display screens, we found that in 68% of cases, the screen is not perpendicular to the light sources, as recommended (Portaria nº. 989/93 de 6 de Outubro European Agency for Safety and Health at Work, 2007), of which 29.4% are not perpendicular to the sources of natural light, 26.5% to artificial lighting sources and 44.1% to both (placed diagonally). These results are also related to the fact that, in many work situations, the artificial lighting sources (lamps) are not parallel to the sources of natural light (windows). The inadequate location of workstations and therefore the screens, contributes to the occurrence of glare (Portaria nº. 989/93 de 6 de Outubro) making it difficult to visualize information presented on the screen and as mentioned in the preceding paragraph, may have consequences also at musculoskeletal level. But, as has happened in relation to levels of illuminance, was not found any association between the location of the screen and health symptoms to eye level.
It was at the height of work surface, mouse and keyboard, and features of the chair (non)existence of accessories that found associations with visual complaints. Associations were obtained between the height of the work surface, keyboard and mouse and irritability and red eyes (both values equal, respectively, $\chi2$ = 4,193, p =. 004 for the work surface and mouse, and $\chi2$ = 4,906; p =. 027 for the keyboard). The keyboard height was also associated with eyestrain ($\chi2$ = 4,303, p =. 038). Based on observations, these associations may be related to the fact that workers reduce the height of the chair to support their feet on the ground (18% of workers have support for the feet but is required for more than 40%), and so the work surface was above the recommended height (equal to or slightly below elbow height - WorkSafeNB, 2010), thus compromising the distance and / or angle of vision, thus contributing to an increase in eye strain that can lead to the complaints reported. Note that association was found between the (non)existence of footrest and fatigue that comes back to what was stated above. As stated in the previous section, some characteristics of the seats can compromise the posture taken by the employee (e.g., bending of the spine). Thus, similarly to what was said at the height of work surface, keyboard and mouse, the posture taken may compromise distance and / or angle of view of work and consequently lead to visual complaints. These possible relationships were analyzed and using the chi-square, we obtained association between the regulation of backrest inclination and fatigue ($\chi2$ = 4,056, p =. 044), headache ($\chi2$ = 3,934, p = .047), irritability and red eyes (both $\chi2$ = 5,520, p =. 019). We also observed significant associations between the (non) existence of support for the dorsal spine and irritability and red eyes (both $\chi2$ = 7,219, p =. 007) and with the headaches ($\chi2$ = 5,433, p = .022). In turn, the support for the lumbar spine correlates with the headaches ($\chi2$ = 8,916, p =. 003) and height regulation of this support with visual fatigue ($\chi2$ = 3,939, p =. 047) and irritability ($\chi2$ = 6,003, p =. 014). Finally, it was determined a significant association between repetitive work and fatigue ($\chi2$ = 6,402, p =. 011), which underlines the importance of conducting breaks to reduce the risk not only in a musculoskeletal level but also visual.
In summary, these results highlight the importance not only of the relationship between the location of lighting systems and the workstation, but also the existence or absence of equipment and the suitability of the same, taking into account the nature of the activity performed.

4.3. Psychosocial complaints and work organization

In a psychosocial level we found 116 complaints, with stress having the highest percentage (23%), followed by anxiety (20%) and mood (17%) (chart 3).

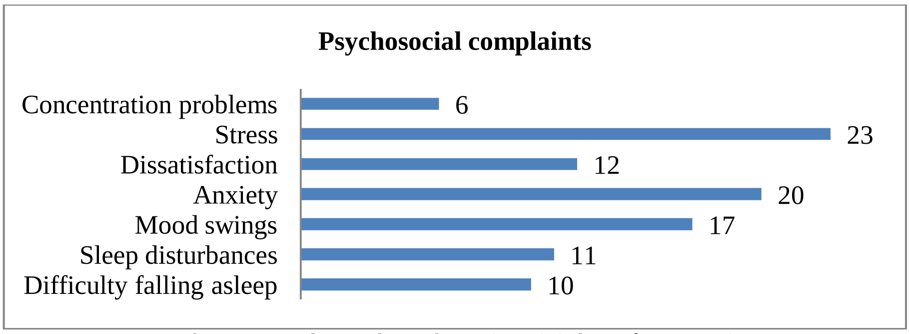

Chart 3 - Pyschosocial complaints (n=50) (relative frequencies)

After analyzing the results obtained in the INSAT on some organizational issues (listed below), it was decided to (re) question these 50 workers, in order to better specify the incidence of these constraints in this particular sample. We found that 72% of workers depend on the work of colleagues, 66% depend on requests from customers, 62% report that they have to rush to do their job and 90% do several things at once. However, 88% of workers said that the goals are reachable, and 66% said that exist balance between human resources and workload, which raises questions as to the origin of this intensification of work. We have also asked the employees about breaks during work and found that although 76% of workers stating that performs breaks throughout the working day (excluding lunch time), but only 2% performs regularly (5 to 7 minutes per hour of work). Still on the breaks, 84% report that can choose the moments to make the breaks, however only 32% were informed about the benefits thereof, which may explain the lack of regular breaks throughout the workday.

The results of the chi-square test show significant associations between organizational constraints and psychosocial complaints. There was an association between repetitive work and stress ($\chi2 = 4{,}836$, p =. 028), dissatisfaction ($\chi2 = 10{,}938$, p =. 001) and difficulty sleeping ($\chi2 = 5{,}246$, p =. 022), which can mean that the worker is bothered with this aspect of the activity, which subsequently has been reported at the night rest. The dependence of the work of colleagues correlates with anxiety ($\chi2 = 5{,}062$, p =. 024), which can be related to the compliance deadlines that can be compromised given depend on other workers. In turn, the data of the question considering the appropriate number of workers was associated with difficulty falling asleep ($\chi2 = 7{,}509$, p =. 006). This may refer again to the concern that labor spreads to the personal lives of workers. The question about worker´s objectives (accessible or not) and the possibility to choose the moments for rest and stress (respectively, $\chi2 = 4{,}537$, p =. 033 and $\chi2 = 4{,}303$, p =. 038), which may relate to the lack of control over their work and the difficulty to cope with the work demands, which some authors have reported to be important aspects for the occurrence of psychosocial problems (Karasek & Theorell, 1990 *in* Duveau & Lanfranchi, 2008).

However, are not only the organizational constraints that are associated with psychosocial complaints. The organization of the work surface and the equipment reach are associated with concentration problems (respectively, $\chi2 = 4{,}368$, p =. 037 and $\chi2 = 5{,}081$, p =. 024). We also determined associations between the adequacy of the software to the task and dissatisfaction ($\chi2 = 8{,}207$, p =. 004) and between the ease of understanding the system feedback information (e.g. error messages) and anxiety ($\chi2 = 6{,}202$, p =. 013), which may underlines the importance of usability of information systems so that workers can conduct their work efficiently without contributing to psychosocial complaints.

In summary, it appears that psychosocial complaints are associated not only with the constraints of this nature, but also have associations with issues concerning the organization of the work surface, reach and usability of systems, which suggests, as previously stated the interaction between different kinds of hazards can be associated with workers complaints at musculoskeletal, visual and psychosocial level.

5.CONCLUSIONS

The introduction of Information and Communication Technologies (ICT) has introduced changes in working methods and consequently the introduction of new hazards and risks to health and safety of workers. As such, it is essential the participation of ergonomics to create workplaces that promote health, safety and efficiency of workers. The analysis *in loco* allowed to observe the existence of different kinds of constraints (environmental, physical, organizational / psychosocial) which, individually or in interaction, may endanger worker´s health and safety and therefore the productivity of SMAS.

With respect to musculoskeletal complaints, it was found that the improper use or lack of certain equipment, can contribute to awkward postures that subsequently lead to the onset of complaints. In visual complaints it was revealed that, despite not having been obtained no significant association between the location of the screen and the lighting conditions, the illuminance values obtained in most workstations is considered out of range (between 500 and 750 lux), which can increase the visual demands on workers and contributing to visual complaints at long term. The existing complaints seem to be related to certain variables such as the height of work surface and (non) existence of dorsal and / or lower back support. These factors compromise the posture taken by the workers and therefore the distance and / or viewing angle. As such, we can have an increase of the visual effort which can contribute to the occurrence of referred complaints.

The complaints about stress, anxiety, mood swings, among others, and the associations found between these complaints and organizational constraints such as to depend on other workers, to choose the moment to make a break, etc., may mean an increased work, which in turn may call into question the quality of life (in and out of SMAS) as well as its productivity.

Above all, the results warn of the association between the characteristics of the physical environment, activity and equipment and the occurrence of musculoskeletal, visual and psychosocial complaints. In addition, the association between certain variables such as the reach of equipment and complaints at musculoskeletal and psychosocial level, or the repeatability associated with visual and psychosocial complaints means that a given constraint may contribute to the occurrence of complaints at different nature, even though at first sight is not readily apparent. Thus, it is possible to predict an interaction between different kinds of hazards, which may increase the risk of musculoskeletal, visual and psychosocial disorders in the office environment. The identification and analysis of these interactions should be investigated by ergonomics to improve the working conditions of these professionals. The registration and monitoring of these and other health symptoms reported by workers are extremely important to allow intervention at an early stage of development of pathologies, in order to prevent their occurrence.

Considering the relevance of their results, the aim now is to devise strategies for intervention to be implemented in every operational situation examined to improving working conditions.

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Ergonomic Work Analysis contributions: observational nursing activity analysis in a hospital ward

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ABSTRACT
Ergonomic work analysis has an increasing use in Hospitals in order to improve the risk assessment process.
The main goal of this kind of assessment is to register and analyse all available data related to the observation of the real worker's activity, making a chronological sequence of sub-activities. It allows identifying the risk factors and the risk issues at the workplaces.
We have used this methodology with a two-folded aim. Firstly, we analysed those chronological nurses' sub-activities and their main risk exposures in a Continuous and Palliative Care Ward (Long-Term Care Department from a Large Hospital).
Secondly, we made an assessment with a widely used instrument (DINO method) to analyze this nurses´ performance on the most dependent patients' transfers.
Doing so, we're able to establish some safety level for both patients and health care professionals and, in some cases finding critical activity situations.
Throughout the analysis of different nurses´ shifts, we found these health care workers spending an impressive amount of their working providing care (52%) in the patient's room. These results are significantly higher than previously published data from other similar studies.
DINO results showed that healthcare professionals carried out the transfers in compliance with safety standard techniques for health care workers, but the real work analysis also shows that some patient transfers (27.8%) did not finish in the best conditions which required patient repositioning without mechanical transfers.
So, some critical aspects need to be addressed in order to elaborate preventive measures to minimise or eliminate these nurses' activity risk factors, mainly on those dependent patients' transfers.

Keywords: Ergonomic work analysis; DINO; nurses; hospital; continuous and palliative care ward.

1. INTRODUCTION

Identifying Ergonomics concerns in the nursing environment should be carried out with an Ergonomic Work Analysis methodology: (1) work task analysis, (2) work activity analysis, and (3) work results (i) for the worker (e.g. adverse effects) and (ii) for the organization (e.g. quality of work). That should establish the probability of adverse events in the workplace, related to healthcare demands, human resource management, floor space layout, and equipment location in hospital wards. With all this in mind, the hospital environment poses a great challenge to the Ergonomics of healthcare professionals in a wide range of workplaces.
Ergonomic work analysis will significantly improve not only the quality of nurse care provided, and patient safety, but also the safety and well-being of health professionals' in hospital wards (Serranheira, Uva, & Sousa, 2010). Portuguese ergonomics projects in hospital environments began in 1994 at FMH, Technical University of Lisbon, in the Ergonomics Department. These projects were focused on work-related musculoskeletal disorders and the risk assessment of health professionals' physical capacity (Cotrim, 2006). Since then, Ergonomics in hospitals was focused on work-related musculoskeletal disorders (WRMSDs), evaluating the health professionals' physical load when caring for patients, and on the identification, detection and prevention of human error. Equipment, instrument design, information technology (IT), workplace organization and other nursing activity factors were analyzed to manage and prevent adverse effects on health professionals.

The objectives of this study were to:

a) Analyze work by nurses in the morning and afternoon shifts (ergonomics work analysis process) in a continuous and palliative care hospital ward;
b) Evaluate patients transfer performance.

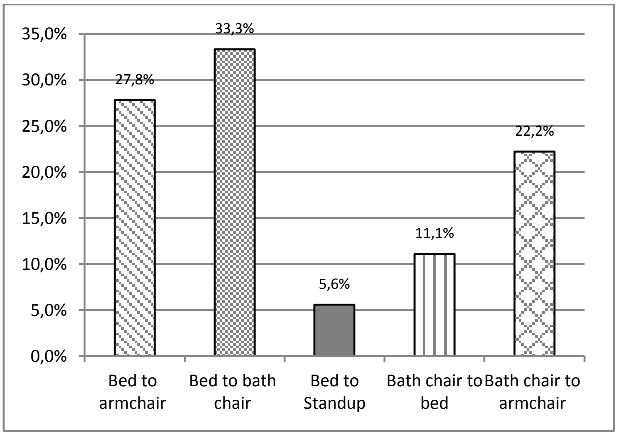
2. MATERIAL AND METHODS

A study was conducted in a continuous and palliative care hospital ward that began in July 2011 and is still continuing. It was divided into different stages and began with an analysis of nursing ergonomics.

Stage one consisted of several meetings with the nurse manager to understand the key issues needing close attention, for the observation of daily work activity. This allowed the elaboration of an observation tool that covered the morning and afternoon shifts (the night shift was not considered in this study). An ergonomist experienced in work analysis chronological observed the time nurses´ spent on shift activities and in ward locations (e.g. medication preparation room, corridors, patients' rooms and nursing rooms). An overall picture of the activity of ward nurses was made enabling a real work activity chronogram, including work interruptions, and other relevant aspects of ergonomic work analysis.
In the second stage, the DINO method was applied (Johnsson et al., 2004) for the evaluation of nurse performance on the transfer of dependent patients'. This allowed the safety level for both patients and health professionals to be established, while critical activity features were still being detected. The DINO score is from 0 to 16 points, 16 corresponding to a transfer task completed safely (Johnsson et al., 2004). The DINO is an observational method carried out by a fully trained ergonomist. The first step was the ranking of patients' degree of impairment by the Head Nurse. Patients were ranked by their degree of dependency from partially dependent, dependent, to totally dependent, thus an important factor for their selection and inclusion in the lifting and movement observation tasks. The second step consisted of reclassifying patients according to the ARJO criteria (Cotrim et al., 2011).

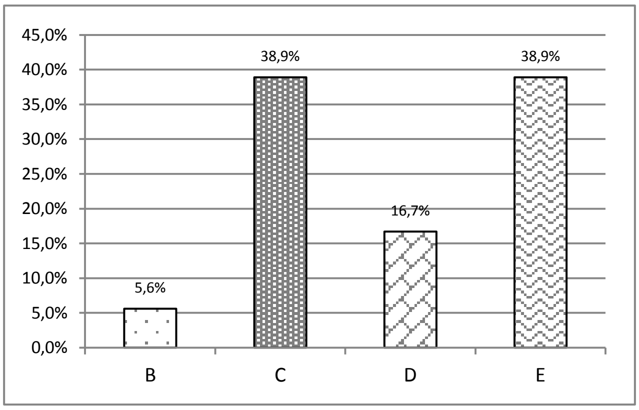
3. RESULTS AND DISCUSSION

For this ergonomic work analysis, eight nursing shifts were randomly selected from a continuous and palliative care hospital ward, four of those were morning shifts and the remaining were afternoon shifts. In the morning shifts (a), the following average percentages of nursing activity time spent in each one of the ward's stations were registered: patients' rooms (52%), corridors (16%), change of shifts (nurses´ handovers) (13%), nursing records (8%) and in the nursing room (4%). In the afternoon shift (b) there were changes: patients' rooms (26%), corridors (18%), nurses´ handovers (11%), nursing records (18%) and in the nursing room (14%).
Observation of the nurses' work allows us to understand the different activities in a hospital ward. For instance, in-room nursing activity in the morning period includes both patient hygiene (5-6 per shift) and patient mobilization and subsequent repositioning in bed (20 to 45 minutes each). In the afternoon period, only patient mobilization and repositioning in bed were observed, however, they were observed more frequently (8-9 per shift, 40 to 50 minutes each). Nurses' work in the corridors was mainly related with medication preparation processes and travelling from one room to one other.
The results show us that there are different workloads in each shift. At this point in the study, the need to better organize staff distribution by shift and schedule activities becomes clear so as to achieve a more balanced allocation of human resources during real healthcare work.
Other studies such as Estryn Behar and et al. (Estryn Behar, Milanini-Magny, Deslandes, Fry, & Ravache, 2008) under the "European Nurses' early exit study" presents different values from the ergonomic work analysis, namely from average time spent in overall medicine, urology, dermatology and oncology in: patients' rooms (32%, 28%, 30% and 30%), corridors (24%, 16%, 14%, 11%) and nursing rooms (14%, 15%, 18%, 12%). The results of our study show that a considerable amount of time is spent in in patients´ rooms (52%). This may be related with demands, such as: (1) human resources allocation, namely the (reduced) number of nurses, and the (high) rate of dependent patients per nurse, (2) wards layout, particularly the long section of the assigned work area that demands extensive travel within the hospital unit, (3) workload organization, such as the assignment of dependent patients (partially dependent to totally dependent) to nurses in the shifts, among others.
With regards to transferences and to the DINO application, 18 transferences were observed (Graph 1), a sound nurse majority (83.3%), female (88.9%) was accounted for, being in charge of transferring from the bed to the bath chair (33.3%), from the bed to the armchair (27.8%) or from the bath chair to the armchair (22.2%).



Graph 1: Distribution of different types observed transfers

The description of the degree of patient dependency was made through the ARJO criteria (Cotrim et al., 2011), ranging from A (autonomous or non-dependent standalone patients) to E (totally dependent patients). The overall majority of observations
Graph 2) were collected from patients type C (partially dependent, 38.9%) and type E (totally dependent, 38.9%).



Graph 2: Distribution of patients regarding their dependency level

The average DINO score was 14.61 (sd=1.72) and the values ranged from 10 to 16. It should be stressed that 50% of all transferences got a score of 16, which is the top mark and means that the given task was carried out in compliance with safety standard techniques for health care workers.
The analysis of the results was outlined by the 3 phases of DINO: (1) preparation, (2) performance and (3) result phase, allowing us to highlight respectively (i) as critical factors, the failure to use mechanical aids in 33.3% of transfers where they would be advisable and the equipment not been accurately handled in 16.7% of observations; (ii) the results are in broad terms (a) positive, with the patient Communication and Participation criteria presenting a median value coinciding with the highest point of the scale, (b) the criteria with the lowest follow-through are the "low effort policy", with 22.2% presenting a "moderate" classification, and a "load on the back" with a 27.8% placed in "moderate" and 11.1% placed at the "high" level; (iii) in 27.8% of the transfers the patients did not end up in an appropriately functional position, thus burdening the professionals (nurses and nurses-aids) with repositioning of the patient.

4. CONCLUSIONS

The ergonomic work analysis presents several contributions to the hospital setting, particularly when a real work activity analysis is used. Such contributions may be the starting point for patient safety and the health professionals' well-being and safety risk management (Serranheira, Uva, Sousa, & Leite, 2009; Uva & Serranheira, 2008; Serranheira, Uva, Sousa, 2010). This study allowed for the analysis of activity in a continuous and palliative hospital ward (nurses shifts), stressing the substantial amount of time that was spent providing care in patients' rooms (52%). This figure is outstandingly different from those in other mentioned studies in several other hospital wards, where essentially lower values were registered.
DINO results showed that healthcare professionals carried out the transfers in compliance with safety standard techniques for health care workers, but the real work analysis also shows that some patient transfers (27.8%) did not finish in the best conditions which required patient repositioning without mechanical transfers.
This is a clear example of some of the critical factors identified during this work analysis and that allows us to equate preventive measures for the elimination or minimization of risks during nurses' activity, namely at patient transfers.
It highlights a higher workload for ongoing and palliative care nurses, which should be the object of further study, in order to face the nurses' capacities and work demands, in order to come up with eventual interventions at an organizational level, work layouts and equipment distribution and design.
This study is part of another study with a broader scope where the nurse work analysis, including risk assessment and workload evaluation, will contribute to spot situations of either dysfunctional stations or widespread systemic dysfunction, and call on those demanding situations an ergonomic intervention (risk management).
An ergonomic work analysis in the nurse's workplaces contributes to identifying, classifying and analyzing the work activity in each station, in every ward, so as to improve human resources management tools, adapting working areas and equipment design for workers, which, together, may contribute to preventing adverse results, for nurses (e.g. work related musculoskeletal disorders) and promoting patient safety.

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The Less Visible Side of the Work Effects on Health: Reflection on the Emergence of Psychosocial Risks

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ABSTRACT
The aim of this study was to examine the less visible side of work effects - psychosocial risk - on health in two groups – White-collar and Blue-collar - both belonging to a municipal public service. We used a Portuguese survey, INSAT, to collect the subjective perception of work constraints and characteristics, and health and well-being complaints. 351 workers were surveyed from a universe of 404. We made a descriptive statistical analysis for all questions in the inquiry and used the logistic regression models to determine associations between working conditions and health complaints and well-being. The results showed that the two groups were exposed to different kinds of psychosocial risk factors. The White-collar group results showed that, besides the common characteristics (expected in office work), this group was exposed to an intensification phenomenon based on the need of being seated for long periods of time, hurrying, solving unforeseen problems without help, canceling or shortening a meal or even not taking a break, going beyond regular work time, etc. We found strong association evidences between some of these problems and sleep disturbances, pain complaints and emotional reactions. The Blue-collar group results showed that this group isn’t only exposed to environmental and physical exertion constraints, but also to relationship constraints in what concerns people (supervisors and colleagues) and municipal public service as a whole. Equally, the pain and sleep disturbances are related to those working conditions. What we found as emergent were the health complaints related to an intensification phenomenon, a recognition process and a dignity of work. But we also found associations between some working conditions and social isolation and a feeling of dissatisfaction. The results show us the work beyond the obvious - "the less visible side" – not only in terms of working conditions, but also in terms of health effects.

Keywords: Psychosocial risk; White-Collar; Blue-Collar; Municipal Service; Survey.

1. INTRODUCTION

Working conditions, in modern societies, have suffered important changes in the last decades. We observe a generalized introduction of new information and communication technologies, new ways of work organization in what concerns contents and time and profound changes in labor relations. These changes can be observed in transformations in the workers professional daily life (and also personal), but the risks associated with them and the related consequences are hardly ever perceived. We refer to the emergency of psychosocial risks (Brun & Milczarek, 2007). Due to its visibility not being immediate, it became indispensable to provide opportunities for workers who experience/feel them to report those risks. When we gave them this opportunity, the workers also ended up expressing discomfort, complaints, and perceptions about the effects of these risks on their health and well-being, setting a scenario of small problems, infra-pathologies, rather than clinically confirmed diseases. But, the absence of a definitive diagnosis of the cause-effect relationships, gives rise to a gap in terms of recognition (Barros-Duarte, 2005).

The normative approaches used by many companies eventually compromise a wide understanding of the problem, because they only emphasize the obvious, immediate and simple effects. We should abandon the logic that health and well-being of people at work are only gauged by indicators such as absence of sickness, diagnosed occupational diseases or accidents at work. We should also look for the complaints, feelings and discomforts, not as marginal or irrelevant aspects, but as aspects that actually affect the worker daily.

These concerns are present in the 5th and last edition of the European Working Conditions Survey (EWCS) promoted by Eurofound (European Foundation for the Improvement of Working and Living Conditions - http://www.eurofound.europa.eu/surveys/index.htm). In that edition, a set of new questions was introduced into a survey that tries, precisely, to surround the psychosocial risk factors, contributing to another interpretation of the effects of the working conditions on health and quality of life.

It is decisive how we approach the relationships health-work, if we want to give visibility to the less visible risk factors and their consequences. We believe in a multifactorial approach of work-related health problems, centred on workers, listening to their perspective and giving them the opportunity of explaining their experiences/sufferings at work.

In this paper we propose a reflection about “The less visible side of the work effects on health” based on the results of a surveillance project of work conditions, conducted in the Municipal Service of Water and Sanitation of Oeiras and Amadora , in which the Faculty of Human Kinetics, Technical University of Lisbon is a partner.

2. METHODOLOGY

2.1. The instrument and its application

The INSAT – Inquérito Saúde e Trabalho (Health and Work Survey) (Barros-Duarte & Cunha, 2010) - survey is a Portuguese survey, that tries to "understand how workers evaluate their working characteristics and conditions, their health state, and the nature of the relationships they establish between their health and work" (Barros-Duarte, Cunha & Lacomblez, 2007, p.59).

The survey is organized in different sets of questions, trying to identify the constraints and characteristics of work that workers perceive when being exposed and also the discomfort they feel related to that exposure. Other two sets of questions broach the effects of work on health. One of them corresponds to the Nottingham Health Profile (Ferreira & Melo, 1999) which is considered to be the best instrument to evaluate well-being. Its questions are organized in six dimensions: energy, physical mobility, pain, sleep, social isolation and emotional reactions. The other set corresponds to a list of common health problems which includes among others: back pain, headache and musculoskeletal disorders.

So, besides a more traditional relation of cause-effect, between exposure to certain work risk factors and the clinically confirmed diseases, the survey also allowed another approach, revealing a subjective dimension in the work-health relationships. Therefore, the small health problems and the complaints, which really affect the well-being and quality the worker's life, could be explained with this instrument. We know that some kind of analysis consider them as marginal symptoms, because they don't belong to a scenario of confirmed diseases. But, the exploitation of this data can reveal discrete relationships between working conditions and health (Barros-Duarte, 2005).

So, the INSAT survey appears as a multifaceted methodological approach that includes indicators from different scientific areas, focusing on experiences at work, and incorporates a wide health definition, including its subjective dimension (Barros-Duarte & Cunha, 2010).

We applied this instrument to workers of the Municipal Services of Water and Sanitation of Oeiras and Amadora (SMAS). The survey application was carried out in collective class room sessions, with a maximum of ten people, under the guidance of the researchers. The survey was filled in individually and was also anonymous.

2.2. Participants

In a universe of 404 workers, the survey was applied to 351 (87%). Two worker groups were considered, one named "White-Collar" (n=192) and the other named "Blue-Collar" (n=159). The first one consisted mainly of female workers (61%), with academic levels between the 3rd and the post-graduate grades, with an average age of 43.6±9.6 (x±sd) years and corresponding to the workers with executive functions, technicians and office workers. The second one consisted exclusively of male workers, with academic levels between the 1st and secondary grades, with an average age of 48±8.9 (x±sd) years, corresponding to the workers who have functions as water and sanitation operators, warehouse operators, drivers, workshop operators, pumping stations operator and inspectors.

2.3. Data treatment

We have done a descriptive statistical analysis for all questions in the survey and multivariate logistic regression analysis – Forward method – including as co-variables, the exposure and related-exposure discomfort to conditions and characteristics of work, and as dependent variables the health problems. We accept, as explanation factors, the constraints and characteristics of work that have probability values of $p \leq .05$.

3. THE LESS VISIBLE EFFECTS OF WORK ON HEALTH

The INSAT results reinforced not only the knowledge we had about conditions and characteristics of work and their effects on health, obtained from real activity ergonomic analysis (Costa & Silva, 2010; Cravo et al., 2011; Santos et al., 2011; Saraiva, 2012), but also revealed the exposition to another type of less visible constraints. Its impact on health and well-being needs the workers' verbalization to be known.

3.1. "White-Collar" on their way to work intensification

In spite of the White-Collar workers, from a municipal public service, having different jobs, we can identify a set of answers that converge to the traditional representation of the activities developed in an office context (table 1): being in direct contact with the public (49.9%), depending on clients' requests (33.9%), being in the presence of other people (85.9%), always learning (85.4%), doing varied work (82.8%), being seated for long periods of time (66.1%) depending on rules and standards (39.1%) and working at a computer for long periods of time (79.7%). From these characteristics, we found that the workers who mention discomfort associated with the exposure of being seated for long periods of time have four times more likelihood of complaining about emotional reactions (OR=4.464, p=.006). A large number of workers also complained about back pains (50.5%) and from these, the majority considered that they were caused or intensified by work (76.6%).

Beyond those predictabilities, the results showed us that this group of workers was exposed to other constraints (table 1), not always visible, but influenced their health and quality of life: doing different things at once (71.9%), changing work methods and instruments frequently (49%), being exposed to frequent interruptions (60.4%), having to rush (62.5%),

solving unforeseen problems without help (64.6%), canceling or shortening a meal or even not taking a break (46.4%), working beyond regular work time (65.6%). The results also showed that the need of keeping the prescribed pace, indicated by 16.7% of the respondents, is decisive in the appearance of sleep disturbances (OR=2.758, p=.023). 26.6% of the respondents referred having headaches, and of those, 64% considered that they were caused or intensified by work.
Considering the large number of pace constraints declared by the workers (table 1). Brun and Miczarek (2007) refer that exposure to time pressures affects the ways of accomplishing a task (in terms of posture, procedures, information, tools, etc.). But, the way of accomplishing a task isn't the only one affected, health is too. According to Eurofund (2011), the greater the number of factors (customers, colleagues, deadlines, schedules, etc.) that define the work pace, the higher the demands put on workers and, therefore, the negative impact on their health and well-being.

Table 1 –The constraints and characteristics most indicated by White-collar workers. Perceived exposure and discomfort (%) (n=192)

Constraints/Characteristics	**Exposed Workers (%)**	**Uncomfortable Workers (%)**
Physical		
Being seated for long periods	66.1	65.6
Pace		
Depending on clients' requests	33.9	23.7
Working at a computer for long periods of time	79.7	40.0
Doing different things at once	71.9	35.2
Changing methods and instruments frequently	49.0	28.9
Being exposed to frequent interruptions	60.4	66.4
Having to rush	62.5,	48.0
Solving unforeseen problems without the help of colleagues	64.6	28.0
Canceling or shortening a meal or even not taking a break	46.4	47.9
Keeping the prescribed pace	16.7	40.6
Working beyond regular work time	65.6	34.1
Depending on rules and standards	39.1	16.9
Autonomy		
Not having the possibility of participating in the choice of working hours	39.6	45.6
Not having the possibility of making his/her own decisions	22.5,	47.1
Not having the possibility of deciding how to accomplish a task	20.3	50.0
Not having the possibility of changing the order of accomplishing a task	19.3	48.8
Relationship		
Being in direct contact with the public	59.0	15.7
Dealing with the demands of the public	42.7	37.9
Confronting stressful situations with the public	41.7	64.0
Being in the presence of other people	85.9	5.1
Characteristics		
Always learning	85.4	1.3
Doing varied work	82.8	1.3
Being unable to do regular work when you are 60 years old	27.4	73.1

The long term work sustainability must be assured by the organizations (Coninck & Gollac, 2006). It is not by chance that more than a quarter of these workers (27.4%) considered being unable to do their regular work when they are 60 years old and this is felt like a discomfort by a large number of them (73.1%). We found an association between this perception about himself and energy dimension (OR=28.84, p=.038). Besides, we cannot look at the intensification phenomenon, circumscribe it to restrictions in managing work time, although this aspect is relevant for the workers, since they complain about the impossibility of participating in the choice of working hours (39.6%). Other factors contributed to the work intensification, e.g., how autonomy is used, what commitment is required for workers, how work activity is controlled and how fast organizational changes occur (Askenazy et al., 2006).

The intensification of work when viewed on its own might not have a negative impact on the quality of work or on the workers' health. As Perilleux (2006) writes, "work intensification, a source of internal tension, can be attractive when it presents itself as an opportunity to be exposed to (and be modified through) contact with a plethora of exciting challenges. In certain conditions (including a high level of autonomy or a high level of social support), intensification can lead to individual investment and learning, greater worker responsibility, social reward and job satisfaction" (p. 373).

However, when we analyzed autonomy we registered that they cannot make their own decisions (22.5%), do not have the possibility of deciding how to do the task (20.3%), cannot change the order in which the tasks are accomplished (19.3%), aspects are perceived as uncomfortable by about half of the respondents (respectively 47.1%, 50% and 48.8%). It is certainly not by chance that the pain dimension did not emerge associated to physical demands of work, but emerged associated to other types of constraints reflecting the absence of autonomy: the workers who indicated feeling discomfort due to not having the possibility of choosing work hours have a higher likelihood of pain complaints (OR=17.500, p=.019).

Furthermore, most of the analyzed office workers have a close relationship with the public, given the nature of the business. Various subjects are dealt with including billing, contracts, supply difficulties, etc. These can cause stressful situations when dealing with the public (41.7%), and the feeling of being forced to respect all the demands of the public (42.7%).

Bridger & Brasher (2011) also found in office workers, that the interaction between cognitive task demands and self-control demands had the strongest association with mental well-being, suggesting that the deleterious effect of one was greater when the other was present. This shows the cumulative effects of pace and autonomy constraints in these workers.

Work intensification has been broadly associated with deterioration in working conditions, whether they are assessed in terms of physical or psychological discomforts, nuisance or occupational risks (Askenaky, 2004; Eurofound, 2011).

3.2. Blue-Collar - between schedule pressure, client pressure… and the desire for professional recognition

The Blue-Collar group consists of workers who develop their activity in an urban context, near structures of water and sanitation, by drivers and by workshop employees. The work done by this group can be determined by schedule or the client's request and it can be necessary to skip from one activity to another. Therefore, their activities are carried out mainly in outdoor environments and in the presence of other people (84.9%). Thus, we emphasize a set of answers that reinforce the representation (table 2) that we have about the constraints that these workers are exposed to in their daily work life: harmful noise or uncomfortable (35.8%), intense heat or cold (52.8%), dusts or gases (61.6%) and biological agents (35.2%), repetitive movements (39%), awkward postures (45.3%), physical exertion (45.3%), prolonged static standing posture (33.3%) and standing posture with displacement (44.7%). With regards to health implications, we emphasize the musculoskeletal disorders (28.9%) and back pains (52.2%) and work is regarded as the cause of their appearance for more than 85% of respondents.

This group, like the White-Collar group, considers being exposed to pace constraints, imposed primarily by the urgency of concluding work/interventions in the field, requiring them to hurry (49.1%), eliminating meals or breaks (56%), working beyond regular working hours (67.3%), doing several things at once (45.9%), subjecting them to frequent interruptions (38.4%), solving problems or situations without the help of colleagues (62.9%), and often feeling the need for them (77.4%). For some of them, these constraints are linked to the lack of autonomy for setting the order of accomplishing the tasks (27%) and how to accomplish them (23.3%), limiting the ability for managing working time (43.4%). The dependence on supervisors for making decisions (21%) proved decisive in the likelihood of emotional reactions (OR=3.854, p=.032).

We found, once again, pain not directly associated with the physical component, but with one aspect of the work pace: hurrying (OR=5.873, p=.005). As we said before, time pressures affect the used postures, the performed movements, the number and duration of the breaks, etc. Being subjected to work intensification, as described by the workers themselves, is awkward, causes suffering and the pain may be interpreted as one of its expressions.

Table 2 – The constraints and characteristics most indicated by Blue-collar workers. Perceived exposure and discomfort (%) (n=159)

Constraints	Exposed Workers (%)	Uncomfortable Workers (%)
Environmental		
Being exposed to harmful and uncomfortable noise	35.8	84.8
Being exposed to intense heat or cold	52.8	80.5
Being exposed to dust or gases	61.6	84.2
Being exposed to biological agents	35.2	89.5
Physical		
Performing repetitive movements	39.0	58.1
Adopting awkward postures	45.3	82.5
Causing physical exertion	45.3	78.5
Adopting static standing posture	33.3	86.0
Adopting a standing posture with displacement	44.7	64.8
Pace		
Depending on clients' requests	32.1	21.6
Having to rush	49.1	54.5
Canceling or shortening a meal or even not taking a break	56.0	61.4
Doing several things at once	45.9	57.7
Working beyond regular hours	67.3	43.8
Solving unforeseen problems without the help of colleagues	62.9	34.4
Being exposed to frequent interruptions	38.4	53.3
Autonomy		
Not having the possibility of changing the order of accomplishing the task	27.0	28.9
Not having the possibility of deciding how to accomplish a task	23.3	45.2
Not having the possibility of making his/her own decisions	21.4	66.7
Not having the possibility of participating in the choice of working hours	43.4	37.7
Relationship		
Feeling the need for help, although there is none	77.4	21.7
Supporting the demands of the public	52.8	31.4
Confronting stressful situations with the public	56.0	50.0
Being in the presence of other people	84.9	5.4
Being exposed to work not recognized by a supervisor	28.9	58.5
Being exposed to work not recognized by colleagues	27.0	51.4
Being exposed to work where my points of view are not considered	28.3	60.0
Characteristics		
Being unable to do regular work when you are 60 years old	32.7	61.4
Being exposed to work that undermines my dignity	15.1	52.2
Being exposed to work that I don’t wish for my children	40.9	67.3
Being dissatisfied with my work	24.5	73.3

According to Brun and Miczarek (2007) it has been reported that almost half of the European employees work at a very high speed three quarters or more of the time. We know that in our Blue-Collar workers the need for hurrying often causes neutralization of the safety systems in order to work faster and respond quickly to the customers’ needs. This situation may lead to injuries or even accidents. Because of this, some authors have suggested a link between accident occurrence and work intensity (Askenazy, 2003; Askenazy & Carolli, 2003). However, at present, this link has not been extensively researched and the number of accidents registered in this public service is almost close to zero. So, in spite of workers feeling affected by an intensification phenomenon, their consequences aren't visible in the number of accidents, injuries or even in professional diseases, but emerged in others forms like pain or emotional reactions.

We identified other constraints related to the dependency generated by customer orders and/or road users (32.1%) forcing workers to support their demands (52.8%) establishing strained relationships with them (56%) and disturbing the workers' sleep quality (OR=2.922, p=.009). It should be noted that almost a third of these workers believe that they cannot maintain their current profession when they turn 60 (32.7%).

However, other results have shown different features of the work experienced by this group of professionals.

Although not many, some workers expressed the feeling that they are exposed to a work that undermines their dignity (15.1%). And those who consider themselves to be exposed to this situation have nearly six times more likelihood to have complaints of emotional reactions (OR=5.663, p=.006) and five times more likelihood to have sleep disturbances (OR=4.955, p=.002). To feel this exposure as uncomfortable is decisive to the occurrence of social isolation phenomena (OR=16.000, p=.024). Maybe this is the reason why they don't wish this work for their children (40.9%) and feel dissatisfied (24.5%).

The results for this group also revealed the importance of professional recognition, once they declared its non-existence on the part of supervisors (28.9%) and colleagues (27%) and frequently their points of views are not considered by the team to which they belong (28.3%).

The issues related to dignity of work, professional recognition, job fulfillment and psychological violence (or bullying) have been surveyed by Eurofound (Eurofound, 2006; Brun & Miczarek, 2007). According to the results of previous editions of EWCS (1995, 2000 and 2005) these kinds of problems have grown and cover almost all sectors of activity, although the prevalence is higher in the service sector, which is the sector analyzed in our study.

It's necessary to treat these matters with sensibility and try to understand the problem considering that it has very complex and multi-factorial causes, and therefore it is difficult to draw a simple picture of why they occur. However, Martino, Hoel and Cooper (2003) point out a series of variables or risk factors: (1) individual factors like age, gender and education level, personality characteristics and affiliation with their workplace; (2) situational factors like working in contact with public, working with people in distress, perceptions of injustice; (3) organizational factors as hierarchical structure, leadership style, relationship management, local culture; and (4) social factors like representation of job and social climate.

We could try to understand those results considering on one hand the task/situation of these Blue-collar workers (manually executed, exposed to high physical exertion, executed in extreme conditions of environment, exposed to the public, dealing with people in distress and not socially valued), on the other hand the workers characteristics (all of them are male, with low or an intermediate level of education and training and almost two thirds are over 45 years). Towards a better understanding of the problem it is necessary to analyze, in a real context, the used organizational model.

We see how these almost invisible aspects of lived work experience, eventually emerge when we asked the workers, under a status of confidentiality, and giving them the opportunity of expressing themselves, revealing their feelings about work and its actors.

4. CONCLUSION

The results show us that the work beyond the obvious, the immediate, also has "a less visible side" whether in terms of conditions and characteristics, whether in terms of effects on health. It is therefore necessary to define approaches which go beyond the trends of health problems related to the physical or environmental aspects of the work and considering that the organization of time and content of work, interpersonal relations and contact with public are also determinants in the development and construction of health. Giving visibility to these relations is an enormous and urgent challenge, given the changing conditions of work (new labor relations, downsizing policies, etc.), which have been drawing in the last decade. In this process it is necessary to establish a framework of participatory action, including the workers and giving them the opportunity to express themselves. INSAT has proved to be an instrument that plays the role of mediator between everyone involved in the process of prevention and promotion of health and safety at work.

In this paper, we presented "the less visible side" of the work of two professional groups – White-Collar and Blue - belonging to a municipal public service.

We noticed that White-Collar professionals seem exposed to a phenomenon of work intensification. In the opinion of Brun & Miczarek (2007), "there are no ready-made recipes and solutions for reducing the harmful effects of work intensification" (p. 67), so it is important to do a field study. But even that is facing difficulties: how can we highlight work intensity, in the field?

The work intensification is the result of different processes that are not always easy to understand and characterize. Anyway reducing intensity also entails questioning the various forms of organization.

In its turn Blue-Collar workers, also exposed to the intensification of work, presented other far less well known aspects of the experienced work that relate to dignity, recognition and satisfaction. Everyone agrees that there are no simple solutions or unique and general principles. The job design and work organization is also questioned at this level.

We should continue the investment of surveying work conditions and developing field studies aiming at promoting awareness of all actors of the risks and their relationship to health, in order to improve the health and well-being of workers.

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Temporal characteristics of foot roll-over during walking with a side-cut maneuver: A comparison between obese and non-obese postmenopausal women

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ABSTRACT
Obesity affects the temporal characteristics of foot roll-over during straightforward walking which can lead to injuries. However, there is a lack of research regarding the effects of obesity on foot behaviour during walking with side-cut maneuvers. The aim of this study was to compare the temporal characteristics of foot roll-over during walking with side-cut maneuver at 45º between obese and non-obese postmenopausal women and to establish a reference dataset for temporal parameters. Plantar pressure data were collected using the two-step protocol. The initial contact, final contact, and contact duration of ten anatomical areas were measured, as well as five instants and four phases of foot roll-over. The initial contact of regions, M1, M4, M5, MF, HM and HL, occurred significantly earlier in both feet, in obese women. The final contact of M3, M4, M5 and MF, occurred significantly later in both feet. On the right foot, the duration of contact was significantly longer in obese women, in the areas, M1, M3, M4, M5, MF, the FMC and FFF instants occurred significantly earlier, ICP and FFCP phases were significantly shorter, and the FFP was significantly greater in obese women. On the left foot, the duration of contact of regions, M1, M4, M5 and MF were significantly greater, the instant FFF occurred significantly earlier, the FFCP phase was significantly shorter, and the FFP phase was significantly greater in obese women. Additionally, in both feet, the sequence in which different foot areas touch the ground diverges between obese and non-obese postmenopausal women. The results suggest that the presence of obesity in postmenopausal women leads to changes in temporal parameters of foot roll-over during walking with a side-cut maneuver. Furthermore, a representative reference dataset for temporal characteristics of foot roll-over while walking with side-cut maneuver of postmenopausal women was established.

Keywords: Gait; Plantar Pressure; Postmenopausal Women.

1. INTRODUCTION

In human locomotion, plantar pressure measurements can provide relevant information about the various structures of the foot during foot-ground interaction (De Cock, De Clercq, Willems, & Witvrouw, 2005). Within this context, a reference dataset for temporal characteristics of foot roll-over of young adults during jogging has been established (De Cock et al., 2005) as well as during walking (M. Monteiro, R. Gabriel, M. Sousa, M. Castro, & M. Moreira, 2010), for postmenopausal women (PW). In the last quoted study the plantar pressure parameters were analysed during straightforward walking however, several changes in direction occurs on daily activities, which can affect foot behaviour. The study of the feet in its different functional strands is important not only to standardize foot roll-over but also to predict plantar pressure patterns that tend to induce injuries (De Cock et al., 2005). Only a few studies (Birtane & Tuna, 2004; Gravante, Russo, Pomara, & Ridola, 2003; Hills, Hennig, McDonald, & Bar-Or, 2001; Mickle, Steele, & Munro, 2006; Teh et al., 2006; Utian et al., 2008), have addressed the plantar pressure characteristics of obese adults and even less in postmenopausal women (Faria, Gabriel, Abrantes, Bras, & Moreira, 2009, 2010; M. Monteiro, R. Gabriel, J. Aranha, et al., 2010; M. Monteiro, R. Gabriel, M. Sousa, et al., 2010). Nevertheless some reports suggest that obesity can affect the behaviour of the foot during the stance phase (Faria et al., 2009, 2010), and can be a risk factor for flatfoot deformity that impairs hindfoot stability (Richie, 2007). Therefore, the purpose of this study was to compare, the temporal characteristics of foot roll-over in both feet between obese and non-obese PW during walking forward with a side-cut maneuver at 45ºand to establish a reference dataset for temporal parameters.

2. MATERIALS AND METHODS

2.1. Subjects

Sixty-one postmenopausal women participated in this study. Two groups (twenty-nine obese and thirty-two non-obese) were defined based on the body mass index cut-off value of 25,5 kg/m2 (Sardinha & Teixeira, 2000), as illustrated in Table 1. Before testing, all subjects visited a physician for a comprehensive injury history, in order to verify the inclusion criteria, and register some variables that must be under control of the researcher (Hills et al., 2001; Willems, Witvrouw, Delbaere, De Cock, & De Clercq, 2005), such as absence of: (1) acute foot pain and deformities, (2) severe lower extremity trauma, (3) lower extremity surgery like prosthesis operations of the hip, knee, ankle or foot, (4) leg length discrepancies, (5) coordination problems, including eye, ear or cognitive disorders, and (6) diabetes related peripheral neuropathy.

Table 1 – Sample Characterization

	Obese PW (n=29)		Non-obese PW (n=32)	
	Mean	SD	Mean	SD
AGE (years)	58,59	6,02	58,75	5,16
MASS (Kg)	82,35	10,38	56,98	6,00
HEIGHT (cm)	156,65	5,21	155,91	4,55
BMI (Mass/Height$^{2)}$	33,52	3,59	23,38	1,66

2.2. Instrumentation/procedures

Plantar pressure parameters were evaluated by the Footscan platform (1m×0.4 m, 8192 sensors, RSscan International, Olen, Belgium) at 250 Hz using the 2-step protocol (Bus & Lange, 2005). Each subject was instructed to walk barefoot and perform a side-cut maneuver at 45º, as illustrated in Figure 1. In the present study, the right foot was the dominant foot for all the subjects (Houck, Duncan, & De Haven, 2006), and was used, to be the supporting foot during the change of direction (Gabriel et al., 1998). Before measurements, the individuals practiced walking at a self-selected speed over the pressure platform for a period of ten minutes. Five valid trials (Bus & Lange, 2005), were collected. A trial was discarded if foot contact with the pressure platform was incomplete, if the participant targeted the platform, or if the coefficient of variation of the duration of contact was greater than 4%. This final criterion was employed to minimize the effect of walking speed on the data (Burnfiel, Few, Mohamed, & Perry, 2004; Chuckpaiwong, Nunley, Mall, & Queen, 2008; Warren, Maher, & Higbie, 2004).

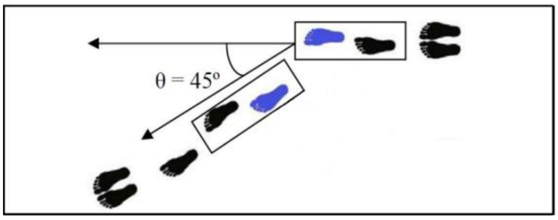

Figure 1 – Side Cut Task.

The initial contact time (IC), final contact time (FC) and duration of contact (DC) was obtained for 10 anatomical pressure areas during foot roll-over. The areas considered were: medial and lateral heel (HM, HL), metatarsal areas (M1–M5), midfoot (MF), hallux (T1) and toes (T2–5), as illustrated in figure 2.

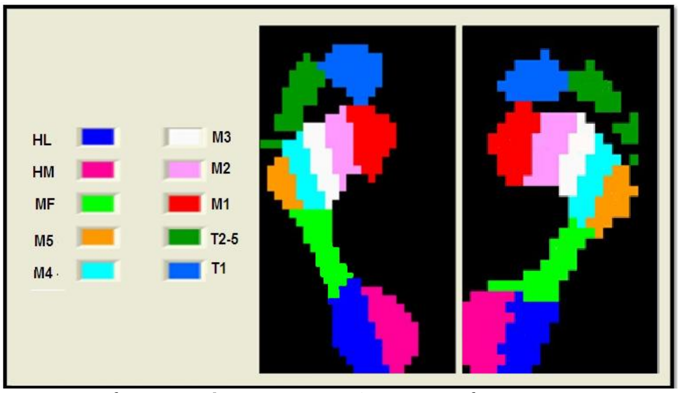

Figure 2 – Location of anatomical pressure areas (Footscan Software 7.1, RSscan International)

Five instants of foot roll-over (Figure 3) were determined: (FFC-first foot contact, instant the foot made first contact with the pressure platform; FMC-first metatarsal contact, instant when one of the metatarsal heads contacted the pressure platform; FFF-forefoot flat, first instant when all the heads of the metatarsals made contact with the pressure platform; HO-heel off, instant the heel region lost contact with the pressure platform and; LFC-last foot contact, last contact of the foot on the platform). Based on these instants four phases were established (De Cock et al., 2005): initial contact phase (ICP; between FFC and FMC), forefoot contact phase (FFCP; between FMC and FFF), foot flat phase (FFP; between FFF and HO) and forefoot push off phase (FFPOP; between HO and LFC).

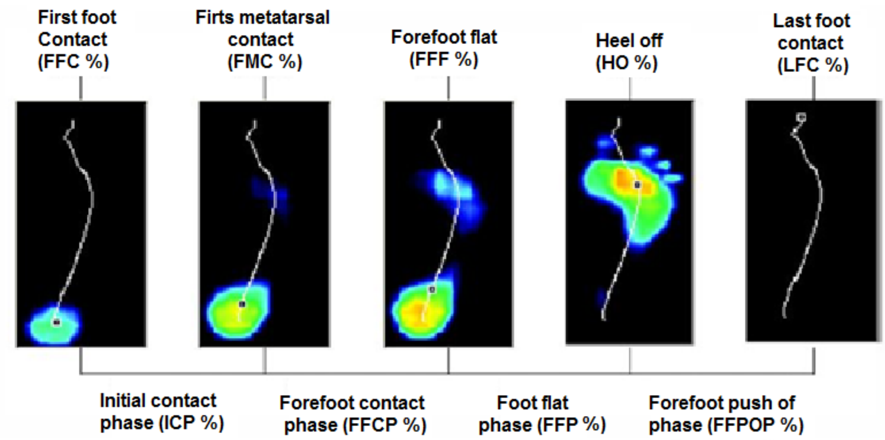

Figure 3 – Five distinct instants and phases regarding total foot contact.

2.3. Statistical analysis

The data were analysed with SPSS 18.0 (SPSS Inc., Chicago, Illinois) and a *p*-value ≤0.05 was considered to be statistically significant. Independent T-Tests or Mann-Whitney U tests were employed in group comparison. Both feet were compared between obese and non-obese groups.

3. RESULTS AND DISCUSSION

The results were obtained and analysed between groups (obese and non-obese) for each foot independently, due to the specificity of its role in the side-cut task (table 2 and 3).

Table 2 – Relative initial contact time and final contact time between groups.

	Right Foot			Left Foot		
	Obese (n=29)	Non-obese (n=32)	T-test Man-Whitney U [a]	Obese (n=29)	Non-obese (n=32)	T-test Man-Whitney U [a]
	Mean ±SD		P	Mean ±SD		P
Initial Contact (%)						
T1	50,4± 12,0	51,3 ± 13,7		13,8 ± 15,5	18,3 ± 14,7	
T2-5	50,0 ± 14,8	46,7 ± 14,0		26,2 ± 16,7	32,1 ± 15,4	
M1	26,9 ± 10,3	34,7 ± 10,4	P < 0.01	2,1 ± 5,1	5,3 ± 6,8	P < 0.01[a]
M2	17,3 ± 6,5	20,7± 8,0		0,9 ± 3,3	1,6 ± 4,6	
M3	12,1 ± 4,0	14,1± 6,7		0,5 ± 1,8	0,8 ± 2,2	
M4	9,5 ± 3,1	13,7± 6,0	P < 0.01[a]	0,6 ± 2,0	1,0 ± 2,3	P < 0.01[a]
M5	10,5 ± 4,0	18,2 ± 11,9	P < 0.01[a]	1,5 ± 3,7	5,6 ± 6,7	P < 0.01[a]
MF	3,4 ± 1,3	4,0 ± 1,8		0,0 ± 0,1	0,7 ± 2,3	
HM	0,0 ± 0,1	0,0 ± 0,0	P < 0.01[a]	0,0 ± 0,1	0,1 ± 0,2	P < 0.01[a]
HL	0,0 ± 0,0	0,0 ± 0,0	P < 0.01[a]	0,0 ± 0,1	0,1 ± 0,2	P < 0.01[a]
Final Contact (%)						
T1	99,9 ± 0,4	99,8 ± 0,4		99,5 ± 1,2	99,2± 1,3	
T2-5	96,6 ± 2,7	96,1 ± 2,0		94,7 ± 7,8	94,9 ± 2,7	
M1	94,5 ± 1,6	94,3 ± 1,8		89,9 ± 3,3	86,1 ± 6,4	
M2	95,2 ± 1,1	94,6 ± 1,7		92,5 ± 2,0	91,4 ± 2,8	
M3	94,5 ± 1,0	93,4 ± 1,6	P < 0.01	92,5 ± 2,1	91,5 ± 3,0	P < 0.01
M4	91,9 ± 1,5	90,2 ± 2,1	P < 0.01	91,9 ± 1,54	90,2 ± 2,09	P < 0.01[a]
M5	86,4 ± 2,7	82,0 ± 4,7	P < 0.01	86,4 ± 2,68	82 ± 4,72	P < 0.01
MF	67,2 ± 6,9	61,5 ± 7,9	P < 0.01	67,2 ± 6,87	61,5 ± 7,93	P < 0.01
HM	60,6 ± 6,3	57,1 ± 8,3		61,7 ± 13,5	52,2 ± 14,2	
HL	59,6 ± 6,3	56,4 ± 8,3		37,6 ± 10,8	38,2 ± 9,1	

Data are expressed as mean ±SD. Independent T-Test; [a] Man-Whitney U test.

Table 3 – Relative duration of contact and values of FFC, FMC, FFF, HO, ICP, FFCP, FFP, FFPOP between groups.

	Right Foot			Left Foot		
	Obese (n=29)	Non-obese (n=32)	T-test Man-Whitney U [a]	Obese (n=29)	Non-obese (n=32)	T-test Man-Whitney U [a]
	Mean ±SD		P	Mean ±SD		P
Duration of Contact (%)						
T1	49,0 ± 11,9	47,9 ± 13,5		84,3 ± 15,4	79,6 ± 14,5	
T2-5	46,1 ± 16,0	48,9 ± 14,3		67,4 ± 17,3	61,7 ± 15,3	
M1	67,0 ± 10,6	58,9 ± 10,7	P < 0.01	86,3 ± 6,0	79,5 ± 9,3	P < 0.01[a]
M2	77,1 ± 6,9	73,1 ± 8,5		90,1 ± 3,6	88,3 ± 5,8	
M3	81,5 ± 4,5	78,4 ± 6,9	P < 0.05[a]	90,5 ± 2,9	89,2 ± 3,7	
M4	81,7 ± 3,7	75,7 ± 6,1	P < 0.01[a]	88,7 ± 3,5	87,3 ± 3,7	P < 0.01[a]
M5	75,2 ± 5,2	63,1 ± 12,4	P < 0.01[a]	81,1 ± 6,8	76,2 ± 7,8	P < 0.01[a]
MF	63,1 ± 6,9	56,9 ± 7,9	P < 0.01	60,7 ± 13,2	50,7 ± 13,2	P < 0.01
HM	60,0 ± 6,2	56,4 ± 8,3		37,1 ± 10,7	37,5 ± 9,0	
HL	59,0 ± 6,3	55,8 ± 8,3		37,0 ± 10,6	38,1 ± 8,5	
Instants and Phases (%)						
FFC	0,01 ± 0,03	0 ± 0,02		0 ± 0	0 ± 0	
FMC	8,7 ± 2,6	11,6 ± 4,3	P < 0.01[a]	0 ± 0	0,34 ± 1,59	
FFF	27,4 ± 9,8	37 ± 9	P < 0.01[a]	4,0 ± 6,6	10,6 ± 9,9	P < 0.01[a]
HO	60,7 ± 6,2	57,4 ± 8,6		38,2 ± 11,5	36,0 ± 9,3	
ICP	8,7 ± 2,6	11,4 ± 4,3	P < 0.01[a]	0,0 ± 0,0	0,3 ± 1,6	
FFCP	18,7 ± 8,9	26 ± 9,7	P < 0.01	3,7 ± 6,7	10,1 ± 9,9	P < 0.01[a]
FFP	33,3 ± 10,5	19,8 ± 10,7	P < 0.01	33,7 ± 11,3	24,2 ± 11,2	P < 0.01
FFPOP	39,3 ± 6,2	42,79 ± 8,5		62,5 ± 11,7	65,4 ± 10,4	

Data are expressed as mean ±SD. Independent T-Test; [a] Man-Whitney U test.

The aim of this study was to compare, the temporal characteristics of foot roll-over in both feet between obese and non-obese PW, during walking forward with side-cut at 45º, and to establish a reference dataset for temporal parameters. The results showed that the initial contact of the regions, M1, M4, M5, HM and HL, occurred significantly earlier in both feet, in the obese postmenopausal women, which are consistent with the results obtained by Monteiro, et al. (2010), where the authors studied the plantar pressure parameters during straightforward walking in postmenopausal women.

According to Blanc, Balmer, Landis and Vingerhoets (1999), the sequence in which different foot areas touches the ground are relevant because they allow us to assess the mediolateral and longitudinal behaviour of the foot and these elements are critical to distinguish between normal and pathological gait. In relation to the right foot obese group touch the ground in the sequence HL, HM, MF, M4, M5, M3, M2, M1, T2-5, T1 while the non-obese HL, HM, MF, M4, M3, M5, M2, M1, T2-5, T1. As can be seen, obese group tend to make a smoother movement between metatarsals than the non-obese group. In a study about the effects of joint stiffness on standing stability an association between the increase in BMI and the decrease in overall stability was reported (Edwards, 2007). On the cited study it was also suggested that people with greater BMI would have greater ankle stiffness to compensate for instability. In fact this trend was also reported in another study (Faria et al., 2009) that compared triceps-surae musculotendinous stiffness between obese and non-obese postmenopausal women. So, it is possible that the increase in stiffness seen in obese subjects may help in the stabilization process contributing to a smoother behavior of metatarsals. Based on this argument we expected to see a similar smoother behavior for the left foot in obese group, however this did not happen. The sequence for the left foot in the obese group was HL, MF, HM, M3, M4, M2, M5, M1, T1, T2-5 and for the non-obese was HM, HL, MF, M3, M4, M2, M1, M5, T1, T2-5. Further studies are needed to address this issue.

As can be seen in table 2 the initial contact of the metatarsals M1, M4, M5 of both feet occur significantly earlier in obese subjects and the final contact of the regions MF, M3, M4, M5 significantly later. This behavior originates a greater duration of contact on the right foot for the regions MF, M1, M3, M4, M5 and MF, M1, M4, M5 for the left foot in obese women. It was reported that an increase of BMI over time due obesity can overload foot structures leading to structural changes in foot anatomy and to the collapse of the medial longitudinal arch (Faria et al., 2010), while in another study Scott, Menz and Newcombe (2007) reported that the more flattened the foot is, greater tend to be the relative duration of midfoot and metatarsals.

In the right foot the instants FMC and FFF occurred significantly earlier, the phases ICP and FFCP were significantly shorter, and the FFP were significantly longer in obese women. For the left foot, the FFF occurred significantly earlier, the FFCP was significantly shorter, and the FFP were significantly longer in obese women. The differences obtained in the present study are in accordance to those reported by Monteiro, et al. (2010), for obese non-sarcopenic that showed a shorter ICP and a longer FFP, however the instants and phases are not consistent with those presented in others studies (Blanc et al., 1999; M. Monteiro, R. Gabriel, M. Sousa, et al., 2010), where the task studied consisted in walking straightforward.

In bipedal locomotion there are many changes of direction when regarding daily activities (Gabriel et al., 1998), these changes in direction can induce modifications in the foot behaviour (Houck et al., 2006). To fully understand the behaviour of plantar pressure in postmenopausal women it is important to establish a reference dataset for temporal parameters of foot roll-over during walking with side-cut maneuvers, which may help to distinguish between normal and abnormal foot roll-over patterns. For the author's knowledge this is the first study that establishes a reference dataset for temporal parameters during this type of task. Nevertheless, future studies should seek to analyze this task using different speeds.

4. CONCLUSIONS

The results suggest that obesity in postmenopausal women, changes the temporal characteristics of foot roll-over (Initial Contact Time; Final Contact Time; Duration of Contact, Instants and Phases), in both feet, during walking forward with a side-cut maneuver at 45º. It also suggests that obesity in postmenopausal women changes the sequence in which different foot areas make the first contact with the ground. Furthermore a representative reference dataset for temporal characteristics of foot roll-over during walking with side-cut maneuver of postmenopausal women was established.

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A Study of the Thermal Comfort in Surface Car Park Booths, Managed by a Municipal Company in Lisbon

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ABSTRACT
This study was based on the hypothesis that a model of thermic comfort could be applied to the job of clerk in a car park in Lisbon or if the model of subjective analysis would be more suitable for areas already occupied. On the other hand, we aimed to assess whether there are significant differences in the application of both models during summer and winter, as well as analyze possible correlations between variables. Based on bibliographic reviews, we created a questionnaire for subjective evaluation of thermic comfort and support for variables in the prediction model of comfort. We also developed an observation form to collect variable architectural characteristics and special technical facilities. The research was conducted during two field campaigns between 2009 and 2010. It was applied to fifty-three workers (whole sample) in eleven parks (the same in two different seasons: summer and winter). We made collections of environmental variables continuously, covering all the working shifts. The results validate the prediction model of comfort but with low correlation, especially in winter. We concluded the subjective rating scales provide reliable and comparable data on the subjective aspects of thermic comfort. After analyzing the data, we observed that there is acceptability and tolerance from the workers, regarding the thermic environment of their workplace. On the other hand, there are the ones who are unsatisfied by the prediction model of comfort which shows a thermic environment unsuitable to their activities. The results of the environmental variables were not within the legal values. This happened with temperature and humidity values such as the correlation between variables of operative temperature, radiant temperature and average outside temperature. The prediction model of comfort should be used with caution, particularly in the winter period, if applied with the conditions described in our study.

Keywords: thermic comfort, PMV, subjective evaluation, car parks.

1. INTRODUCTION

Although this area of knowledge is emerging in Portugal, at the present time, the definition of thermal comfort conditions is a developing theme in the international community. This is, nowadays, considered vital to the well-being, health and productivity of occupants of buildings.

The research taken place in the laboratories was based on the theory of thermal balance between the body and the environment. This theory is influenced by personal factors of the occupants, physical factors and environmental characteristics. The diversity of variables involved, essentially individual susceptibility, leads to different approaches in the analysis of this issue.

The commonly accepted methodology is based on the comfort model of Fanger PO (1973) which was the basis of ISO 7730 (2005). Among other characteristics, for this model to work, it needs field measurements, which is not always possible due to costs.

From a physical and physiological point of view, the human being is represented as a thermal system, therefore, his interaction with the environment is based on the thermal balance represented by several parameters. However, as you know it is not possible to predict the physiological responses, for Parsons KC (2000), thermal sensation is related to the "how the person feels." Therefore, the subjective methods are presented as a tool for evaluation of physiological responses, ie, thermal sensation and comfort. Several scales have been applied in the subjective assessment of thermal comfort, of which, the scales addressed by ISO 10551 (2001) are internationally accepted. This method does not require the use of measuring equipment, which leads to the question: if we are in the presence of a less costly method and perhaps as reliable as the so-called direct methods, why is it not used in a comprehensive manner, by the technical and scientific community? This work was based on a doctoral thesis with the same title, defended at the University of Leon.

2. REASONS FOR THIS STUDY

Why a study on surface car parks, or rather surface car park booths? For a simple reason: most studies are confined to the users area and rarely to the places where non automatic payments in are made. There the workers have a permanent job, in a confined space, where in most cases the meals are eaten, that is, there is a continuous stay in a job at the same location. During this study - thermal comfort – our concerns are risen in surface parks as a result of direct exposure to weather conditions and all the aggression resulting from deployment in urban areas. You can add the possibility of withdrawing some conclusions for the same type booths, supporting the existing tertiary base in modern cities, including points of tickets sale, and newspapers and food sale.

Let us focus, in detail, on every point mentioned above.

2.1. COMPARISON OF METHODS

Generally, and according to Humphreys MA's view (1994) , the first laboratory studies are in line with the prediction of thermal comfort model. However, as stated by Charles KE (2003), most recent lab results show major discrepancies in neutral predicted temperatures. A number of other studies also support this conclusion including the ones by Busch JF (1992), Croome DJ et al. (1992), NA Oseland (1995) and Schiller GE (1990) . He goes further, saying, "Our review indicated that the prediction model of comfort is not always a good predictor of actual thermal sensation, particularly in field studies ". Parsons KC (2000) also raises doubts about the validity of applying the model at an international level. The comparisons made have not obtained consensual results, and there are at least two strands held by different authors: the use of prediction models, based on studies of Fanger, and ergonomic analysis based on actual subjective assessment. Starting from these two models of analysis, it's important to validate the following situations which had never been studied in Portugal before, namely:

- If there is actual validity of the prediction model of thermal comfort for a climate with the Portuguese characteristics of or if the model of subjective analysis is more suitable for evaluation in already occupied areas. We should note that the Portuguese technical community uses the prediction model, which requires costly equipment and high maintenance costs, and there is no scientific study base in this area in our country. In addition to this situation, the authorities responsible for the protection of workers in Portugal do not know alternatives to the prediction model of comfort;
- If there are significant differences in the application of the models during summer and winter periods;
- If there are any correlations in the various variables being studied.

2.2. OPTION FOR STUDY IN THE CITY OF LISBON

As we can easily understand, if we choose a robustly defined space, the object of work is simplified and the relations of cause and effect emerge with another visibility. In addition, most cabins are deployed in this city.

2.3. OPTION FOR SURFACE CAR PARKS

In a preliminary assessment for this study, we found that most worldwide studies were centered in the cabins of underground car parks. We chose to study the surface parks, since there was a gap in data collection for this type of spaces and we felt the need to examine the relationship between the climate and the thermal indoor comfort.

2.4. OPTION PERIODS FOR MEASURING

According to Monteiro A (1997), when the objective is to demonstrate the existence of some evidence of of climate change / climate variability manifestations, the consistency of the arguments is diluted in a tangle of relational webs, among a multitude of independent variables, which we hardly can undo. The definition of allowable fluctuation in variables that are intrinsically characterized by a large and constant variability, such as temperature, is a difficult, controversial and always unfinished task. In order to define a strategy likely to continue in future studies, we opted for the full measurement of the entire work shift (continuous) and taking into account the normal climate situations, implying measurements in August and January, to cover the existing variability. We also recall that in the field of hygiene, traditional field evaluations, using the prediction model of comfort, measurements are usually made without any foresight or resources to planning an intervention.

3. PROBLEM DEFINITION AND OBJECTIVES

3.1. MAIN GOAL

The overall objective of this research is based on checking the suitability of the method of prediction of thermal comfort, proposed by ISO 7730 (2005), for the jobs in question, compared with a subjective method proposed by ISO 10551 (2001), in Lisbon.

3.2. SPECIFIC OBJECTIVES

The specific objectives are based on:

- Evaluation of thermal comfort, based on the method of prediction of thermal comfort;
- Evaluation of thermal comfort, based on a subjective method;
- Look for any similarities or not, between the two methods in the study;
- Analysis of possible cause-effect relationships in thermal comfort in the face of architecture options and special technical facilities;
- Creation of knowledge that will enable the scientific and technical community to use the most appropriate method of analysis of thermal comfort.

4. METHODOLOGY

In this study, we chose to analyze the entire population. In the present study a total of fifty-three workers were inquired, spread across eleven parks located in the city of Lisbon.

After the delimitation of our study, we prepared a set of procedures in order to serialize the various stages of intervention.

4.1. PROCEDURES

Based on the objectives, we highlight the following development stages:

- Evaluation of thermal comfort, based on normal climate levels in Lisbon. The measurement campaigns were carried out in a continuous collection during the workday in two distinct periods of the year - in August 2008 and January 2009. In these measurements we evaluated the air temperature, the average radiant temperature, the air humidity and the air velocity using the data acquisition equipment, DeltaOhm HD32.1and its probes, in full compliance with all ISO standards for equipment , mode of data collection and processing, including the ISO 7726 (1998) regulations.
- Application in both periods, of the model of prediction of thermal comfort, developed by Fanger and regulated by ISO 7730 (2005);
- Application of an evaluation questionnaire of psychological responses, based on the use of subjective assessment scales, regulated by ISO 10551 (2001);
- A survey of architecture and technical facilities of the special booths where we carried out the fieldwork;
- Statistical treatment: correlations between physical variables raised, as well as evaluation of any significant differences either between the two measurement periods, either of several variables presented above;
- validation of the applicability of the methods described above with the issuance of any recommendations for use of tools for analysis of thermal comfort, given the multiple of instruments used.

5. RESULTS AND DISCUSSION

Fifty-three workers participated in the study, thirty-three females (62.3%) and twenty males (37.7%). From these fifty-three, twenty-six were surveyed in the summer and twenty-seven in the winter. Most of them (79.2%) had ages between 21 and 40 years old. Ten people were aged between 41 and 60 years old and only one was more than 60 years old. The participants' average height was 1.67 meters, their average weight was 73.6 kg and they had a body mass index of 26.3. At the general time (summer and winter), 41.5% of workers feel neutral: in the summer, the temperature rises to 57.7% and in winter it drops to 25.9%. We note that, in general terms, 35.8% considered themselves to be hot, very hot or cold, or very cold. In the winter season, 48.1% of the inquired feel cold or very cold.

In a subjective assessment, it is essential to analyze in depth, the estimation scope, preferences, acceptability and tolerance of the worker against the thermal environment. After analyzing the thermal environment in the workplace, we reached the following conclusions: in the summer, 15.3% of workers considered themselves to be uncomfortable or very uncomfortable; 37% of the workers considered the same in the winter and 26.4%. of the workers felt the same during the general time (summer and winter). It is evident that winter has the highest percentage.

Regarding the question, "How would you rather be right now?", the results were the following: At the general time (summer and winter), 69.8% of the workers would like some kind of change; 69.2% of the workers have the same answer in the summer and 70.4% in the winter . Similarly, the question "How do you view the thermal environment in your workplace?" reveals that in the general time (summer and winter) 35.8% of workers believe the environment is not acceptable; in the summer, the figure drops to 30, 8%, and it rises to 40.7% in the winter.

Finally, with regards to tolerance, we directly asked the workers' opinion about the existing thermal environment in their workplace: at the general time (summer and winter), 45.3% of workers find it quite tolerable, 24.5% slightly difficult to tolerate, 18.9% fairly difficult to tolerate and 11.3% very difficult to tolerate. In the summer, 46.2% of the inquired consider it to be perfectly tolerable, 30.8% slightly difficult to tolerate, 19.2% fairly difficult to tolerate and 3.8% very difficult to tolerate. Finally, in the winter, 44.4% think it is perfectly tolerable, 18.5% slightly difficult to tolerate, 18.5% fairly difficult to tolerate and 18.5% very difficult to tolerate.

We have also established statistically significant differences in mean values in independent samples (summer and winter) in the question "How would you rather be right now?" There are equally significant differences between summer and winter on the issue "How do you feel right now? ".

We found a direct significant correlation ($R = 0.345$) between the two variables: subjective PMV and PMV (Predicted Mean Vote). However, there is a low correlation. In a time assessment, we found that there are no significant differences between the means of the two variables under study in the summer; however, in the winter, the difference between the means is considered significant.

At the Meteorology Institute of Portugal, we asked for data obtained by a meteorological station in the days where fieldwork was carried out. We highlight the significant and direct correlation between the item "average outdoor temperature" and the variable PMV.

With regards to the room temperature in the winter, we observed that the minimum and maximum values obtained are pronounced, with differences of more than 20 ° C, pointing to some inefficiency in thermal insulation. The collected values of mean radiant temperature in the winter are approximately equal to the values of air temperature, except in *Luz* car park where you get 22.4 degrees C, that is, less 4.6 ° C.

Looking at the PMV variable we did not find any significant correlations with the variables of special architectural and technical facilities.

We would like to note that, with the exception of the meteorological variables, the operative temperature was the only variable which obtained directly significant correlation with the variable PMV or Subjective_05 PMV which demonstrates the importance of this variable to the thermal sensation.

In the applied observation form, it is emphasized that all cabins were built of brick, plastered and painted, with the exception of the one in *Luz* car park where the cabin is made of metal sheets. All areas visited were equipped with air conditioning equipment, without air exchange.

6. CONCLUSIONS

One of the key questions of the study is to investigate which of the methods, the prediction of comfort or subjective method, would be more appropriate for assessing the level of thermal comfort in payment booths in surface car parks. We have obtained statistically significant direct correlation (R = 0.345) between the two variables under study (PMV and PMV Subjective_05, where 50% of occupants who voted +1 or -1, were transformed into voting -0.5 or +0.5). However, the values of this correlation were admittedly low which suggests the use of the prediction model of comfort, as set out in our study, with many reservations. These increase in the use of the method in the winter season. In workplaces with few employees and with conditions similar to our study, we recommend the use of assessments of thermal comfort through the subjective method, as defined by ISO 10551 (2001). This conclusion is in line with the formulation that we have made initially when we stated that the supervisory and technical community can and should use the subjective method, in squats, for analysis of thermal comfort.

It was demonstrated how this approach allows a screening of thermal comfort with accuracy, low cost and therefore it extends to all sectors and types of companies (Micro Enterprises, Small and Medium Business and Large Business), so it should become standard practice the same , or similar conditions to the ones in which this work was developed. Taking these general conclusions as a starting point, we thought fit to examine in detail the set of specific objectives, in order to obtain scientific evidence of the phenomenology associated with the subject being studied.

Related to the first specific objective, the validity of the prediction model of thermal comfort, despite what has been said earlier, the present results reinforce the fact that this model should continue to be used in workplaces where we want to predict the thermal sensation of a group of occupants, particularly in empty rooms where we predict occupation or alteration of environmental conditions, activity or uniform characteristics of the occupants.

This conclusion is evidenced by the interpretation of the results obtained after the study of the two methods (prediction model of thermal comfort and subjective method). Based on the prediction model of thermal comfort, we got a PPD (Predicted Percentage Dissatisfied) of more than 10% in 40% of the cases. In practice, in these cases, more than 10% of the population was dissatisfied. There were even special cases of dissatisfaction with grades above 44%. We conclude that the absence of normative acceptance conditions, reinforces the difficulty of implementing the standard rules, a situation that we consider it should be revised.

Regarding the second specific objective, focused on the method of subjective validation, the difference was noticeable on the results on the sense of neutrality: in the summer 57.7% of respondents felt neutral and 25.9% felt the same in the winter. From the results obtained in the two periods, 35.8% of workers surveyed considered themselves to be hot, very hot, cold and very cold.

In estimated terms, in the summer, 15.3% said they were uncomfortable or very uncomfortable. In the winter, the percentage rises to 37%. These values are enhanced by 69.8% of the workers who stated they would prefer a change in the thermal environment. We add that 35.8% of them considered the environment not to be acceptable. It was found that the subjective rating scales provide reliable and comparable data on the subjective aspects of thermal comfort.

Based on the results obtained, the need for a multidimensional assessment was reinforced, valuing the estimates, the preference, the acceptability and the tolerance of workers, to the thermal environment. Each dimension allows a differentiated analysis which is not always relatable. So, we should not be limited to a subjective method of analysis which is based on estimates. Instead, we should move to a case by case approach, which can lead to possible reductions in intervention costs.

Based on the third specific objective ,aimed at investigating possible correlations between architecture / technical facilities and thermal comfort, it was found that the values of temperature in the summer campaign gathering are outside the range defined by the Portuguese legislation. However, it is emphasized that, in most cases, values have not significantly exceeded the upper range. On the other hand, in the winter there were pronounced differences between the minimum and maximum values pointing to some inefficiency in the thermal insulation of cabins. This was most evident in cabins with construction of the removable type (metal sheets).

The sampling time for collection is recognized as essential in all risk assessments. In the evaluations of thermal environment we consider an analysis of preliminary risks is essential in order to set a time to collect appropriate and representative data.

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Reflections on the work capacity of teachers in schools environments of João Pessoa-Brazil

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ABSTRACT
Because of the multiplicity of variables that can affect the health and welfare of teachers and considering that according to national and international standards in the studied classrooms the noise levels are not adequated for teaching, this paper aims at assessing the work ability of teachers in the 5th grade of municipal elementary school in the city of Joao Pessoa, Paraiba, Brazil, characterizing them in relation to sociodemographic and occupational data, reflecting on what factors might affect their capacity to exercise the activities of teaching. These finds will subsidize the rate of capacity for work (WAI) for the construction of non-linear regression model to analyze the relationship between these variables and WAI entres. It was observed that most of the population has ICT in the category "Good" (39.2%) or "Excellent" (38.3%), despite the discomfort from the noise on the classrooms; teachers who are mothers and that had devote themselves to the teaching activities in educational establishment only in the morning and/or afternoon shift have a good WAI; variables "leisure activity" and "marital status" have good reflexes in WAI for teachers; the logistic model shows that "physical activity" is important for the teacher to have a good performance, considering that with advancing age this performance may not be satisfactory. Yet the noisy environments associated with other variables related to the teaching-learning process and the socioeconomic aspects can collaborate with the low performance of the teachers.

Keywords: Reflection; Work capacity; Teacher.

1. INTRODUCTION

The teacher's work is primordial to the development of a population, since acting as direct participant in the formation of citizens contributes to the occurrence of new transformations in the political and social areas of the country. However, despite the importance of this kind o professional to the society, which is observed is the neglect of the way and working conditions, which may lead over the years in the exercise of the profession an exhaustion, emotional depletion with the possible development of negative attitudes toward work and lack of interest and personal involvement with the school in which it operates, leading him often to develop burnout syndrome (CODO, 2002).

Thus, being or not satisfied in relation to work incurs several consequences, whether in personal or professional plan, directly affecting the behavior, the health and well-being of the worker. This assertion is based on the model of the consequences of job dissatisfaction proposed by Henne & Locke (1985), in that job dissatisfaction can lead to consequences on individual lives, mental health and physical health of that individual.

Thereby, due to the multiplicity of variables that can affect the health and well-being of the teachers, this study aims to evaluate the capacity to work of teachers from "5º ano" of the Municipal Elementary Schools in the city of João Pessoa, Paraíba, Brazil characterizing them in relation to sociodemographic and occupational data, reflecting on what factors might affect their capacity to exercise teaching activities, which subsidize similarities surrounding the Index for the Work Ability - IWA for the construction of model nonlinear regression to assess the relationship of these variables and IWA.

1.1. Capacity for Work

It is known that the performance of a task is directly linked to man's ability to perform it, but that each worker develops his own capacity and did not remain constant over the years. According to Sell (2004), the physical, mental and psychoemotional capacities vary among individuals depending on the physical constitution, sex, health status, knowledge, skills and experiences, as well as physical and psychological characteristics of each individual. These variations among different individuals are known as interindividual differences. In addition to these variations there are those observed in individuals throughout their lives, these differences are called intraindiviuais and refer to the losses and changes in capacities over time. Tuomi et al. (2005) states that the capacity for work is related to the capacity that the worker has in performing their work according to the requirements of this work, their health and their physical and mental abilities.

Several instruments have been used to measure and evaluate the capacity for work, among them stands out Index for the Work Ability - IWA, self-administered instrument that was developed by a multidisciplinary team (psychologists, physicians, biostatisticians, epidemiologists and researchers in the field of Occupational Health) of the Finnish Institute of Occupational Health - FIOH during a decade (1981-1992) for monitoring of municipal employees in the process of aging. This instrument measures the "how well is or will be, a worker now or in the near future, and how well he or she can perform their work, according to the requirements of his/her health status and physical and mental capabilities"(Tuomi et al., 2005), based on the perception of employees and is comprised of seven items, as shown in Table 1.

Table 1 - Index for the Work Ability: Its Items and its Referential Values

Item	Achievable Scores
1. Current capacity for work compared to the best of all life	0 – 10
2. Capacity for work in relation to job requirements	Balanced points
3. Number of current diseases diagnosed by physician	1 – 7
4. Estimated loss to the work due to diseases	1 – 6
5. Work absences because of diseases in the last 12 months	1 – 5
6. Own prognosis on the capacity for work in two years	1, 4 or 7
7. Mental resources	1 - 4

Source: Tuomi et al. (2005)

The results of the seven dimensions provide a measure of work capacity ranging from 7 to 49 points, being this value the concept that the worker has its own capacity to work. With the score achieved is the IWA category of the worker and the objectives of the necessary measures to be taken, as shown in Table 2.

Table 2 - Points of IWA and its Objectives

Points	Capacity for work	Objectives of the Measures
7 – 27	Low	Restoring the capacity for work
28 – 36	Moderate	Improve the capacity for work
37 – 43	Good	Support the capacity for work
44 – 49	Great	Keep the capacity for work

Source: Tuomi et al. (2005)

Thus, it is clear that the purpose of this index is to provide information that allows actions to support workers through accompanying measures that can be used from the moment that the workers join the workforce, helping thereby maintenance evaluation of capacity for work over the time.

According to Willians (1997) and Liira, (2000) apud Meira (2004), the evaluation of the capacity to work helps in prioritizing and identifying workers who need or will require a short period of time the support of occupational health services, thus ensuring an early attention to optimize the conditions to prevent a premature decline of the capacity to work. The methodology of IWA can be used in the monitoring of individual workers as well as in groups or sections of employees to support, guide and monitor the results of interventionist measures and additional evaluations as may be necessary for workers and the workplace.

Thus, from a set of observations about the possible variables that may impact in the teacher's performance, will produce a logistic regression model that will allow the prediction of values taken by the variable IWA

1.2. Logistic Regression

It is not always possible to collect information of all the population in which one wishes to study, whether the cost or the time that this collection would need. In this context, Regression Analysis becomes an extremely powerful tool, since through mathematical and statistical resources you can find some function that estimates the behavior of the data set that is not available, from the data collected. Logistic regression can be considered an extension of linear regression but the dependent variable is categorical. While the linear regression gives an answer in numeric value, the logistic regression gives a response probability of chances to occur the fact that is being studied (Batistela et al., 2009).

The purpose of this tool is to find a model which has a good fit to describe this relationship between the response variable and explanatory variables. However, in order to Garson (2005 apud PACAGNELLA JR. Et al., 2009) the deduction of the logistic regression model must obey certain presuppositions, namely: the dependent variable must be binary or multinomial (with more than two categories); one should include all relevant variables in the model; it should be excluded the irrelevant variables of the model; it should not exist any multicollinearity; and one should search a proper fit.

The parameter π of the logistic regression model takes values between 0 and 1, and can be interpreted as the probability of an event. Its value is given by:

$$\ln\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_p X_{pi}$$

An important coefficient when working with logistic regression is the odds ratio (ratio of chance). This coefficient will report the effect of variation in a certain variable on the chance of the occurrence of an event. It is given by:

$$Razão\ de\ Chance = \frac{\pi}{1-\pi} = e^{\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_p X_{pi}}$$

The most commonly used method for estimating the parameters of a logistic regression model is the method of maximum likelihood (Ryan, 2009). With this method are sought coefficients that allow us to estimate the highest probability of an event happen or a certain characteristic to be present (Correia et al., 2007).

It is noteworthy that when working with subjective variables, which are difficult to measure, it is important to make use of other techniques and/or statistical methods to analyze the relationship among variables in their various groups. Among the various techniques that verify the similarity among the process variables, one gets the cluster analysis.

1.3. Cluster analysis

Multivariate analysis is a statistical tool that processes information in order to simplify the structure of the data and synthesize the information when the number of variables involved is very large, facilitating the understanding of the relationship between process variables. It is also composed of several methods that have different objectives to each other, but you need to know what is actually to argue about the data. If the interest is to see how the samples are related, or, how these are similar, the method to be used for hierarchical clustering analysis (Souza et al., 2006).

According Mingote (2005), the cluster analysis, also known as conglomerate analysis, classification, or cluster, aims to divide the elements of the sample or population group so that the elements belonging to the same group are similar to each other with respect to variables (characteristics) that were measured in them, and the elements in different groups are heterogeneous with respect to these same characteristics.

Thus, the problem of cluster analysis intended as a set of data consisting of n sample elements, each measured on p-random variable, find a classification scheme that can group these elements into g groups. For each sample element j, we have, therefore, the vector measures Xj defined by

$$X_j = [\, X_{1j}\ X_{2j}\ \dots\ X_{pj}\,]',\ j= 1, 2, ..., n$$

where Xij represents the observed value of the measured variable in the element j. In order to make the clustering of elements, it is necessary to decide a priori the extent of similarity or dissimilarity to be used. In the measure of similarity, the higher the values observed, are more like objects. As for the dissimilarity measure, the higher the values observed less alike (most dissimilar) are the objects. The correlation coefficient is an example of similarity measure, while the Euclidean distance is an example of dissimilarity. In this study, will be used Euclidean distance which is defined by:

$$d(X_l, X_k) = [(X_l - X_k)'(X_l - X_k)]^{\frac{1}{2}} = [\textstyle\sum_{i=1}^{p}(\, X_{il} - X_{ik})^2\,]^{1/2}$$

According to Gimenes et al. (2004), the cluster analysis is interesting, especially under the descriptive aspect, because its outcome, the methods, a graph of hierarchical scheme which is called dendogram. This represents a summary of the results, which causes some loss of information. Even so, if this loss is small, a summary of information becomes easier to be handled and stored, it is important for comparison, classification and discussion of the material studied.

2. MATERIALS AND METHODS

The research was conducted in the Municipal Elementary School in the city of João Pessoa, Paraíba, Brazil which are distributed according to the city's neighborhoods and are composed of nine poles, forming a total of 88 schools. Of this total, only 22 schools were not included in this study, either by reason of being under construction or for some unforeseen at the time that was made the visit at the school (eg, the addition of classes or even vague class) or by school does not have the 5 th year since the research was conducted only with teachers in this series.

To evaluate the capacity for work of the teachers was used the Index for the Work Ability - IWA (Tuomi et al., 2005 and Martinez et al., 2009). In this questionnaire, we added a brief introduction explaining the research objectives, in addition to sociodemographic and occupational issues that help to establish a more detailed profile of these professionals.

The questionnaire was hand delivered to each teacher in his post and his work shift, taking about 10 minutes to be answered. The return was made soon after the completion of the filling so that the delivery of it was guaranteed.

The current perception of capacity to work compared to the best of life contained in the questionnaire was analyzed categorically, according to the following ranges: $0 \leq$ Low ≤ 2, $3 \leq$ Moderate ≤ 5, $6 \leq$ Good ≤ 8, $9 \leq$ Great ≤ 10.

After completion of data collection, tabulation and data analysis were performed using SPSS software v. 13.0. To make the cluster analysis was made the use of the software Statistica v. 7.0, taking to the variables the following encodings: A - Age, MS - Marital status, E - Education; IA - Age you started working, TTS - Teaching time in the current school; NW - Night work; OA - Other Activity; DW - Domestic Work; Ki - Kids; PA - Physical Activity; LA - Leisure Activity; LR - Labour Requirements; PDW - Preventing the Disease to Work; Abs - Absenteeism, AA - Appreciation of Activity; CCW - Capacity for Current Work; CCW - Capacity for Current Categorized Work; CPD- Capacity for Current Work in relation to the Physical Demands; CMD - Capacity for Current Work in relation to the Mental Demands; IWA - Index of Capacity for Work; ICTC - Index of Capacity for Categorized Work. For the logistic regression model was used the backward method with support from the R software (MCCULLAGH & NELDER, 1989; RYAN, 2009) such that 36< IWA ≤49, if Y=0; and 7≤ IWA≤36, if Y=1.

3. RESULTS AND DISCUSSION

3.1. Analysis of IWA - the sociodemographic and occupational issues

The population for this study consisted of 120 teachers, all of which were female and mean age of 41,71 years ($\sigma = 9.43$). The analysis of the variables in the questionnaire showed that most respondents do not work at night exercising the same profession (77.5%) did not have another job (53.3%) did not practice physical activities (63.3%), perform household

chores (98.3%) and have children (69.2%). Among the respondents who have children, 79.5% are married and living with a partner and 20.5% are single / divorced / widowed.
Regarding the number of diseases diagnosed by a doctor, 38.3% have no disease, 20.8% have only one disease, 24.2% have two to four diseases, and 16.7% have five or more diseases. However, considering not only the diseases diagnosed by a physician, but also those which the teachers think they have, the results showed a significant increase in the amount of disease, since there was a decrease of more than 50% of the teachers who have one or no disease, besides having a considerable increase in the number of teachers with more than two diseases. These results are shown in Table 3.

Table 3 - Numbers and percentages of diseases diagnosed and undiagnosed by doctors

Number of diseases	Diseases only Diagnosed by the doctor		Diseases in general (Not only Diagnosed by the doctor)	
	n	%	n	%
5 or more diseases	20	16,7	40	33,3
4 diseases	8	6,7	17	14,2
3 diseases	14	11,7	17	14,2
2 diseases	7	5,8	14	11,7
Only 1 disease	25	20,8	12	10,0
No disease	46	38,3	20	16,7
TOTAL	120	100	120	100

With respect to IWA, 22.5% of teachers are in the range moderate; 39.2%, good and 38.3%, great. The average IWA score was 40.80 points (σ = 5.05), comprising the interval between 30 and 49 points, showing that the teachers have a great performance for work.
However, if the diseases that have not been diagnosed by doctors could be considered in the calculation to get at the IWA of each teacher, the number of teachers in the moderate category would increase 10%, down 12.5% in the category Great. Another difference in perception was the result of each teacher as its current capacity for work compared to the best of all life (categorized as low, moderate, good and great). This perception resulted in a difference of response of 48.3% of capacity obtained based on questionnaire responses and 60% of capacity for work determined by the same questionnaire, but having considered all diseases. Figure 1 shows the percentage of teachers according to the classification of the capacity for work achieved by these three ways.

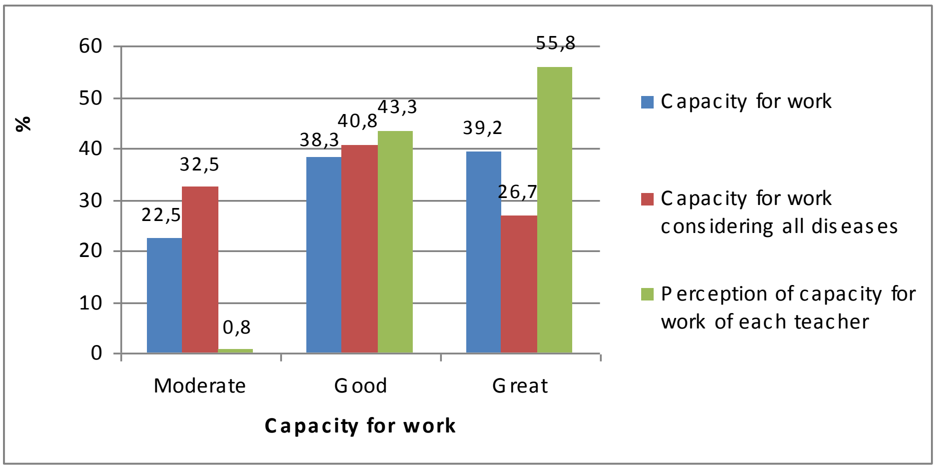

Figure 1 - Percentage of teachers according to three ways that determined the Capacity for work

On the other hand, the analysis of some socio-demographic conditions in relation to IWA showed that 78.5% of the teachers who do not work at night, 78.1% do not have another job and: Teachers (75%) who have children their performance for the work are in the category of good to great. These results can be explained by the lower physical and mental effort of those who do not work at night and does not have another job, but also by those who have greater responsibility with their children, which is one way to ensure the job. Figure 2 shows the amount in percentage of teachers who have the IWA category at the Good / Moderate regarding sociodemographic conditions described previously.

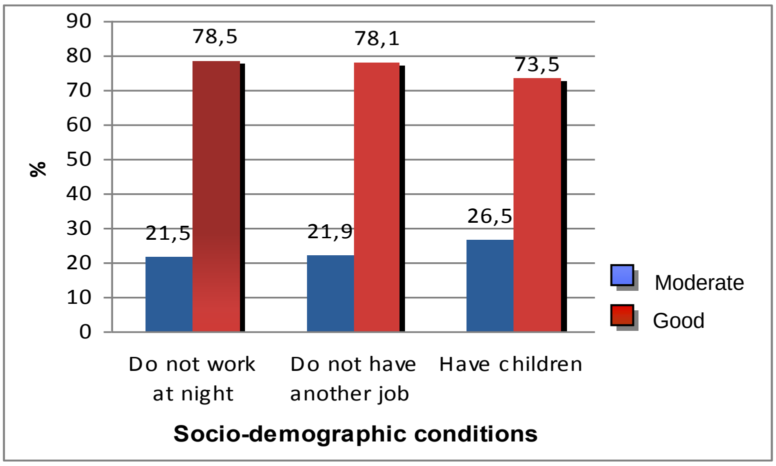

Figure 2 - Percentage distribution of the IWA of the teachers according to the sociodemographic conditions.

3.2. Cluster Analysis

In order to identify possible variables that involve the Capacity for Work of teachers, which may present some similarity among them, it was done a cluster analysis, thus getting hierarchical graph schemes summarizing the results and makes it easy to visualize that group, shown in Figure 3.

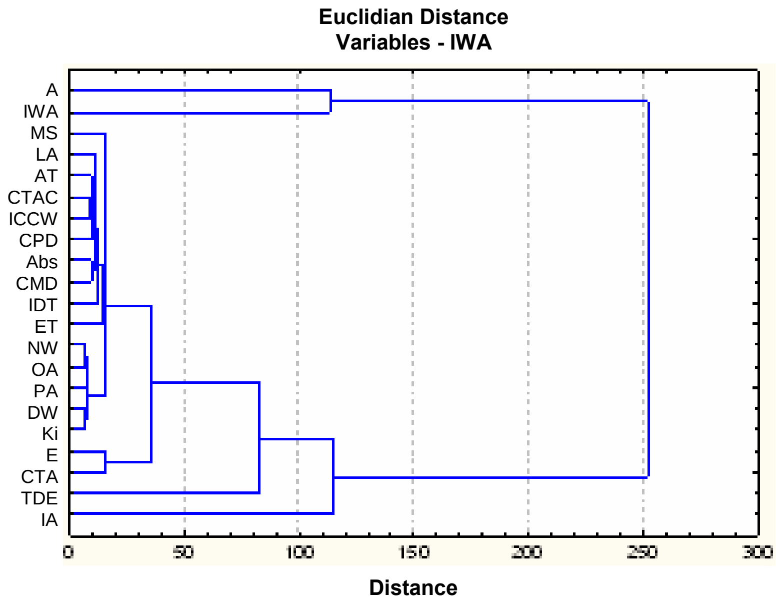

Figure 3 - Dendogram of the variables that form the basis of the teachers' performance

As the dendogram and according to the Euclidean distances (HUSSON et al., 2011), the variables which have more similarity and its supposed explanations are described below:

- **Ki** (kids) and **DW** (Domestic Work): Teachers who have children end up having almost always the need to perform beyond professional tasks, beyond the professional chores.
- **NW** (night work), **OA** (other activities) and **PA** (Physical Activity): night work as well as being inherent in other activities, it generates other than those carried out during the day (morning and / or afternoon - working time where the research was performed). Thus, it is expected that the completion of large number of activities in which the teachers do have a increased need for perform some physical activity, seeking in this way, reduce stress and prevent diseases as well as provide additional impetus.
- **Ki** (Kids), **DW** (Domestic Work), **NW** (night work), **OA** (other activities), **PA** (Physical Activity), and **MS** (Marital Status): It is expected that the marital status and presence of children may interfere directly in need of teachers to perform other work activities, as well as in the precision of performing physical activities as a way to prevent diseases and achieve greater energy and strength to work.

To better understand the similarities described above, the figure 4 shows another way to visualize the relationships between the variables commented.

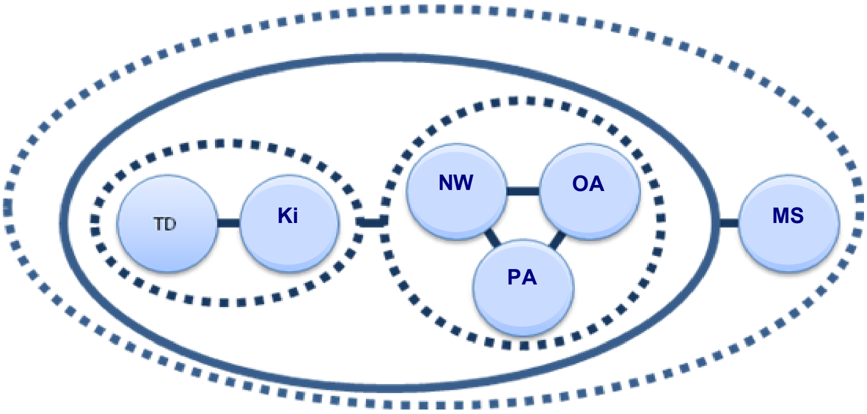

Figure 4 - Visualization the of similarities between variables

• **CMD** (Current Capacity for Work in relation to Mental Demands) and **Abs** (absenteeism): It is expected that the job can require the more mental effort of teachers, the lower, over time, will be your mental ability in realizing your work and, consequently, the amount of lack of these professionals in their workplace will be bigger, they will have more chances to get sick and also bigger necessity for medical and school exams.
• **AA** (Appreciation of Activity), **CCW** (Capacity for Current Categorized Work), **ICCW** (Index of Capacity for Categorized Work) and **CPD** (Capacity for Current Work in relation to the Physical Demands): **AT** (assessment activity), **CTAC** (Current capacity for work categorized) **ICCW** (index of capacity for categorized work) and **CPD** (Current capacity for Work in relation to the Physical Demands): It is expected that the more the work of teachers require physical efforts, the lower is its current capacity for work in relation to physical demands over time and, consequently, their capacity for current work and its index of capacity for work. Thus, it will be unlikely these professionals can appreciate their daily activities.
• **CMD** (Current Capacity for Work in relation to Mental Demands), **Abs** (absenteeism): **AT** (assessment activity), **CTAC** (Current capacity for work categorized), **ICCW** (index of capacity for work categorized), **CPD** (Current Capacity for Work in relation to the Physical Demands) and **LA** (Leisure Activity): it is expected that as its physical and mental health of teachers is increased, the current capacity for work is diminished, as also the index capacity for work and their appreciation for the activity performed. Thus, it is necessary to have the conduct of leisure activities so that we can somehow help at least maintaining the current capacity of these professionals.
Similarly, to better understand the similarities described above, the figure 4 shows another way to visualize the relationships between the variables commented.

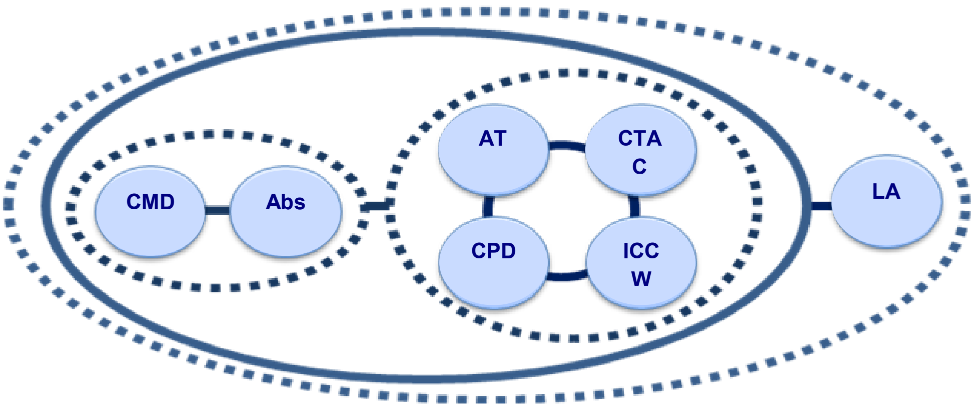

Figure 5: Clustering of variables CMD, Abs, AT, CTAC, ICTC, CPD, MS by similarity according to the dendogram shown in Figure 3.

3.3. Modelling non-linear regression

Following the backward method and adopting as acceptable variables presenting only two variables remained in the model: PA (physical activity) and A (age) α <0.06, 11 models were generated. The table 4 shows the characteristics of this model.

Table 4 – Results of Logistic Regression Model

Parameter Estimates				
Var (variable)	Estimate	Standard Error	Wald	prob.>Wald
PA	-0.950097	0.499521	-1.902	0.057169
A	-0.022319	0.005994	-3.724	0.000196

From the estimated parameters was constructed the logistic model (1)

$$Y = \frac{e^{-0.95010 \cdot PA - 0.02232 \cdot i}}{1 - e^{-0.95010 \cdot PA - 0.02232 \cdot i}}$$

IWA is divided into two categories (36 <IWA≤ 49, Y = 0 and 7 ≤ IWA≤ 36, Y = 1), one can say that people who practice physical activity (PA) is 0.387 times more likely to have capacity for work in a lower category, ie, there will be 63.1% less chance to have the capacity for work in the lowest category. As for the age (I), one can say that over the years (each year) increases the chances of their capacity for work suffer a decrease, ie, there will be 2.2% (1-.978 = .022) less chance to have the ability for work in the lowest category.
However, seeking a more consistent model was adopted α <0.001, making it necessary to delete the variable PA (Physical Activity) of the model. Thus, was generated only one new model with the variable I (Age), obtaining p_value <<0.001, as shown in Table 5.

Table 5 – Results of Logistic Regression Model

Parameter Estimates				
Term	Estimate	Standard Error	Chi- Square	prob.> Chi-Square
I	-0.029037	0.005252	5.529	3.22e-08

Thus, according to Table 5, the new model can be expressed by Equation 2:

$$Y = \frac{e^{-0,029037 \cdot i}}{1 - e^{-0,029037 \cdot i}}$$

So for this last model, the increase in one year increases the chance of their capacity for work pass to lower category in "exp (-0.029037) = 0.971" times, ie, there will be 2.9% (1-.971 = .029) less chance of the teachers possess the capacity for work in the lowest category, with a 0.7% decrease in the chance in relation to the previous model.

4. CONCLUSIONS

- ✓ Most of the studied population presented the IWA in the good category (39.2%) or great (38.3%), despite the discomfort of the noise of the rooms;
- ✓ Mothers teachers who devote themselves only to the teaching activities in the school have a good IWA;
- ✓ The variables “leisure activities” and “Marital Status” have a positive impact on teacher performance;
- ✓ The logistic model shows that the "Physical Activity" is important for the teacher to have a good performance, considering that with advancing age the performance may not be satisfactory.

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Bayesian modeling approach for data analysis of acoustic comfort in classrooms of primary education in Joao Pessoa, Paraíba, Brazil

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ABSTRACT
The education process is essential in all modern societies. This process involves intense verbal communication and therefore it is necessary that school environments have suitable conditions for acoustic comfort. Acoustic comfort is a factor that is directly related to good or poor performance of teachers. The Bayesian inference arises in this context as a powerful tool, as it allows more complete analysis about the working conditions which teachers are exposed. The steps for the construction of a Bayesian model are: determining the likelihood function to sample data, an initial distribution point (a priori) to represent the phenomenon, and finally, using the Bayes theorem to combine the likelihood function for the prior determination of the posterior distribution. A major advantage of Bayesian inference is the possibility of using subjective information related to existing phenomena studied. Any existing knowledge associated with the phenomenon under study will allow a better future analysis, since the analysis was based on a step further. This study aims to obtain the posterior distributions that will enable more complete analysis of environmental thermophysical parameters, here more specifically the parameters of acoustic comfort. In addition, we propose a Bayesian model that relates the variables of interest (acoustics and speech intelligibility of the teacher). The proposal of the Bayesian model was performed by combined distributions. It was used an uninformative Jeffreys priori and as a result it was obtained distributions of Student for the model parameters. One of the most important contributions of this work is to propose a Bayesian modeling methodology. This methodology relates to the combination of probability distributions to the parameters of the fitted model. The use of this practice in further studies would allow a thorough analysis, since values would no longer be estimated, but the probabilities of occurrence would be found.

Keywords: Bayesian Inference; Acoustic COnfort; Elemantary Schools

1. INTRODUCTION

Many experiments have shown that for a nation to progress it is needed Government's large investment in education. Zannin & Zwirtes (2009) claim every citizen education is essential to all modern societies. For the same authors, the formal education takes place in the classroom where the learning process involves intensive verbal communication between teachers and students. Over the years school environment has proven to be significantly important for the researchers. That is the reason for the classroom environment has been one of the most studied and analyzed in the research of environmental comfort. This trend can be explained by the widespread influence that these environments play in the formation of citizens.

In this context, Zannin & Kruger (2004) state that acoustic comfort is an essential factor in the development of classroom activities, especially those requiring a high level of concentration.Noise in the school environment is not only a nuisance, but interferes with the performance of the teaching activities (Fernandes, 2006). When working in a noisy environment, the worker will require more energy to run. To Gonçalves (2008), acoustic comfort in classrooms is one of the factors that are directly related to good or bad vocal performance of the teachers. For this reason it is necessary to investigate the influence caused by this phenomenon in the performance of teachers.

Much has been made with regard to the study of working conditions. In this context, the development of research in Experimental Ergonomics has raised questions in observation level as well as in choosing the method for processing and analyzing data and that is where the statistical models are fundamental. In this paper the data analyzed are related to speech intelligibility of the teacher and the acoustics of classrooms. In order to determine the relationship between experimental variables, these models allow an analysis of the influence of each variable on a dependent variable.

For a long time conventional statistics prevailed in much of the analysis of studied phenomena, however, computational advances associated with the emergence of many statistical packages, allowed the popularity of Bayesian inference mechanisms. One of the great advantages of this technique is the possibility of using existing subjective or not subjective information to the phenomena studied. Any existing knowledge associated with the phenomenon under study will allow a better analysis, since the analysis will go a step further. This existing information is modeled by probability distribution called the prior. The collected data is explained by means of a likelihood function, which when associated with the prior distribution, will result in a subsequent function. The inference is made from this function.

Thus, this work had the objetcive to analyze parameters of acoustic comfort in classrooms of public schools in João Pessoa and evaluate the speech intelligibility of the teacher in this environment. These data were used to construct a

Bayesian model that aimed to relate the above parameters, comparing some of these obtained values with those determined in the related standards.

2. LITERATURE REVIEW

2.1. Ergonomics experimental

To IIDA (2005), there are many ways to define ergonomics, but they all point to the interdisciplinary nature and its object of study, that is the interaction between man and work.According to the Ergonomics Society, Ergonomics is the study of the relationship between man and his work, equipment, environment and particularly the application of knowledge of anatomy, physiology and psychology in solving problems that arise from this relationship.

In Brazil, ABERGO adopts the following definition: "Ergonomics is defined as the study of interactions between people and technology, organization and environment, interventions and projects aiming to improve, in an integrated and non-dissociated way, security, the comfort, welfare and effectiveness of human activities."

Hendrick (2008) also highlights the fact that the science and practice of ergonomics are the same anywhere in the world, because although the emphasis in certain situations or applications may differ in each location, the actions of ergonomists are the same regardless the geographic region in which it is.

Kroemer et al (1994 cited in Smith 2001), say that there are two distinct aspects in Ergonomics: one related to research and experimentation, which determine the particular and specific human characteristics necessary for preparation of a draft, and another related to the implementation of engineering, where design tools or instruments, machines, environments, tasks and working methods to adapt and accommodate the man. Experimental Ergonomics, focused on research, development and experimentation, raises question-level observations as well as in choosing the method for processing and data analysis. The search for solutions through logical and /or operational instruments guarantees the accuracy of scientific information and conclusions you want.

2.2. Acoustical Comfort

Conceptualize the noise is not as easy as it seems. There are several definitions, among which the most usual, considers the noise as an unwanted sound (Gerges, 2000). Physically, the noise can be considered a complex mixture of various vibrations measured on a logarithmic scale, whose unit is decibel (dB) (IIDA, 2005).

Usually the term sound is used to the pleasurable sensations, such as speech or music, while the term noise is used to describe an undesirable sound like horns, traffic noise and machinery (SOUZA, 1998). However, contrary to popular belief, noise levels are not only those likely to cause injury to the hearing aid, but also any condition which might influence the performance of the task (Juang, 2010).

Iida (2005) states that according to Brazilian standards (NR-15) for a workday of 8 hours, the tolerance limit is 85 dB, and every increase of 5 dB(A), the maximum noise exposure is reduced by half. In turn, the ABNT NBR 10152/87 fixed noise levels compatible with the acoustic comfort in different environments, establishing the acceptable ranges for the sound pressure level (LPA) in decibels [dB], according to its typology.

Table 1- Shows the noise levels recommended for school environments:

Local	Sound Levels (dB)
Libraries, music rooms and drawing rooms	35 – 45
Classrooms and Laboratories	40 – 50

Source: NBR 10152/87

2.3. Intelligibility of speech

Besides the absence of noise, another parameter that indicates good conditions for acoustic comfort is speech intelligibility. The common definition of intelligibility corresponds to the quality of what is intelligible or hears well, or understands well. Levitt and Webster (1991) define speech intelligibility as the understanding of spoken words.

For Fernandes (2003), the concept of intelligibility is quite general and can be defined as the reason why we understand the sounds. Intelligibility can be applied to language, singing, musical notes, or even other sounds. As the voice is the sound heard in more than 90% of the time in our day to day, the intelligibility of speech is more usual.

In the classroom is very important to have a good intelligibility. To Nábělek and Nábělek (1997, cited in Gill, 2008) speech intelligibility in classrooms is influenced by three factors: the level of speech, the room reverberation and background noise.The importance of each depends on the distance from the listener to the sound source, because the levels of direct and reflected sound and background noise vary throughout the room.

To have a good intelligibility, the signal-noise ratio must be greater than 30 dB. The signal-noise ratio is given by the difference between the level of voice and background noise. Thus, if the environment is noisy and the background noise is high, the teacher will have to raise his voice, which for obvious reasons can not always happen.

The intelligibility of speech in an environment can be assessed by subjective or objective methods. The objective evaluation can be obtained through a variety of indexes. There are several ways of measuring speech intelligibility, among which we quote:

- STI (*Speech Transmission Index*)
- ALCons (*Articulation Loss of Consonants*)
- Psili (*Octave Preferred Speech Interference Level*)
- SIL (*Speech Interference Level*)
- RASTI (*Room Acoustical Speech Transmission Index*)

For assessment of intelligibility in built environments, one of the most indicated is the STI. It is an objective measure based on the contribution of the number of frequency bands within the frequency range of speech signals. Its value is determined by the effective contribution of the signal-noise ratio.

2.4. Bayesian inference

To perform a statistical analysis some of the possible approaches are: the conventional approach and the Bayesian approach. The conventional approach admits probabilities restricted to phenomena that can be measured by relative frequencies. The Bayesian approach allows probability as a rational measure for a number of uncertainties. It means that in the Bayesian conceptualization probabilities quantify the plausibility of propositions or events. Thus, according to the Bayesian concept, Kinase & Andrade (2010), define probability as a measure of plausibility that is assigned to a proposition whose truth is uncertain in light of available knowledge.

For Walpole et al. (2009), statistical inference consists of methods by which generalizations are made about a population from samples collected. In this context, in the Bayesian inference, prior knowledge about the subjective probability distribution of unknown parameters is used beyond the sample data.

According to Santos (2007), the results have revealed that Bayesian inference is presented with great advantage over classical inference, because it allows the incorporation of existing prior information, often subjective, being less dependent on sampling.

The Bayes theorem provides the combination of knowledge obtained from the sample data and subjective prior knowledge, where θ summarized information available through a probability distribution $p(\theta)$ can be increased by observing a random number X and relating these measurements by the $p(x/\theta)$ distribution. Bekman and Costa Neto (1980) claim that Bayes Theorem provides a review of probabilities due to a new state of information. The authors also highlight an important property of the Bayes Theorem: the information obtained can be built piecemeal, incrementally or all at once, obtaining in all cases the same posterior distribution.

2.4.1. Select the appropriate priority

Although some authors have hinted that there is some subjectivity in the choice of prior distribution, Santos (2007) states that subjectivity is not a unique feature of Bayesian inference, but also the very process of induction. The author shows that in the definition of population, one of the pillars of statistical inference, it is necessary the definition of common characteristics that define an interest group. However, in this definition, the question of how many and which features are necessary for the identification of a population, creates subjectivity implicit in the essence of the induction process.

The choice of prior distribution must be made to represent the uncertainty contained in the parameters studied. Some questions can be asked regarding the plausibility of the prior distribution, since this is sometimes obtained in a subjective way. To Kinas & Andrade (2010), if the prior distributions have low values in their parameters they represent low uncertainty due to this influence in some posterior distributions, which in this case will respond more strongly to information from the data.

2.4.2. Bayesian Inference Process

The ratio $p(x/\theta)$ provides the plausibility of each of the possible values of θ, while $p(\theta)$, and is called the prior distribution of θ. Denoted by $p(\theta/x) = \frac{p(x,\theta)}{p(x)} = \frac{p(x/\theta)\, p(\theta)}{\int p(\theta,x)\, d\theta}$

The combination of the function of plausibility to the prior distribution leads to a posterior distribution $p(\theta/x)$. The posterior distribution is the most complete way to express the state of knowledge about the phenomenon under investigation (Kinas & Andrade, 2010).

The use of a priori information in Bayesian inference requires the specification of a prior distribution for the amount of interest θ.This distribution should represent (probabilistically) the knowledge we have about θ before the experiment. The posterior distributions can be obtained in two ways:

i) Using combined families of posterior distributions and

ii) Using stochastic simulation procedures. (Kinase & ANDRADE, 2009; Ehlers, 2007).

Situations that allow the use of conjugate families' distribution greatly simplify obtaining solutions. In the operational aspect this management is much like a conventional statistical analysis. However, it is sometimes preferable that the choice of the posteriori be made through stochastic simulations, since it is not always possible to obtain priors that are easily handled analytically. Often the choice of a posteriori by means of a priori combined may not represent the problem with reality as it relates to the fact of choosing a priori that it will be analytically tractable.

Gamerman (1996 cited in Ehlers 2007) points out to watch with the indiscriminate use of conjugate priors. Essentially, the problem is that the conjugate prior is not always an adequate representation of priori uncertainty. Its use is often associated with the resulting analytical tractability.
Gains derived by using the Bayesian inference analysis of data are enormous, since through it none knowledge is lost. Another advantage of Bayesian inference is the possibility of updating the data, ie, the function of today's post, may be a priori function tomorrow. Thus, as new information about the object of study are emerging, the knowledge about the phenomena studied will acumulate, thus enabling models more representative of reality.

3. MATERIALS AND METHODS

For the delimitation of the survey, some criteria were considered. To ensure the representativeness of the sample it was aimed to analyze all the municipal schools of the city of João Pessoa. This sample consists of 77 schools, totaling more than 100 classrooms. These schools are grouped into clusters that meet certain socioeconomic and geographical coherence.
Given the large number of schools present at the cluster, it was chosen to analyze only the classes of the 5th year of elementary schools. This choice was based on two aspects: to associate each classroom with only one teacher, the study was limited to analyzing only class of the first stage of primary school (1st – 5th years), another aspect considered was that older children would get used more easily to the presence of the researcher in the act of collecting data on acoustic comfort, since the measurements were also carried out with the classes in progress. This conclusion was done when conducting a pilot study that aimed to gauge the methodology of data collection.
The study consisted of the stages: collection, analysis and processing of data and proposed construction of a Bayesian model to analyze the acoustic conditions.

3.1. Data Acoustic Comfort

To measure the equivalent sound levels it was used a measurer consisting of an amplifier and an indicator of sound pressure level, of Instrutherm brand, model SL 4011, manufactured by Instrutherm Measuring Instruments Ltd. This equipment meets the parameters of normality required by Brazilian standards to calculate the LAeq and is composed of a “A” circuit weight, a "slow- SLOW" circuit response, the reference circuit is 85 dB and the measurement range between 50 and 115dB (A).
Measurements were made in all rooms of the 5th year, while the in activity and when schools were not in operation (11:30 am to 1 pm or 5:30 pm to 7 pm) to determine the external noise. Measurements were taken at moments that the teacher was in silence. The purpose of this step was to check only the noise to which the teacher is daily exposed to.
Inside the room, measurements were made at 5 pointsa and 3 consecutive times at intervals of 30 seconds. The collection of noise aimed to evaluate the equivalent sound pressure level (LAeq), for such it was used the equation present in the NBR 10.151(2000):

$$\mathrm{LAeq} = 10\ \log 10\left(\frac{1}{\mathrm{N}}\sum_{\mathrm{i}=1}^{\mathrm{N}} 10^{0,1\mathrm{Li}}\right).$$

Where: LAeq - Equivalent sound pressure level in dB (A);
Li - Sound pressure level measured at each instant;
N - Total number of measurements;

3.2. Data of the Speech Intelligibility of the teacher

Due to limitations of equipment, it was chosen an alternative form of assessment the STI where it could be calculated from the data collected. So, after searching various ways of determining the intelligibility of speech, it was found that the index ALcons (Consonants Articulation Loss) would be sufficient for the scope of the work.
Besides the ease of its calculation, the ALcons has an empirical relationship with the STI. Through the empirical method of Farrell-Becker (Müller, 2005) the STI can be easily calculated from ALcons.

$$ALcons = 170{,}5405 * e^{-5{,}419*STI}$$

Making up the necessary mathematical manipulations, it is stated that: $STI = \frac{-1}{5{,}419}\ ln\left(\frac{ALcons}{170{,}5408}\right)$
The analytical determination of ALcons occurs according to the expression: $AL_{cons} = \frac{200*D^2*TR^2}{V*Q}$
Where:
D - Distance from listener to sound source;
V- Volume of the environment;
Q – Factor sound source direction;

To calculate the ALcons index some considerations should be made. The distance from listener to sound source was considered for the most adverse conditions, *ie*, a student sitting in the back. Thus, the distance from the sound source to the listener considered was the length of the room. The sound directivity (Q) according to Bedaque (2003) is the ratio of sound intensity in a certain direction and the average sound intensities in all directions. For practical purposes, however, one can calculate the sound directivity as the exponential of the tenth part of the directivity index.

3.3. Analysis of Data

For data analysis, we used two statistical softwares. The Statistica 8.0.550 was used for descriptive data analysis, building data histograms and correlation analysis between the variables under study. The R software 2.13.1 was conducted for the application of the Shapiro-Wilk test to check normality of the data and the application of stochastic simulation to estimate the parameters of the posterior distribution.

3.4. Bayesian Modeling

The following structured model allows evaluating the influence of noise levels of classrooms of João Pessoa public schools with the intelligibility of speech as well as finding the probability of whether or not noise levels are within the range allowed by national and international standards.

3.5. Construction of the Model

When a response variable y (intelligibility) is associated with a single predictive numeric variable x (Acoustic), through the equation of a line $f(x,\theta) = \beta_0 + \beta_1 x$, then it is said to have a simple linear regression.
However this linear relationship is not perfect, because there is a considerable degree of unpredictability in the form of noise. Thus the simple linear relationship can be described in the model below:

$$y_i = \beta_0 + \beta_1 x_i + \omega_i$$

The values ω_i are interchangeable and therefore may be associated with any observation. The proposed methodology was to obtain the posterior distributions of uncertain model parameters that are β_0, β_1 and σ. For developing the model, it is necessary the formulation of summaries, notations and formulations, which are described below:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n};\ \bar{y} = \frac{\sum_{i=1}^{n} y_i}{n};\ \overline{xx} = \frac{\sum_{i=1}^{n} x_i^2}{n};\ \overline{yy} = \frac{\sum_{i=1}^{n} y_i^2}{n};\ \overline{xy} = \frac{\sum_{i=1}^{n} x_i y_i}{n}.$$

The variances for x and y and the covariance for (x, y) are:

$S_{xx} = \frac{\Sigma(x-\bar{x})^2}{n} = \overline{xx} - (\bar{x})^2$; $S_{yy} = \frac{\Sigma(y-\bar{y})^2}{n} = \overline{yy} - (\bar{y})^2$; $S_{xy} = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{n} = \overline{xy} - \bar{x}\bar{y}$,

Where the correlation coefficient (r) and the variance of the waste: $r = \frac{xy - xy}{\sqrt{S_{xx}S_{yy}}}$ and $S_e^2 = nS_{yy}\frac{(1-r^2)}{(n-2)}$

The S_e term is usually called the standard error of the residuals. Denote the estimates of least squares for β_0 and β_1 as b_0 and b_1 respectively. Such estimates can be obtained by: $b_1 = \frac{\overline{xy} - \bar{x}\bar{y}}{S_{xx}}$ and $b_0 = \bar{y} - b_1\bar{x}$.

The acoustic data collected follow a normal probability distribution with mean 71.75 and standard deviation 5.65. This is confirmed by applying the test of Shapiro-Wilk normality. On the other hand, as can be seen in the figure below, the speech intelligibility data following a Gama approximate distribution range.

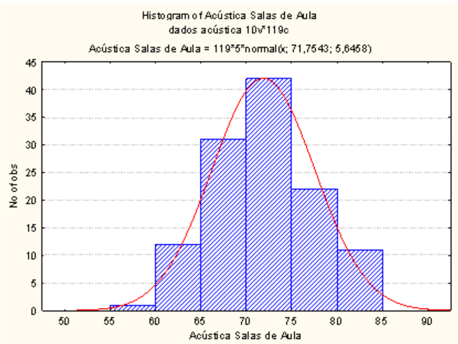

Figure 1: Histogram of data distribution of acoustic comfort

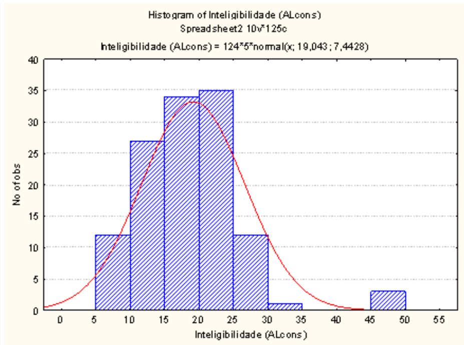

Figure 2: Histogram of data distribution of speech intelligibility

In order to obtain the posterior distributions of uncertain parameters, we present a solution that uses a Jeffreys' priori non-informative. This priority is as follows:

i) Uniform priors for β_0 and β_1, defined over intervals exceeding loose any reasonable values for these parameters;

ii) Prior variance σ² are given by $p(\sigma^2) = \frac{1}{\sigma^2}$

Adopting the elements mentioned above, one can show the marginal distributions:

If $p(\beta_0, \beta_{1,}\sigma^2) = 1/\sigma^2$ is a Jeffreys' priori non-informative and $p(\beta_0, \beta_{1,}\sigma^2) = 1/\sigma^2$ has normal distribution $N(\beta_0 + \beta_{1,}\sigma^2) \forall\ i = 1,2, \dots, n$, then:
$p(\beta_0/x_i, y_i) \sim St(n-2, b_{0,}S_{\beta_0})$; $p(\beta_1/x_i, y_i) \sim St(n-2, b_{1,}S_{\beta_1})$; $p(\sigma^2/x_i, y_i) \sim GInv(\frac{n-2}{2}, \frac{n-2}{2}S_e^2)$.
The values of b_0 and b_1 are estimates of least squares for β_0 and β_1 respectively. S_e^2 is the variance of the residuals. The scaling parameters of the distributions of studentare: $S_{\beta_0} = S_e\sqrt{\frac{\overline{xx}}{nS_{xx}}}$ and $S_{\beta_1} = S_e/\sqrt{nS_{xx}}$.

3.6. Application of the Method

Given the data collected, the methodology proposed above can be adapted as follows:
$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = 71{,}75$; $\bar{y} = \frac{\sum_{i=1}^{n} y_i}{n} = 19{,}10$; $\overline{xx} = \frac{\sum_{i=1}^{n} x_i^2}{n} = 5180{,}17$; $\overline{yy} = \frac{\sum_{i=1}^{n} y_i^2}{n} = 420{,}13$; $\overline{xy} = \frac{\sum_{i=1}^{n} x_i y_i}{n} = 1375{,}56$; $S_{xx} = \frac{\sum(x-\bar{x})^2}{n} = \overline{xx} - (\bar{x})^2 = 31{,}61$; $S_{yy} = \frac{\sum(y-\bar{y})^2}{n} = \overline{yy} - (\bar{y})^2 = 51{,}56$; $S_{xy} = \frac{\sum(x-\bar{x})(y-\bar{y})}{n} = \overline{xy} - \bar{x}\bar{y} = 5{,}52$; $r = \frac{xy - xy}{\sqrt{S_{xx}S_{yy}}} = 0{,}13$; $S_e^2 = nS_{yy}\frac{(1-r^2)}{(n-2)} = 55{,}63$; $b_1 = \frac{\overline{xy} - \bar{x}\bar{y}}{S_{xx}} = 0{,}17$; $b_0 = \bar{y} - b_1\bar{x} = 7{,}10$; $S_{\beta_0} = S_e\sqrt{\frac{\overline{xx}}{nS_{xx}}} = 8{,}83$; $S_{\beta_1} = S_e/\sqrt{nS_{xx}} = 0{,}12$

Data were collected in 77 schools. However, since the measurement was made in each school classroom, and the number of classrooms were 117, we have n = 117. Now proceed with the assembly of the distributions:
$p(\beta_0/x_i, y_i) \sim St(115; 7{,}10;\ 8{,}83)$; $p(\beta_1/x_i, y_i) \sim St(115; 0{,}17; 0{,}12)$; $p(\sigma^2/x_i, y_i) \sim GInv(57{,}5; 3198{,}72)$

4. RESULTS AND DISCUSSION

4.1. Acoustic analysis of the classrooms

The sound pressure levels collected inside the classrooms of the schools surveyed in activity, also called background noise, varied between minimum LAeq of 56.64 dB(A) and maximum LAeq of 83.79 dB(A) in rooms in full activity education as shown in table 1 and figure 3. These values are summarized in the table below that describes the maximum, minimum and average noise levels distributed by cluster (called Pole), noting that all are above the ideal limit established as acceptable by the ABNT NBR 10152/87 and the resolution of CONAMA 001, being the environment uncomfortable.
Regarding the measurement of LAeq in silence classrooms, they showed variations between the minimum LAeq of 42.02 dB (A) and the maximum LAeq of 61.57 dB (A). This confirms that even when the rooms where not in school activities and with the windows closed, acoustic measures are above the extent permitted by applicable law, highlighting the need to alert the Government about the school construction projects. This finding can be seen in Table 1 and Figure 3.

Table 1: Comparison of noise in schools in João Pessoa

Background noise – dB (A)		
Standard	**Level of Confort**	**Higher level acceptable**
NBR 10.152	40	50
CONAMA	40	50

Pole	Min		Mean		Max		Standard Desviation	
	Activity	**Empty**	**Activity**	**Empty**	**Activity**	**Empty**	**Activity**	**Empty**
1.	56,64	42,02	69,59	48,98	80,95	62,15	4,60	4,10
2.	61,18	46,78	72,66	51,87	82,59	58,30	4,63	2,94
3.	60,22	52,68	65,59	57,55	73,80	61,89	4,09	2,48
4.	63,99	47,45	73,07	52,71	81,16	57,08	3,35	2,96
5.	67,14	43,85	76,81	53,62	84,57	66,01	4,42	7,55
6.	61,55	44,33	70,87	52,71	76,59	59,39	4,45	3,33
7.	68,51	42,73	74,21	51,83	83,79	58,94	5,03	5,20
8.	64,79	51,40	71,02	53,74	77,34	61,05	3,62	2,07
9.	66,02	52,73	74,58	56,58	83,33	61,57	5,63	2,32

Source: 10 152 (1987); CONAMA (1990), Lookup (2011).

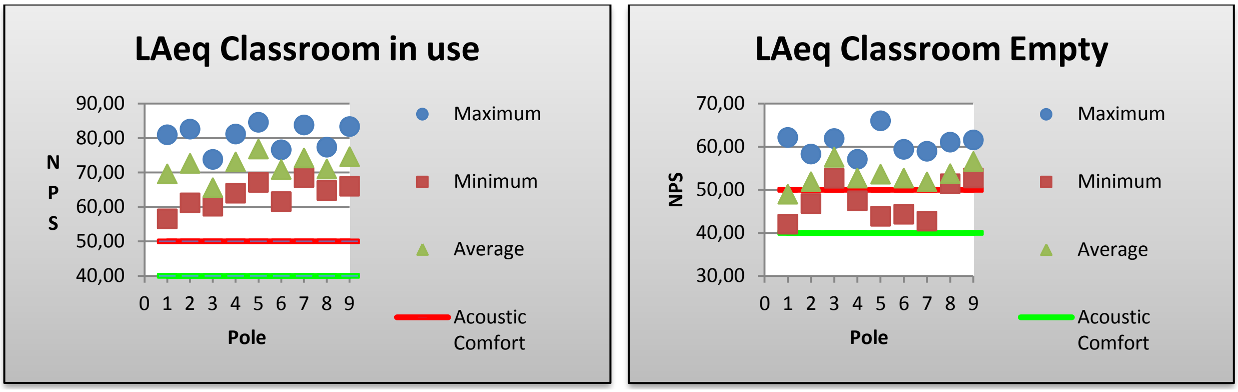

Figure 3 - Measurement of SPL equivalent (LAeq) in classrooms in activity x empty classrooms (per pole)

4.2. Speech intelligibility of the teacher

For the intelligibility analysis it was used STI and found that none of the environments has good intelligibility. Only one of the environments studied showed more than 60% intelligibility, which is already in a band of poor intelligibility. The other rooms had intelligibility located in a unacceptable range.

This situation becomes more serious when it is considered the type of studied environment: school environment – precisely the classroom. From literature it is known that one of the most important factors in the learning process is the good acoustics conditions. From the analysis it appears that almost all the basic learning environments are in a range that is out of the acceptable, thus compromising the teaching-learning process.

4.3. Statistical and Computational Results

The proposed Bayesian model aimed to associate each of the interest parameters a probability distribution. For the prediction of values of the variable y (intelligibility) as a function of values of the variable x (acoustic), it is necessary to obtain a predictive posterior distribution for $\hat{y}$.

A solution based on Jeffreys' predictive solution is presented below:

$$\hat{y} \sim St(g, \mu, \sigma)$$
$$g = n - 2$$
$$\mu = b0 + b1 * x$$
$$\sigma = Se\sqrt{\frac{n+1}{n} + \frac{(x_p - x)^2}{nS_{xx}}}$$

It is made a proposition of a code built into the software R for determining the parameters of the distribution above, these parameters are respectively: degrees of freedom, mean and standard deviation. These results allow us to analyze the prediction of the response variable. The interval obtained allows estimation of probabilities by the chance occurrence of the values assumed by theresponse variable. It is possible to determine, for example, the probability of intelligibility rates to be on the "great" band, that is, ITS = 90%. The values of the above parameters are: μ = 6.71 and σ =11.40 Once you have the parameters of non-central student distribution above, it becomes possible to extract interest information about the model. The quantiles, which correspond to the limits of $ICr_{95\%}$ for $\hat{y}$ are: -15.879039 e -8.155986.Where this values are the limits the confidence interval in this analyzis.

5. CONCLUSIONS

For an appropriate teaching-learning process, it is necessary for teachers to be physically healthy. However, given the conditions in which they are exposed in their work environment this will unlikely happen. From the analysis, it is observed the disturbing reality that teachers of municipal schools in the city of João Pessoa are exposed to. It was found that 100% of the rooms in activity had noise's leveles the specified limits by the NBR 10152. Furthermore, over 75% of the empty rooms were also out of this specification.This scenario shows that teachers in the exercise of their professional activities are in situations of acoustic discomfort, requiring them to raise their voices, compromising the health of their vocal cords.

The acoustic inadequacy of the school buildings could also be verified. Assessing the speech intelligibility of teachers in the classrooms of public schools has revealed that almost 100% of the environments present unacceptable intelligibility.

One of the most important contributions of this work was to propose a Bayesian modeling methodology. This methodology relates to the combination of probability distributions to the parameters of the fitted model. The use of this practice in other studies allows a greater depth of analysis since it no longer estimates values but the probabilities of occurrence.

In the field of acoustic comfort analysis, the great "revolution" would be the possibility to analyze the probability of the occurrence of some tracks of sound pressure level and intelligibility. This approach would not be restricted to what is done today, that is, the examination of whether or not the parameters. In the new approach proposed here, besides the analysis of the currently used parameters it is also possible to specify the probability of occurrence of certain values as the data present in the standards.

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Emergency Measures in the Regulation of Fire Safety in Buildings

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ABSTRACT
The Regulation of Fire Safety in Buildings establishes the self-protection and of management of safety measures to buildings. These measures consisted in the definition of a set of rules to be observed during the explotation of the buildings. The self-protection measures establish preventive measures, action in the face of an emergency, safety records, training and awareness on fire safety and evacuation exercises. Planning is an important element in effective monitoring of any operation. Without planning, actions and activities tend to occur in a casual way. Planning helps in accomplishing the goals with minimal resources and time. In this regard planning actions in case of fire, besides being a legal requirement it is a fundamental aspect for protection of human life, as it is based on existing resources, human and materials in a building with the aim to operate and simplify the response in an emergency situation. This paper summarizes the main intervention measures to fight a fire provided by the Fire Safety in Buildings.

Keywords: emergency, protection, organization, fire, safety.

1. INTRODUCTION

The Fire Safety Regulations establishes the self-protection and the management and organization measures of fire safety to be implemented in buildings. The self-protection measures are the establishment of a set of rules that must be adopted during the lifetime of buildings.

The self-protection measures foresee preventive measures, actions in case of an emergency, safety records, training and awareness on fire safety and evacuation exercises.

The performance in case of an emergency is characterized as a set of rules and procedures, duly organized and systematized, that articulate the human and material resources available in the building, so that in case of emergency the occurrence will be properly treated, minimizing or annulling its effects.

The Regulation of Fire Safety in Buildings classifies the buildings according to its use-type, defined as the dominant use-type of any building or area. Table 1 presents the uses-type defined in the Regulation of Fire Safety in Buildings [1].

Table 1: Uses - type

I	Housing	VII	Hotels and restaurants
II	Parking	VIII	Commercial and transportation stations
III	Administrative	IX	Sports and Leisure
IV	Schools	X	Museums and art galleries
V	Hospitals	XI	Libraries and archives
VI	Shows and public meetings	XII	Industries, workshops and warehouses

The uses - type of the buildings can be classified as 1st, 2nd 3rd and 4th category, being considered as low, moderate, high and very high risk, respectively.

Table 2 presents as an example the risk factors to be considered for an administrative building (use-type III) [1].

Table 2 - Risk factors considered for the use-type III - administrative

Risk Factors	Risk Category 1st	2nd	3rd	4th
Height	≤ 9	≤ 28	≤ 50	> 50
Effective	100	1000	5000	> 5000

The intervention measures varying in function of the category of risk assuming the form of emergency procedures to uses - type of the lower category of risk or the form of an internal emergency plan for the higher categories of risk.

When in a certain use-type are not required emergency procedures or internal emergency plan, must be displayed in the places simplified safety instructions showing what to do in case of emergency.

Table 3 presents the intervention measures required for the uses – type according to its category of risk [2].

Table 3 - Self-protection measures required for the uses -types

Uses-type	Risk Category	Safety Instructions	Procedures in Case of Emergency	Procedures in Case of Emergency
I	1.st and 2.nd	×		
	3.rd (only for the common spaces)		×	
	4.a (only for the common spaces)			×
II	1.st	×		
	2.nd		×	
	3.rd e 4.th			×
III, VI, VIII, IX, X, XI and XII	1.st	×		
	2.nd		×	
	3.rd and 4.th			×
IV, V and VII	1.st (no local risk D or E)	×		
	1.st (with local risk D or E) and 2.nd (no local risk D or E)		×	
	2.nd (no local risk D or E) 3.rd and 4.th			×

2. REGULAMENTARY INTERVENTION MEASURES

2.1 Internal Emergency Plan

The document must be prepared based on the predictable scenarios of fire or other situations, so it is necessary to identify and enhance the internal and external risks inherent to the organization, with the aim to establish in advance the actions to perform, in order to quickly mitigate a possible emergency situation [2].

The internal emergency plan should be constituted by the following information:

- Identification of the risks;
- Definition of the organization to adopt in case of emergency;
- Plan of action;
- Evacuation plan;
- Safety instructions;
- Information of the internal and external entities to contact in case of emergency, and
- Emergency drawings that can be accompanied by emergency schemes.

2.1.1 Plan of action

The plan of action includes the organization of the operations to trigger in case of emergency, giving answers to the following questions: [3]

- What will do?
- Who will do?
- When?
- How? and
- Where?

The plan of action must be adjusted to the availability of human resources in the building and behold the different arrangements of occupation:

- Day;
- Night;
- Week-ends;
- Holidays; and
- Vacations.

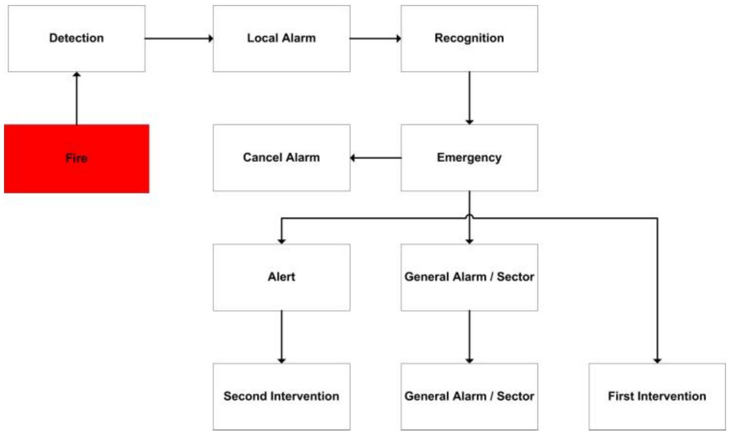

Figure 1 - Example of a flowchart of operation [3]

The plan of action should address the following criteria: [2]

- Prior knowledge of the risks in buildings
- Procedures to adopt in case of detection or perception of a fire alarm;
- Planning the spread of restricted and general alarms and transmission of the alert;
- Coordination of the operations predicted in the evacuation plan;
- Activation of first intervention means that will serve the building;
- Execution of the operation of the safety devices such as cutting the power-supply and fuel, closing fire resistant doors and smoke control facilities;
- Provision of first aid;
- Protection of risk places and hotspots of the building;
- Receiving, information, guidance and support of the fire-fighters; and
- Replacement of the safety conditions after an emergency situation.

2.1.2. Evacuation Plan

The evacuation plan is defined as a document that comprises the instructions and procedures to be followed by all personnel within a building related to operations designed to ensure an orderly evacuation, total or partial, of the areas considered at risk. [2].

The evacuation plan and other documents should include the:

- Quickly and safely forwarding of the occupants from these areas to outside or to a safety zone;
- Assistance to people with disabilities or in trouble, to ensure that nobody gets blocked; and
- Confirmation of the total evacuation of areas and ensure that no one returns to them.

Figure 2 - Evacuation of a building [4]

The evacuation of all people at risk is the primary objective and it is preferable to all other procedures in an emergency situation. Therefore, to ensure a successful evacuation is essential that the following provisions are respected: [3]

- Signal of evacuation should be audible in any place of the building and has a different tone of any other sound;
- Escape routes and emergency exits are clear and permanently free of obstacles;
- Be assured at all times the correct lighting of the escape routes;
- Escape routes are properly signalized, taking into account the normal and alternative routes;

- Avoid crowds, imposing order, calmly and quickly;
- People in a panic should be positioned close to the exits, not obstructing evacuation routes;
- Collection of personal items that could delay or block the movement of people should not be allowed;
- Evacuation is processed with order and without abuses, and people should be forwarded to outside the premises using the most appropriate route in each situation;
- People shouldn't return to the evacuated areas; and
- People shouldn't use elevators during an emergency.

2.1.3 Organization of Safety

The human intervention, in the different moments influencing the fire safet, it is of vital importance, by the role played in the phases of prevention, extinguishing and actions after fire. Looking for an appropriate human behavior can be achieved a higher level of fire safety [3].

The key to the human organization is extended to all departments of the enterprise is based on the responsibility be taken by all and each employee.

The safety in its overall content is the responsibility of the highest body of management of a company. Figure 3 shows the hierarchical and functional position on fire safety in a company organization flowchart.

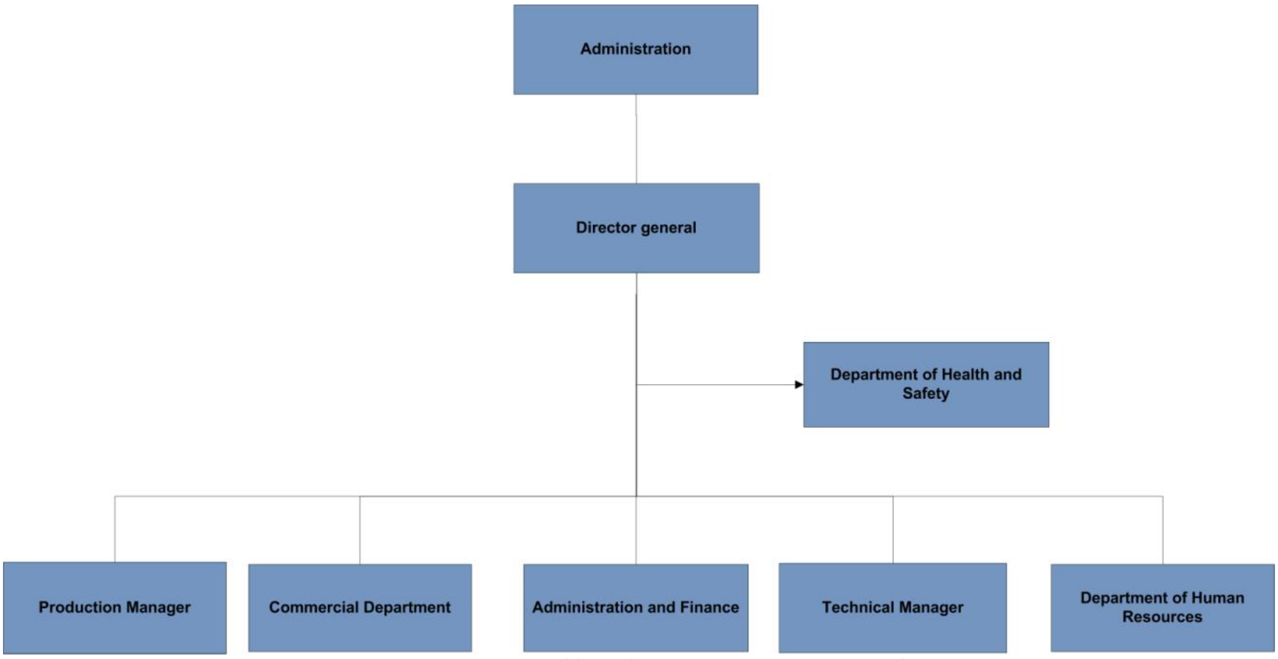

Figure 3 - Hierarchical position of fire safety in a company organization flowchart [5]

In this sense, the safety responsible, individual or collective person, who is responsible for the maintenance of the conditions of fire safety must establish the necessary safety organization in order to implement and maintain the self-protection measures.

The safety organization should include:

- Functions of routine / surveillance of the use-type;
- Hierarchical and functional organization flowcharts covering the various stages of development of an emergency situation, including the activities inherent in the plan of action and evacuation; and
- Identification of safety officers and delegates belonging to the various intervention teams, their tasks and responsibilities, to be implemented in emergency situations.

The minimum number of elements in the safety teams varies depending on its use-type and risk category. Table 6 indicates the minimum number of elements in the safety teams, depending on the use-type and risk category.

Table 6 - Minimum number of elements of the safety teams

Use-type	Risk Category	Minimum Number of Elements
I	3.rd e 4.th	1
II	1.st e 2.nd	1
	3.rd e 4.th	2
III, VIII, X, XI e XII	1.st	1
	2.nd	3
	3.rd	5
	4.th	8
IV e V	1.st (no local risk D or E)	2
	1.st (with local risk D or E) and 2.nd (no local risk D or E)	3
	2.nd (with local risk D or E)	6
	3.rd	8
	4.th	12
VI e IX	1.st	2
	2.nd	3
	3.rd	6
	4.th	12
VII	1.st (no local risk D or E)	1
	1.st (with local risk D or E) and 2.nd (no local risk D or E)	3
	2.nd (with local risk D or E) and 3.rd	5
	4.th	8

In this way, institutions must establish a safety structure that covers all aspects of the self-protection measures (see Figure 4).

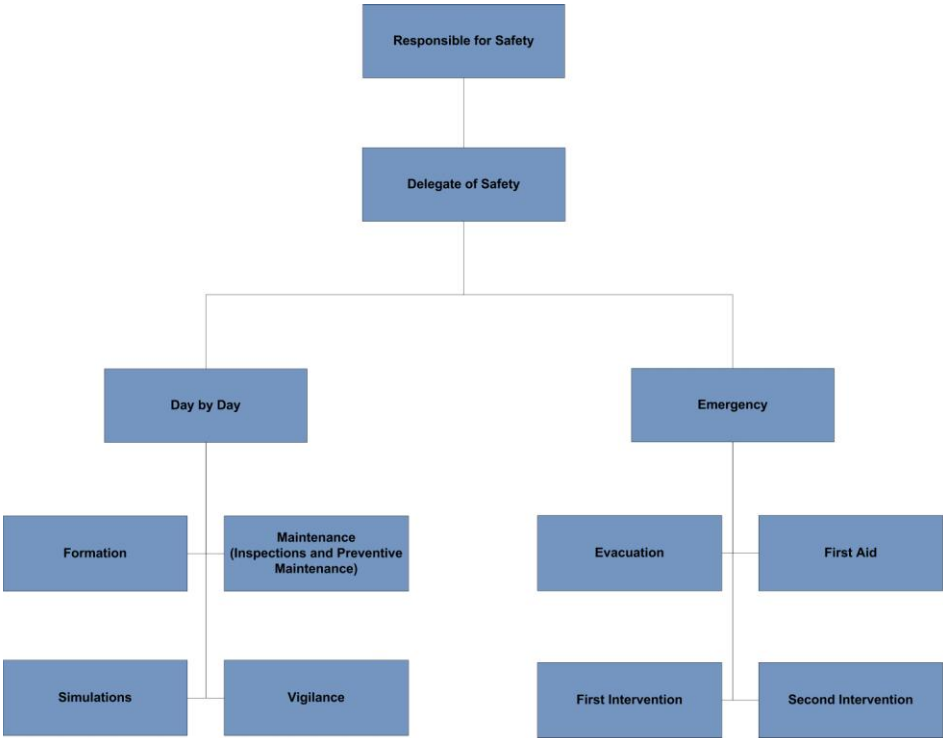

Figure 4 – Flowchart of a safety service [6]

The Fire Safety Service (FSS) shall be composed by two components, the daily and the emergency one. The daily component has as mission to implement and update the self-protection measures, through the realization of training actions, evacuation exercises, updating constantly the safety records and guarantee the maintenance of the prevention procedures.

The component of emergency has as mission to act in case of emergency, mainly through the establishment of functions, such as:

- First intervention;
- Evacuation;
- First aid; and
- etc.

2.1.4 Emergency Drawings

In addition to the safety signs used in the prevention, protection and fire fighting, emergency drawings are used. The emergency drawings are also emerging as an instrument for putting into practice some of the actions recommended in the internal emergency plan, especially those designed for the everyday user. [2]

Emergency drawings prepared for each floor should be:

- Displayed at strategic locations along the main access routes of the floor referred to; and
- Displayed in places with permanence of people with disabilities in perception and reaction to the alert, on sleeping and refuge places.

The emergency drawings must provide to all users of the facilities, information on the location and / or nature of the:

- Means of alarm and alert;
- Fire fighting equipment;
- Escape routes; and
- General safety instructions.

Figure 5 - Example of an emergency drawing [3]

2.2 Emergency Procedures

The emergency procedures are a collection of simple techniques of operation to be adopted by all occupants in case of emergency. The procedures in case of emergency should address the following aspects: [2]

- Alarm procedures to take upon detection or perception of a fire ;
- Alert procedures;
- Procedures to be taken to ensure the quick and safe evacuation of all risk areas;
- Techniques for using the first means of intervention; and
- The procedures for reception and forwarding of fire-fighters.

Figure 6 - Emergency procedures - reception and forwarding of fire-fighters

2.3 Safety Instructions

The safety instructions are defined as a set of simple rules that establish procedures for prevention, protection and mitigation of any emergency situation, and basically meet the following objectives: [3]

- Avoid situations that may endanger the safety of the occupants of a building;
- Define a previous plan of action that will minimize the direct and indirect consequences of any accident;
- Assign people to specific tasks in the self-protection measures; and
- Detail the actions to be taken in emergency situations, particularly in case of fire, leakage of combustible gas, earthquake and bomb alarm.

The safety instructions stand out the following:

- General safety instructions;
- Particular safety instructions; and
- Special safety instructions.

2.3.1. General Safety Instructions

The general safety instructions, as its name implies, are for all the occupants of a given building.

The general safety instructions are usually displayed at strategic points where are easily understood by all occupants of these areas. In particular, should be placed near the entrances / exits of buildings and near the elevators (places where the users can pause for a certain periods of time) to ensure their wide dissemination.

Examples of general safety instructions are those presented in emergency plans, mainly:

- Keep calm;
- Give the alarm by pressing the nearest alarm button;
- Use the emergency telephone number;
- Fight the fire with the extinguisher without danger;
- Head toward the nearest exit, following the signs;
- Head toward the exit following the instructions of coordinators;
- Never use the elevators, just stairs;
- Never go back; and
- Go to the meeting point and wait for instructions.

These instructions can address the following situations:

- Risks of nature (lightning, earthquakes, flood, etc.);
- Technological risks (fire, explosion, leakage of liquids and combustible gases, collapse of structure, etc.); and
- Criminal risks (bomb threat, sabotage, attack, intrusion, suspicious packages, biological or chemical attack, violence, etc.).

2.3.2. Particular Safety Instructions

The particular safety instructions refer to places that present particular risks, including places with high fire risk, or places with people with disabilities in perception and reaction of the alarm and define in detail the prevention procedures to be adopted daily and the actions to be taken in case of emergency or disaster.

Examples of rules of prevention and emergency are the following:

- Prevention:
  - ✓ Do not smoke or light a fire inside the area;
  - ✓ Keep the site permanently clean and tidy;
  - ✓ Do not use, improvised electrical installations;
  - ✓ Do not perform hot work, or with the production of flames, without removing the combustible materials nearby;
  - ✓ Ensure permanently the accessibility to fire protection means;
  - ✓ Keep the fire-resistant doors always closed; and
  - ✓ Keep clear the escape routes and exits;
- Action in case of emergency:
  - ✓ Activate the nearest manual alarm,
  - ✓ Try to extinguish the fire with extinguishers placed in the area, without risks,
  - ✓ Never use water or other water-based agents (foams) on the electrical installation, even though they made the cut-off (it is necessary always to admit an accidental connection or a mistake of cut). Should be used chemical powder or CO_2, and
  - ✓ If you cannot control the fire, close the door and leave the area.

These instructions shall be displayed in visible places, usually on the interior side of the doors of the compartments.

In places with disabled people in the perception and reaction to alarm, in sleeping places and refuge places, the particular safety instructions must be accompanied by a simplified emergency plan, which should include the escape routes serving these locations, and the means of alarm and intervention.

2.3.3. Special Safety Instructions

The special safety instructions are intended only to personnel assigned to perform specific tasks in an emergency situation, mainly the safety responsible, safety delegate, intervention team, evacuation team and helping teams, etc.
These instructions focus essentially on the following:

- Alarm;
- Alert the fire brigade;
- Evacuation;
- Intervention in fire fighting;
- Help (start-up of equipment and fire safety systems, cut-off of power supply and fuel; and
- Reception and forwarding of fire-fighters or other support to its intervention.

When in a particular use-type are not obliged emergency procedures or an internal emergency plan, simplified safety instructions shall be displayed, including:

- Procedures of alarm, to be served upon detection or perception of a fire;
- Procedures of alert; and
- Techniques of first use of the means of intervention and other means of action in case of fire that serves the places of the use-type.

3. CONCLUSIONS

The human intervention, directly or indirectly, is responsible for the occurrence of most fires. Similarly, human participation is fundamental to fire safety in any of its phases: prevention and action after a fire.
Indeed, the physical safety measures such as those adopted in the design and construction of a building (passive measures) or the systems and safety equipment in place, do not limit the possibility of a fire occurrence. The measures of human nature, particularly through the establishment of intervention procedures in the face of an emergency, constitute a very important aspect, since that an intervention properly organized, in its early stage, can ensure the safeguarding of life and materials, until the arrival of external aid.
In this sense it is essential that all buildings have mitigation measures and at the same time, should be adapted to the dimension and characteristics of the building so that their implementation it is possible.

ACKNOWLEDGMENTS

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Self-protection Measures and the Portuguese Regulation of Fire Safety In Buildings

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ABSTRACT
The entry into force of the Regulation of Fire Safety in Buildings has generated an innovative dynamic at the level of the self-protection measures in Portugal, however it seems that the vast majority of the buildings have not yet realised their self-protection measures, so there is still much to do in the area of the organization and management of fire safety in buildings in Portugal. This paper summarizes the self-protection measures foreseen in the Portuguese Regulation of Fire Safety in Buildings and analyses the degree of their implementation. The self-protection measures are divided in: preventive, intervention, safety records, training and awareness and evacuation exercises. As an example it is presented the self-protection measures for the use-type hospital.

Keywords: organization, management, safety, fire, regulation.

1. INTRODUCTION

In January 1st 2009, entered into force the DL 220/2008, which establishes the Regulation of Fire Safety in Buildings and the fire safety conditions to be applied in different buildings and their uses-type [1]. This Law contains a vast number of technical requirements regarding fire safety in buildings in construction, refurbishment or alteration. It foresees also the necessary self-protection measures and organization and management in fire safety in buildings, both applicable to existing and new buildings.

2. CHARACTERIZATION OF BUILDINGS

The DL 220/2008 classifies the buildings according to the use-type, defined as the classification of the dominant use in the building. Table 1 presents the uses-type foresees in the Regulation [1].

Table 1: Uses-type

I	Housing	VII	Hotels and restaurants
II	Parking	VIII	Commercial and transport stations
III	Administrative	IX	Sports and leisure
IV	School	X	Museums and art galleries
V	Hospital	XI	Libraries and archives
VI	Shows and public meetings	XII	Industries and warehouses

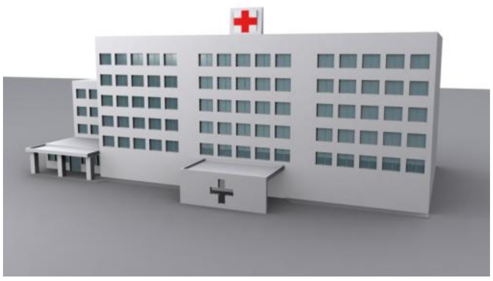

Figure 1 – Use-type V - hospitals

The uses-type defined in the field of fire risk can be classified as 1st, 2nd, 3rd, and 4th category, being considered respectively of low, moderate, high and very high risk.
The risk factors which determine the risk category vary according to the use-type.
Table 2 characterizes, as an example, the risk factors to be considered for hospitals (use-type V), as follows:

- The effective defined as the maximum number of persons who can simultaneously occupy a certain area of the building; and

- The height of the use-type known as the difference between the level of the street accessible to the fire-fighter vehicles and the level of the floor above the ground likely to be occupied by people.

Table 2 - Risk factors considered in a use-type V - hospitals

Risk Factors			Risk Category 1st	2nd	3rd	4th
Height (m)			≤ 9	≤ 9	≤ 28	> 28
Effective	Do not exist places of risk D or E		≤100	≤750	5000	> 5000
	Existing places of risk D or E	In risk places D or E	≤ 25	≤100	≤400	> 400
		Total	≤100	≤500	≤1500	> 1500
Local of risk D or E, with separate exits directly to the exterior, located on the reference plane			Mandatory	Not applicable		

The buildings consist of places and escape routes (horizontal and vertical), being the places classified according to their nature of risk. The risk may be associated with the number of persons, products and equipment, as well as the physical and psychological conditions of the occupants. [1] Table 3 presents the classification assigned to each place depending on the nature of risk.

Table 3 – Classification of the places according to the nature of risk

Local classification	**Nature of risk**	**Example**
A	Places that do not present special risks and to be used by few people	Office
B	Places that do not present special risks that will be used by many people	Auditorium
C	Places that have aggravated risks of origin and development of fire	Power station
C $^{\text{Aggravated}}$	Places with aggravated risk of fire	Electrical power supply with more than 250kW
D	Places for people with disabilities in perception and reaction to the alarm	Room of a hospital
E	Sleeping areas	Hotel room
F	Places destined to the communication centres, command and control	Central of communication of the public network

3. GENERAL MEASURES OF SELF-PROTECTION

The DL 220/2008 – Regulation of Fire Safety in Buildings [1] establish the need of develop the self-protection measures for the buildings. These measures are described in the Law 1532/2008 - Technical Regulation on Fire Safety in Buildings [2]: Preventive measures; Intervention measures; Safety records; Training and awareness and Evacuation exercises. The self-protection measures, required for each use-type, are performed in terms of their use and fire risk category. Table 4, shows the self-protection measures required for the uses-type, depending on their fire risk category.

Table 4 - Self-protection measures required for de uses-type

Uses-type	Risk Category	Measures of self-protection						
		Safety records	Prevention Procedures	Prevention Plan	Emergency Procedures	Internal Emergency Plan	Training and awareness in fire safety	Evacuation exercises
I	3.rd (only for the common spaces)	×	×		×		×	
	4.^{a} (only for the common spaces)	×		×		×	×	×
II	1.st	×	×					
	2.nd	×	×		×		×	
	3.rd e 4.th	×		×		×	×	×
III, VI, VIII, IX, X, XI e XII	1.st	×	×					
	2.nd	×		×	×		×	×
	3.rd and 4.th	×		×		×	×	×
IV, V e VII	1.st (no local risk D or E)	×	×					
	1.st (with local risk D or E) and 2.nd (no local risk D or E)	×		×	×		×	
	2.nd (no local risk D or E) 3.rd and 4.th	×		×		×	×	×

3.1 Safety Responsible

In the Regulation of Fire Safety, the Safety Responsible of a use-type is an individual or collective person who is responsible for the maintenance of the conditions of fire safety, execution and implementation of the self-protection measures applicable to the buildings. The safety responsible may designate a safety delegate to apply the self-protection measures. Table 5 indicates the safety responsible in function of the use-type.

Table 5 - Safety Responsible for each use-type

Use-type	Occupation	Safety Responsible
I	General areas	Owner or responsible of the building
II a XII	Each use-type	Management body of each use-type
	Spaces belonging to different uses-type	Management body of the general areas belonging to the various uses-type

For the achievement of self-protection measures, they must be established the necessary safety arrangements using employees, workers and employees of entities exploiting spaces or third parties.

During periods of operation of the use-type must be ensured the simultaneous presence of a minimum number of elements in the safety teams. Table 6 indicates this minimum number of elements depending on the risk category of the use-type.

Table 6 - Minimum number of elements of the safety teams

Use-type	Risk Category	Minimum Number of Elements
I	3.rd e 4.th	1
II	1.st e 2.nd	1
	3.rd e 4.th	2
III, VIII, X, XI e XII	1.st	1
	2.nd	3
	3.rd	5
	4.th	8
IV e V	1.st (no local risk D or E)	2
	1.st (with local risk D or E)e 2.nd (no local risk D or E)	3
	2.nd (with local risk D or E)	6
	3.rd	8
	4.th	12
VI e IX	1.st	2

Use-type	Risk Category	Minimum Number of Elements
	2.nd	3
	3.rd	6
	4.th	12
VII	1.st (no local risk D or E)	1
	1.st (with local risk D or E) e 2.nd (no local risk D or E)	3
	2.nd (with local risk D or E) e 3.rd	5
	4.th	8

3.2 Preventive Measures

The preventative measures vary in function of the risk category of the building, taking the form of prevention procedures for the uses-type of lower risk category and prevention plans in case of a higher risk category. The prevention procedures are characterized as a set of rules to be adopted by the occupants of a use-type, designed to maintain the safety conditions.

Figure 2 - Regular checking of fire safety conditions [3]

The prevention procedures established in the Regulation are:

- Procedures for operation and use of places, which should be subjected to several rules of conduct on the part of users including: ensuring the accessibility of the emergency; clearing of escape routes, maintenance and conservation of areas, among others;
- Procedures for the operation and use of technical facilities and safety equipment; and
- Procedures for conservation and maintenance of technical sites and safety equipment.

Preventive maintenance should include a description of maintenance actions required, the frequency and other details related to implementation, such as anomalies, materials and techniques to be used for its correction. Table 7 indicates by way of example the program of preventive maintenance of fire extinguishers [4].

Table 7 - Program of preventive maintenance of fire extinguishers

Phases of work		Frequency of Operations		Type of Manager
		Trimestral	Anual	
1.1	Check location and date of the next maintenance operation	X		Not specialist
1.2	Check your state of conservation	X		
1.3	Check if the safety pin was removed	X		
1.4	Check the pressure	X		
1.5	Check the need of recharging	X		
1.6	Check the validity of the extinguishing agent	X		
1.7	Check the life of the extinguisher	X		
1.8	Completely maintenance according the manufacturer's specifications and NP 4413.		X	specialist

The prevention plan must include the following information:

- Description of the use - type, date of entry into force and identification of the Safety Responsible;
- Drawings with the classification of risk category and effective planned for each area, with the horizontal and vertical evacuation routes and location of all fire safety equipment; and
- The prevention procedures above mentioned.


Figure 3 - Prevention plan drawing [4]

3.3 Intervention Measures

The intervention measures like the preventive measures depending on the risk category, taking the form of emergency procedures for uses-type with lower risk category and internal emergency plans in case of a higher risk category.

Note also that when certain use-type emergency procedures or internal emergency plans are not required, simplified safety procedures including alarm and alert procedures and techniques of use of the first intervention means, should be established.

The procedures in case of emergency, to be taken by occupants, must contain:

- Procedures of alarm to be served upon detection or perception of a fire;
- Procedures of alert;
- Procedures to be taken to ensure the quick and safe evacuation of the risk areas;
- Techniques of use the first intervention means and other means of action in case of fire that serves the areas of the use-type; and
- Procedures for reception and forwarding of the fire-fighters.

The internal emergency plan shall consist in the following documents:

- Characterization of the risks;
- Definition of the organization to adopt in case of emergency;
- Indication of internal and external entities to contact in case of emergency;
- Plan of action;
- Plan of evacuation;
- Safety instructions; and
- Emergency drawings may be accompanied with emergency schemes.

Figure 4 - Evacuation exercises [3]

3.4 Safety Records

The safety responsible must ensure the existence of safety records for registration of the relevant building fire safety events. It is necessary a perfect interconnection with other departments of the use - type in order to avoid duplication of information. As example, the safety records related with faults and maintenance of the technical installations, equipment and safety systems are archived in the self-protection measures and in the department of maintenance of the building.

The safety responsible for the use-type must ensure among others the following records:

- Reports of inspection of the safety conditions performed by external bodies;
- Reports of faults and maintenance of the technical installations and safety equipment;
- Report of hazardous works carried out in the areas of the use-type;
- Reports of occurrences, directly or indirectly related to fire safety; and
- Summary reports of training and evacuation exercises with mention the most relevant aspects.

3.5 Training and Awareness in Fire Safety

The safety responsible of each use-type must provide training and awareness courses to the members of the safety team of the building in the field of fire safety, in order to act in the different emergency scenarios predicted on the self-protection measures.

In that way, they must have training in fire safety:

- The employees and collaborators of the entities exploiting the areas belonging to the uses-type;
- All persons engaged in professional activities for periods exceeding 30 days per year in the areas belonging to the uses-type; and
- All elements with responsibilities defined in the self-protection measures.

The training actions above referred should address the following topics:

- Awareness for fire safety and constant briefings that cover the universe of persons listed above, with the aim of familiarization with the areas of the use-type and identification of the respective fire risks, compliance with the generic procedures of fire prevention or, if any, of the prevention plan, compliance with the procedures of alarm; compliance with the general procedures of action in case of emergency namely the ones related to evacuation, instruction in basic techniques of use of the means of first intervention, namely the use of portable fire extinguishers; and specific training for elements which in their normal activity dealing with situations of higher fire risk, namely those who realize the activity in hazardous places.
- Specific training for elements that have special responsibilities to act in an emergency, namely the issuance of the alarm; the evacuation; the use of the commands of the means of action in case of fire and of the second intervention that serve the areas of the uses-type, the reception and forwarding of the fire-fighters, the direction of the emergency operations and other activities foresee in the internal emergency plan, if any.

Figure 5 – Tanning in use portable fire extinguishers

The National Authority of Public Defence (ANPC) has developed some time ago a campaign to inform the school population about the fire risks. This awareness has been achieved through diverse lectures and brochures of technical aspects of civil defence, with the aim of developing a culture of safety since the elementary school.

3.6 Evacuation exercises

For each use-type must be carried out evacuation exercises that involve the largest number of employees and potential users of the places in order to test the intervention measures and train the occupants, especially the safety teams, with the aim to establish routines of behaviour and performance as well as improve the safety procedures [2].
The frequency of performing the evacuation exercises is defined according to the risk category of the use-type. It must be observed the maximum periods between exercises, listed in Table 7.
In schools, for example, it should be carried out an evacuation exercise in the beginning of each year.
In the performance of the evacuation exercises it should be taken into account the following parameters:

- The evacuation exercises must rely with the collaboration of the agents of Civil Defence, mainly the fire brigades, security forces and municipal services of Civil Defence;
- The scenery of the exercises to carry out should lead to the implementation of procedures corresponding to a total emergency situation;
- The level of information available to the building occupants must be lowered from exercise to exercise of evacuation; and
- After performing the evacuation exercises, they must be evaluated, being the results reported, which will include the performance of all elements of the safety team.

Figure 6 - Evacuation exercise in the Shopping city of Oporto - November 2011

Table 7 - Periodicity of the evacuation exercises

Use-type	Risk Category	Maximum Periods Between Exercises
I	4.ª	Two years
II	3.ª e 4.ª	Two years
VI e IX	2.ª e 3.ª	Two years
VI e IX	4.ª	One year
III, VIII, X, XI e XII	2.ª e 3.ª	Two years
III, VIII, X, XI e XII	4.ª	One year
IV, V e VII	2nd category «with places of risk D or E» and 3rd and 4th	One year

The evacuation exercises should be properly planned, executed and evaluated with the eventual collaboration of the fire brigade of the area where the building is located, the coordinators and delegates of civil defence.
It should always be given prior notice to the occupants of the exercises being not rigorously given the programed date and time of beginning.
When the characteristics of the occupants make impossible the realization of evacuation exercises, they should be carried out exercises for employees of higher level in the enterprise and considered compensatory fire safety measures, mainly in the domain of vigilance of fire and safety instructions.

4. SPECIFIC MEASURES OF SELF-PROTECTION

The Law 1532 / 2008 - Technical Regulation of Fire Safety [2] provides a set of specific self-protection measures for certain uses - type in order to adapt those measures to the specificity of each use-type.
The specific self-protection measures prevail over the general self-protection measures applied to all use-types. Table 8 describes the specific points that must be verified with the specific self-protection measures for the use-types.

Table 8 - Specific measures of self-protection

Use-type	Examples
II	• In automatic car-parks, regardless the risk category, the safety team should be composed of at least two elements.
V	• In use-types of the 2nd category of risk or higher, the evacuation plan, integrated in the internal emergency plan, should be individualized for each place of risk, • In the surgery rooms and intensive care units, should be provided, in the internal emergency plan, special self-protection measures to maintain the safety conditions of the occupants.
VI	• The spaces of the 3rd and 4th risk category will need a chief of safety which is responsible for coordinating the safety team. The safety team should be increased in 25%.
VIII	• The train stations or terminals of transport should at least have the following self-protection measures: prevention plan; internal emergency plan and training in fire safety. • In the above, the central traffic transport entity will operate as a central command post of the movement of means of transport, as well as systems and safety equipment attached to the tunnel. • The internal emergency plan should include procedures of safety in case of a fire in a mean of transport inside the tunnel.
IX	• The spaces of the 3rd and 4th risk category will need a chief of safety which is responsible for coordinating the safety team. • The safety post at the campsite should have copies of the emergency plans of all buildings in the park, an emergency plan of the whole park with the location of the risk places and roads. • The rules of the campsites should include measures to prevent and protect themselves against fire. A summary of these rules should be given to each camper.
X and XI	• The self-protection measures should include specific procedures for prevention and protection of the works or items of significant interest to the historical or cultural heritage. • The safety team should include elements with the specific mission to ensure the protection of the mentioned works. • Smoking or open flames is not allowed in places where they are exposed, stored or subjected to operations of conservation and restoration items of significant historical or cultural heritage interest. • It is not allowed using equipment with unprotected incandescent elements and devices and equipment which may produce sparks unless they are essential to the restoration works but in this case compensation self-protection measures should be considered.

5. IMPLEMENTATION OF THE SELF-PROTECTION MEASURES

The self-protection measures should be implemented in the building by the safety responsible testing their operation in evacuation exercises. This point seems crucial, since it still prevails in today's society the idea that the needing of preparing self-protection measures is only to acquire the license of use which, in practical terms, means that most of the buildings users do not know how to act in emergency situations.

It is presented an example of possible actions to be taken in the implementation of self-protection measures:

- Delivery of a copy of the self-protection measures to the safety responsible of the use-type;
- Promulgation of self-protection measures by the safety responsible of the use-type;
- Delivering to ANPC three copies for approval;
- After approval distribution of the self-protection measures to the entities and persons listed on the distribution list;
- Realization of awareness campaigns for all occupants of the use-type;
- Realization of training actions to the members of the safety teams;
- Obtaining of the formal and effective acceptance of the involvement by the appointed for fully discharge of the functions entrusted to them;
- Distribution of procedures of using the places;
- Distribution of the special fire safety instructions to the members of the safety team;

- Display of the general and specific safety instructions and emergency drawings (if the self-protection measures contains the internal emergency plan); and
- Realization of an evacuation exercise in order to assess the internal emergency plan and acquaint those involved.

In order to understand the evolution of the implementation of self-protection measures over the last decade in Portugal and at the same time try to understand if the current Regulation of Fire Safety in Buildings served as catalyst for the promotion of the self-protection measures, a survey was directed to the District Commands of Emergency Operations (CDOS) of ANPC responsible for their review and approval and at a later stage to the President of ANPC [4].
The content of the survey addressed the following points:

- Number and type of self-protection measures submitted for analysis since 2000 for each use-type;
- Number of evacuation exercises carried out per use-type since 2000;
- Number of self-protection measures reviewed and approved without recommendations / changes; and
- Major deficiencies encountered in the self-protection measures submitted to appreciation.

This survey was only answered by a few District Commands of Emergency Operations. Table 9 shows as an example the data obtained for the District of Oporto between 2008 and 2009.

Table 9 - Number of self-protection measures analysed by CDOS of Oporto for each use - type

<table>
<tr><th>Type of Occupation</th><th>2008</th><th>2009</th></tr>
<tr><td>Housing</td><td>0</td><td>0</td></tr>
<tr><td>Parking</td><td>0</td><td>0</td></tr>
<tr><td>Administrative</td><td>10</td><td>10</td></tr>
<tr><td>School</td><td rowspan="2">111</td><td rowspan="2">86</td></tr>
<tr><td>Hospital</td></tr>
<tr><td>Shows / Public Meetings</td><td>4</td><td>2</td></tr>
<tr><td>Hotels / Restaurants</td><td>19</td><td>5</td></tr>
<tr><td>Commercial / Transportation stations</td><td rowspan="2">160</td><td rowspan="2">134</td></tr>
<tr><td>Industries / Workshops / Warehouses</td></tr>
<tr><td>Sports / Leisure</td><td>4</td><td>6</td></tr>
<tr><td>Museums / Art Galleries</td><td>1</td><td>0</td></tr>
<tr><td>Libraries / Archives</td><td>0</td><td>2</td></tr>
<tr><td>Fuelling Stations</td><td>2</td><td>0</td></tr>
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In this study, it was found out that by 2009 the large majority of the existing uses-types haven’t submitted their self-protection measures to appreciation by ANPC. At the same time the information is very scarce and scattered, which makes the study somewhat inconclusive, so it would be important to implement a system to register the self-protection measures analysed. There is still a long way to fulfil in the preparation and implementation of self-protection measures in buildings, in Portugal. The time allowed for the preparation and updating of the self-protection measures was widely exceeded, and the large majority of the buildings have not yet elaborated those procedures.

6. CONCLUSIONS

The entry into force the Regulation of Fire Safety in Buildings has generated an innovative dynamic at the level of the self-protection measures in Portugal however it appears that the vast majority of buildings has not yet the self-protection measures prepared so there is still a lot to do in the organizing and management of fire safety in buildings in Portugal. This is due, on one hand, to the lack of knowledge of the owners and management bodies of the buildings and the other to the lack of money to develop and bring the self-protection measures for appreciation of ANPC. On the other hand it is thought that ANPC would not have at the time structure and capacity to inspect all the buildings if they decide to submit for appreciation their self-protection measures. It constitutes a fact of great utility the prevalence of preventive measures and the obligation of training to all employees of each use-type, in order to become aware of the self-protection measures, as well as the mode of operation of the installed safety equipment.

7. ACKNOWLEDGMENTS

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Development of a safety training program for electricians and locksmiths at a metalworking company, based on a competency approach

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ABSTRACT
Training is often misunderstood when it comes to Occupational Health and Safety since organizations frequently choose to acquire and develop pre-designed training programmes available on the market, without consider the training transfer related factors. Although the large amounts spent on training activities, its effectiveness remains below expectations.
This paper reports a study aimed to design a training program for electricians and locksmiths at a metal working company through a competency based approach. A hazard identification and risk analysis was carried out using the Job Safety Analysis and the competences framework in OH&S was built. Then it was submitted to validation by a board of experts and subsequently translated into a training program.
In order to promote the training efficiency, the program design took into account research results on training transfer, in particular the importance of a strong link between the work environment and the training context. The safety training can not overlook the advances in research on the effectiveness of training and the factors that promote it. This is the way forward to strengthen the safety training status as a preventive measure.

Keywords: safety Training; Training transfer; Risk Analysis; Competencies; Competency-framework.

1. INTRODUCTION

Training is often misunderstood when it comes to Occupational Health and Safety (OH&S) since organizations frequently choose to acquire and develop pre-designed training programmes available on the market, without consider the training transfer related factors. Although the large amounts spent on training activities, its effectiveness remains below expectations.

Research shows that several factors have an influence in the training transfer, and if they are not considered the results fall short of expectations (Bossche *et al*., 2010). In general the investment that is made on training does not have the expected return (Saks & Belcourt, 2006; Burke & Hutchins, 2008; Chiaburu *et al*. 2010; Martin, 2010; Laker & Powell, 2011). A Saks and Belcourt (2006) study showed that in 150 inquired organizations, only 62% of the trainees apply immediately the new skills, 44% still applied those six months after training and 34% one year later.

For training to be effective, trainees should carry new knowledge to the work environment and apply what they learned (Bossche *et al*., 2010). The effectiveness is enhanced by factors such as:

- *the design of customized training programs,* based on training needs assessment (TNA) and on a competency approach, designed to facilitate the learning transfer to the work environment (Burke *et al*. 2006; Macauley, 2006; Burke & Hutchins, 2008; Martin, 2009). Though most research assumes that the contents of training are not relevant to the success (or failure) of the transfer of training, the fact of making no distinction between hard skills (technical, know-how) and soft skills (behavioural) compromises its effectiveness. So, special attention must be given to a proper balance between both types of skills (Laker & Powell, 2011).
- *the composition of training contents and experiences,* with a strong link to the work environment, along with the use of active methods that contributes to increase the effectiveness of safety training (Burke *et al*. 2006; Tophoj, 2006; Velada, 2007; Martin, 2009). Such approach strongly involves the trainees, providing them with the new knowledge, enhancing their skills and motivating them to lifelong learning;
- *the participation and motivation of trainees*, bearing in mind that this is an individual characteristics that predominantly affect the transfer of the training (Holton, 2005 cf. Velada, 2007);
- *the organizational climate and organizational reinforcement* throughout the process, reflected in policies, practices and procedures, as well as support from supervisors and peers (Saks & Belcourt, 2006). Even with a well prepared training program and highly motivated trainees, training transfer only occurs if there is a favourable organizational climate (Martin, 2010). Organizational reinforcement enhances trainees' self-esteem, the sense of being valued by the organization, the sense of self-efficacy and the guidance by objectives (Chiaburu *et al*., 2010). The supervisors have an important role in both pre and post-training by encouraging, supporting, setting goals and assuring that trainees have opportunities to apply what they have learned when developing their usual tasks. Finally, peer support is also significant to the training transfer due to the follow-up, incentive and assistance provided (Martin, 2010);
- *the training transfer evaluation*, specifically the degree to which learning is applied, disseminated and maintained in the workplace (Marques, 2007). These evaluations efforts, besides giving credibility and confidence on the training investment, provide data that can stimulate the training effectiveness and the transfer itself. A competency-framework can provide an important contribute to this kind of evaluation.

The present paper reports a study aimed to develop a safety training program for electricians and locksmiths, at a metalworking company. Due the operative and technical nature of the professional activities involved and the required SST skills, it was considered appropriate to adopt a competency based approach (Tophoj, 2006; Martin, 2009). A competency corresponds to the mobilization of intellectual, affective and psycho-motor assets, properly integrated to respond effectively to everyday professional circumstances. In OH&S, this reply highlights total respect and compliance of OH&S rules, preventing workers from risks related to their activities. A proper identification of the OH&S competencies related to professional activities requires the use of hazard identification and risk analysis results. In this case, were made using the Job Safety Analysis method (JSA) and were organized into a framework.
A competency framework plays a supporting role of the training cycle (Martin, 2009): guides the training needs assessment, the training program planning and design and the evaluation of the learning transfer [3rd level on Kirkpatrick's (1994) scale]. To that extent, a framework is simultaneously the warranty of the training's intervention renewal (Tophoj, 2006).
OH&S competencies can have hard and soft skills: the first case (technical competencies) corresponds to the description of operational actions, indicators of an instrumental and technical know-how to act; the second (behavioural competencies) describes behaviours and attitudes common to several professional contexts (e.g. teamwork, communication, responsibility, proactivity, etc...). Such complementarity makes sense because there is a growing acknowledgement that the fulfilment of hard skills is insufficient to ensure professional success, even in technical areas. Consequently, is increasingly required the accomplishment in soft skills (Laker & Powell, 2011).

2. MATERIALS AND METHODS

2.1. Hazard Identification and Risk Analysis

The Hazard Identification and Risk Analysis was developed by using the JSA methodology, followed by the observation of the workplaces of the professional groups involved, electricians and locksmiths. It was held for three days on the production plant and divided along the workday, in order to observe various working procedures and different workers performing the same task. Videos were used to register as many processes as possible along with no structured short interviews, to clarify some task and procedures.

2.2. Development of the skills framework

The development of the competency framework followed three main steps:

1. *Signalling* – after the hazards identification, we proceeded signalling the required OH&S competencies (Figure 1). It was ensured that each one was equally observable and measurable to enable their easy identification in the workers' performance. Hard and soft skills were considered;

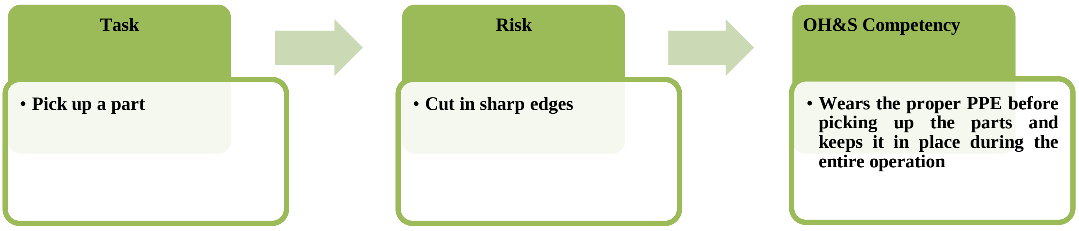

Figure 1 - Procedure for the development of the OH&S competencies framework

2. *Development and validation of the framework* – the OH&S competencies were organized into a framework, aligned with the respective tasks and occupational risks. Then the framework was submitted to analysis by a panel of experts, specialists in OH&S and metalworking. The outcomes and suggestions led to a final version of the framework.
3. *Selecting the competencies for the training program* - in addition to safety training, other alternatives less costly but potentially effective for the promotion of each competency were also considered (e.g. information and awareness activities, visual aids reinforcement). The selected competencies should seem more dependable on a training investment rather than other initiatives to its promotion.

2.3. Development of the training program

The competencies guided the safety training program design: each one was translated into learning objectives. Whenever possible the definition of learning objectives followed Robert Mager's rule (behaviour, condition and degree) (IQF, 2004) to facilitate assessment and feed-back.

The training program adopted a modular structure (the qualities of autonomy and flexibility explains the popularity of this kind of arrangement). Each module intended to promote between 2 and 5 competencies which guided the module program design, i.e., the definition of the usual components (objectives, content, strategies and evaluation). The organization of each module adopted a tripartite structure (IQF, 2004):

- *entry* - link to the previous module and / or previous experience and knowledge; introducing the learning objectives;
- *body* - the development of the training activities;
- *output* - making the final synthesis, summative evaluation if applicable and the link to the next module.

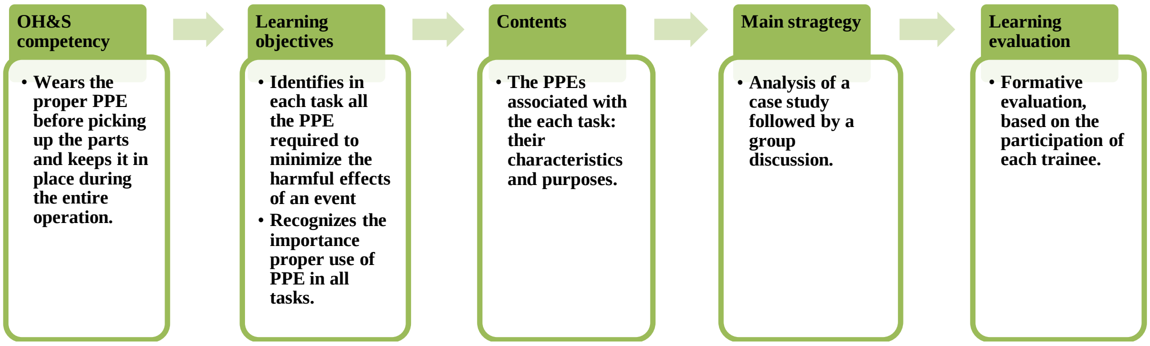

Figure 2 - Procedure for the development of the training program

Other results from training effectiveness research were also observed in the training program design namely a particularly strong proximity between training and professional contexts (Holton, 2005 in Velada, 2007; Tophoj, 2006). Well known educational principles were respected, for example: the contents sequence always started with familiar content to the trainee; privileged to simulations and other active training techniques centred on the workplace; feed-back and formative assessment.
The elaboration of the training recommendations was guided by concerns of feasibility and involvement of workers and their supervisors in the pre and post training phases.

3. RESULTS AND DISCUSSION

The study's main goal was to develop a training program for electricians and locksmiths, in order to develop the OH&S competencies that allow them to safely perform their tasks. We evaluated the risks, elaborated a competency framework and then training program with recommendations to promote the training effectiveness.
The occupational hazards found are aligned with the literature descriptions, concerning the metal work activities and the specific analysed tasks: oxy-fuel cutting; grinding; electric arc welding; basic electrical connections. Were signalled 65 OH&S competencies (61 with hard skills and 4 with soft skills): 42 related to electricians, 61 to locksmiths and 38 common to the two professional categories (Figure 3).

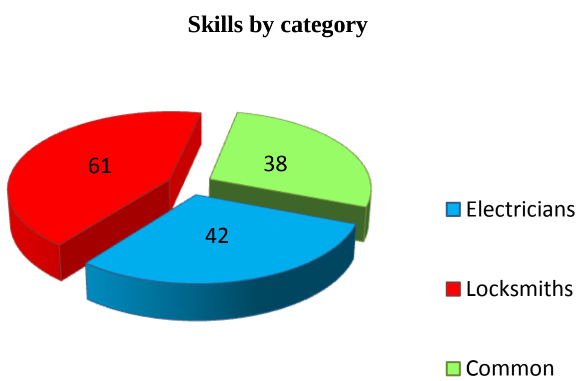

Figure 3 – OH&S competencies by occupational category

It was considered that training was not the most appropriate intervention for all skills; only 23 were translated into learning objectives. For the remaining ones, it was suggested other solutions such as: awareness and constant monitoring in the workplace, displaying visual aids in the workplace and the use of checklists (Figure 4).

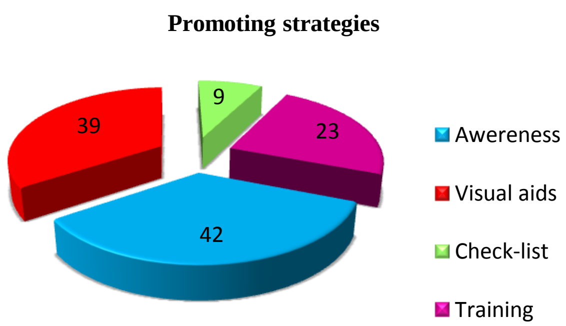

Figure 4 - Distribution of skills in accordance with the promoting strategies

The safety training program is divided into 4 modules with 2 hours each and contains the following components:

a) *Learning objectives* – specific, measurable/observable, and results-oriented;
b) *Content of the training* – topics organized in a logical way; from the easiest to the complexes; and centred on familiar experiences;
c) *Learning experiences* - linked to the work environment; using the expository method sparingly (e.g. introductions, summaries); using demonstrations, debates centred on safety situations, simulations and practical exercises;
d) *Assessment strategies* - the emphasis is on formative assessment because it allows rapid feed-back both to the trainer and the trainee and further readjustments in the learning process.
e) *Recommendations for the training transfer* that includes: the supervisors' involvement in the training preparation and the employee's motivation and accountability before and after training. As an example of pre-training activity, it is recommended that supervisors meet with trainees to inform about the training objectives, its content, the new skills relevance for their professional and personal performance, motivating them to participate and allowing time for their preparation; the supervisors feedback and reinforcement after training it is equally necessary to stimulates and strengthens the learning transfer; it is also strongly recommended a training transfer evaluation using the OH&S competency framework; this instrument should also be used in training needs assessment activities.

It should be noted that this training program is presented as a proposal, open to changes and improvements, whenever the target group of workers or the professional tasks changes. In that case, the skills framework must be reviewed as well as the training program.

4. CONCLUSIONS

It is our belief that the competency approach in safety training is most appropriate whenever professional activities have a highly operational nature. The training investment becomes more rational and optimized.

For the training to be effective, trainees should be able to reproduce the new skills and knowledge in their workplace, applying what they have learned and thus creating an added value for them and for the organization. However, research shows that training transfer is influenced by several factors. We emphasize the support, feed-back and reinforcement by the organizational environment regarding the learning transfer. Support from supervisors and peers, when the trainee returns to the workplace, contributes to the training effectiveness.

In Portugal, training is often chosen as the only approach to prevent or solve organizational problems related to OS&H. The research results do not discredit the training contributions, but it shows that its effectiveness is much below expectations. Fortunately, studies identified some factors that influence the training transfer and this knowledge should be part of the current safety training management and design.

The training bundles available on the market miss the link between the training and the work environment which is one of the strongest conditions for the training effectiveness. For this reason it is particularly important to invest in a personalized training focused on the TNA results and the OS&H competencies required by the organization.

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Car Driving Integrated Auxiliary Equipment Design

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ABSTRACT
Professional light vehicle drivers are probably, within automotive related professions, the more used ones. Accordingly, the main objective of the current study is to define and develop a research framework in order to understand the daily experience of professional drivers and the relationship between drivers' anthropometrics, environmental and instrumental solicitations within the driver package. The emphasis on professional drivers is also related with the fact that it is a relevant group, as there are several types of professionals with automobile driving requirements, such as taxi drivers, mailmen, delivery services, among others.

Keywords: Automotive, Driving, Taximeters, Ergonomics, Equipment.

1. INTRODUCTION

Ryu et al. (2010) refers that a vehicle consists of many systems, some of them that are not specifically conceived for driving, but are, instead, used for supplementary functions, such as air conditioning, radio/multimedia, and more.
As technology evolves, an increasing number of supplementary functions have been added to vehicles. Inevitably, the complexity of the function controls also increases. Ryu et al. (2010) also refer that these kinds of systems require the drivers' visual attention for selecting the desired function, which may increase the probability of an accident. The same authors argue that using an audio display is an alternative, but they also refer some disadvantages. For example, speech feedback is impersonal and ineffective under loud environments, and it is known that the understanding of the meaning of an audio message takes relatively more time comparing with the visual form.
Stanton & Salmon (2011) argue that safety related systems represent a key-challenge across the transportation industry, being transversal to all kinds of transportation. Also other authors, such as Young et al. (2011), Uchida et al. (2011) and Lenné et al. (2011), refer the need of integrated safety-related systems in road transportation. Murata & Moriwaka (2005) also argue that the use of additional in-vehicle information systems to promote safer driving should avoid distracting the driver from their main sources of visual information outside the vehicle. Young et al. (2011) consider a range of devices that have an important role in a safer driving, such as GPS navigation, congestion assistance, intelligent speed adaptation, and others. Accordingly, Regan et al. (2008) also conclude that these "in-vehicle" devices will be competing for the driver's limited attention resources, and therefore any implementation needs to be undertaken with a special and careful design and evaluation.
The aim of this study is to present the result of a literature review regarding the use of non-standard equipment within automobiles that are used as "workplaces".
The main goal of this review is to obtain a comprehensive knowledge about the conception of automobiles, in particular about the driver package. It is also expected to compile information about the non-standard equipment existing in the market, which is being used in professional driving in order to define the state of the art about the relationship between drivers' anthropometric characteristics and the driver package dimensions, within a vehicle. This relationship can also be analysed regarding the use of the non-standard devices.

1.1. Professional framework

Meetings with the National Association of Light Vehicles Road Transport (*Associação Nacional dos Transportadores Rodoviários em Automóveis Ligeiros*) were made, and from them, the interest in the development and cooperation on this study appeared, since actually the disposal of the equipment is at the professionals' criteria (if they work individually) or the transportation companies.
Some problems were identified right away, for example:

- The mandatory placement of the taximeter in a location that should be visible to all the occupants. This usually takes most of the users to, generally, disable the central air conditioning exit, being this one blocked by the equipment.
- Some vehicles have the possibility to adapt some characteristics so that they can be used as a taxi. The majority of those adaptations have to do with mechanical issues (allowing to drive more kilometres without the need of mechanical repairs, for example).
- The cars from the brand Mercedes have an indent in the glove-compartment, which allows users to place the taximeter there, and has been originally projected for that usage. Most of the professionals do not use it for the following reasons:
    1. It is awkward to access it when there is a customer sitting on the passenger seat.
    2. It obligates the user to an exaggerated extension movement, and because of that, inappropriate.

- The placement of the taximeter in the upper part of the dash forces the need to make permanent holes and, at the same time and depending on the brand, at an exaggerated distance of the driver.
- Despite the existence of taximeters that are placed on the rearview mirror, these obligate the user to program them in an uncomfortable position, or the placement of more buttons on the steering wheel. On the other side, they are very expensive.
- The bidirectional radio is positioned in places which are not defined by the manufacturer. Despite the existence of voice controlled Bluetooth applications, there is always the need to control the volume, not to disturb the passengers during service. Some taxi drivers place the "hardware" on the glove-compartment, which is still uncomfortable, because when there is the need to make changes on the volume level, they are faced with the same situation that has already been mentioned, for the placement of taximeters on the Mercedes.
- There is still the use of the GPS, which needs to be programmed according to the destination, and sometimes more equipment per vehicle, as well as the battery cables to connect to the lighter. As well as the referred equipment, we also have the receipt printer, or the cell phones and the ATM terminal.
- The identification and license of the professionals are also obligatory, and have to be visible on the dash.
- The video surveillance systems are not required, but they are still needed on the interior of the vehicles. And despite they do not need a constant maintenance, they should be embedded into the driver package.

2. LITERATURE REVIEW

According to Roe (1993) the "occupant envelope" is, when designing an automobile, one of the first steps. Because of this assumption we may consider that the set of considerations that must be taken into account within the "occupant envelope" are of high importance for de vehicle development. We can state the following factors: Interior space; interior components (e.g. seats, controls, etc.), structural components (e.g. air ducts, steering column and roof rails, etc.).

Designing a vehicle involves the design, development and integration of a large number of systems and subsystems within a vehicle (Bhise & Pillai, 2006). This is a very complex process which involves multidisciplinary teams, working together in order to fit all the features within the existing limited space, nevertheless fulfilling the function for which they were designed, providing the vehicle the ideal combination of all the needed attributes such as appearance, performance, safety, ride and comfort (Bhise & Pillai, 2006).

Roe (1993) argues that the automotive occupant packaging is based on a human factors database, which was developed through years of research and practical application. Both research and practical applications were developed in laboratory and on the road, defining, among other things, the driver's eye location, hand reach, seat positions and other related dimensions.

Ryu et al. (2010) refers that a vehicle consists of many systems that are not specifically for driving, but are, instead, for supplementary functions such as air conditioning, radio/multimedia, and more. As technology evolves, an increasing number of supplementary functions are added. Inevitably, the complexity of the function controls also increases. A recent solution for the problem has been the Driver Information System (DIS): a multifunctional system that provides a unified interface to control the vehicle electronics. Some DISs, e.g., iDrive of BMW, are equipped with a manual interface such as a rotary knob for menu browsing and selection and a visual display for informing the menu state. Ryu et al. also refer that these kinds of systems require the drivers' visual attention for selecting the desired function, which can increase the probability of an accident. Because of that, many functions within the DIS are normally disabled during driving. Ryu et al. argues that using an audio display is an alternative, but it has some disadvantages. For example, speech feedback is impersonal and ineffective under loud environments, and to understand the meaning of an audio message takes relatively more time.

It should be taking into consideration that the most important concept on the automotive industry is safety (Fai et al. 2007), for that each component designed must be able to reduce injury to the occupants during a collision.

Stanton & Salmon (2010) argues that safety related systems represent a key challenge across the transportation industry, being transversal to all kinds of transportation. Also Young et al. (2011), Uchida et al. (2011) and Lenné et al. (2011) refer the need of integrated safety-related systems in road transportation. Murata & Moriwaka (2005) also argue that the use of additional in-vehicle information systems to promote safer driving should avoid distracting the driver from their main sources of visual information outside the vehicle. Young et al. (2011) consider a range of devices that have an important role in a safer driving, such as satellite navigation, congestion assistance, intelligent speed adaptation, and so on, for that they also conclude that these in-vehicle devices will be competing for the driver's limited attention resources, and therefore any implementation needs to be undertaken with careful design and evaluation (Regan et al., 2008).

In most vehicles, the interior development follows the exterior design. The existing exceptions depend on the use of special seat systems or special cargo needs.

Some parts contain the active and passive safety systems, such as the air bags, seat belts and knee blockers (Macey & Wardle, 2009). The driver package has its main safety feature inside the steering wheel.

Automotive interiors can be divided in seven systems (Macey & Wardle, 2009):

- Trim: Is designed to reduce head trauma during an impact or rollover.

- Controls, instruments and switches: The steering wheel, shifter, hand brake and turn-signal stalks all have to be located here. They must be located where the driver can use them effectively. The instrumental cluster is usually seen through the steering wheel, so accurate vision studies are crucial.
- The instrument panel and consoles: Many of its key instruments are directly related to the driver location and posture, in order to provide reach, visibility and safety.
- Seats and seat belts: seats are designed in turn of the occupants' package. The adjustment ranges have to be factored into the location of adjacent components.
- Carpet: This feature has no preponderant influence within the package.
- Heating, ventilation and air conditioning (HVAC) systems: These components have its inputs and outputs clearly visible in all vehicles because of the air distribution, vent and controls.
- Telematics: This feature is intrinsically linked to the type of technology the Original Engine Manufacturer (OEM) wants to give to the customer. Although currently is a technology presented in almost vehicles, a few years ago it was a luxury feature. Nowadays is presented in different range vehicles and it may redefine what a vehicle represents to the mass market.

One of the most complex assemblies within an automobile is the instrument panel. This area is very occupied with instruments and information, with the steering column, instrument panel structure, HVAC ducting and interaction driver-vehicle features, all of them looking for space.

Professionals that use an automobile as workplace also have within the driver packaging other non-standard equipment that sometimes are essential to perform their work, such as GPS systems, taximeters, radio communications, mobile phone, etc.

Although some vehicles already have integrated GPS, most of the light vehicles do not, the majority of the GPS brands available in the market use a suction cup to fix it to the glass. Other equipment in use are randomly placed around the dashboard, like the taximeter or the radio communication system.

There are certain basic equipment required by most of the drivers when working and that are not standard on the common automobiles:

1. GPS system: There are different types of navigation systems most of them are, as indicated, GPS. This equipment helps the driver to find their way around an area they may not be too familiar with;
2. Taximeter: This equipment is exclusive for taxi drivers. It is mandatory by law and it defines the correct amount to be charged for a certain distance travelled;
3. Two-way radio: This communication system is common among companies who have an office where customers' phone and then information may flow to the workers on the field (taxi and transport companies). In the taxi companies the proceeding is as follows: once a customer has booked the taxi the operator is the office will then look on the system to see where the nearest taxi driver is to where the person needs picking up. They will then call the person over the radio system and give them the details of the job. This is a very good help because the taxi driver himself do not need to worry about booking particularities, and also avoids unnecessary travel;
4. Computer communication system: These systems are helpful to the drivers because they arrange different buttons to correspond as different locations, so instead of calling in they simply have to press the button for the location they are passing through at that time and it informs the operator on where they are. Also different jobs come up on the screen, so if a driver is sent a certain job through the system he can either accept or reject it;
5. Video surveillance equipment: The increase of crime associated with violence made important the use of surveillance systems. Portuguese law already allows the use of video surveillance to prevent crime. However it is only possible to use when facing an imminent crime;
6. Mobile phone: Is a very common device among all drivers. One driver can have more than one of these devices.

Makiguchi et al. (2003) also refer that the controls used to turn on or adjust in-vehicle systems have increased in number in recent years. Concerns about the driver's growing workload have led to the following measures:

1. Reduced reach distances;
2. Reduced visual and tactile workloads;
3. Prioritized layout of controls.

They also argue that to reduce the workload is necessary as the number of in-vehicle systems and elderly drivers are both expected to continue to increase.

Also these equipments "struggle" for space, and many times are positioned in places that are out of the optimal range distance. Making them difficult to use, endangering the safety of the user.

2.1. Legal framework

Taxi driver activity is ruled in Portugal by legislations, which is supported by European Directives.

The Decree-Law nº 251/98 of the 11th August regulates the activity of the transportation of passengers on light vehicles. This was updated using the Decree-Law nº 41/2003 of the 11th March.

The Decree-Law nº 192/2006, of 26th September transposed to the national juridical order the Directive nº 2004/22/CE, of the European Parliament and Council, of the 31th of March, which establishes the general essential requirements to pay attention to, in the placement on the market, and in service of the measurement instruments that are referred to, in it.
The utilized equipment and their usage requirements are written in the Portuguese Regulation nº 33/2007 of the 8th January. Given the metrological relevance of the taximeter, this document defines it as being "a device that, together with a signal generator, is a measurement instrument. The device measures the elapsed time and calculates the distance travelled, based on a signal that is issued by the signal generator, and also calculating (and showing) the amount of money to be paid for the trip, based on the calculated distance and/or the time elapsed".
The taximeter should be:

1. Designed to calculate the distance travelled and measure the elapsed time.
2. Designed to calculate and show the amount of money to be paid, incrementing in steps according to the resolution declared by the country, while on "On service" mode; the taximeter should also be designed to show the final amount of money to be paid for the trip, while on "Waiting" mode
3. Able to apply the regular calculation methods S and D. It should be possible for the user to be able to choose between these methods of calculation using a protected device.
4. Able to provide the following data, through an adequately protected interface: Functioning Position: "Free", "In service", "Waiting";

3. CONCLUSIONS

This review, which was the baseline of an ongoing PhD. thesis, allows to synthesize and systematize the available industrial information, which are not always reported in the scientific literature. This approach will, hopefully, produce knowledge about the market that may be extremely important for the scientific community.
As future work it is intended to study the anthropometrical relations between the driver and the non-standard features within an automotive vehicle being used as a workplace. We will define the sample to be considered in the field work, which should be representative of the universe of driving professionals.

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Thermal Environment in Underground Mining Activities: An Integrated Approach

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ABSTRACT
In underground mining the thermal environment is a growing problem when the depth increases. In this context, this paper seeks to present a new approach to quantify the relationship between thermal environment, safety conditions, health and productivity. For that, an objective function has been designed in a cost minimization perspective. The function provides the best parameters set for the operation of ventilation systems, ensuring the most appropriate working conditions. The used units (currency) allow obtaining results that provides a comprehensive analysis of the economic impact.

Keywords: Thermal Environment, Safety, Productivity, Mining.

1. INTRODUCTION

The influence of thermal environment on humans, particularly in productivity, safety and comfort conditions, associated with work activities, is crucial for both individual and company performance (Niemela *et al.*, 2002).
In underground mining activity, workers are exposed to extreme environmental conditions, due to increasing values of temperature and humidity. With increasing depth, grows the influence of these two factors on the working conditions, with a negative impact on workers health. In a study carried out in United States, this sector is referred as one of those where workers suffer the most from heat (Balbus, 2009).
There are thousands of published studies on the effects of thermal environment in humans. However, almost all of them deal with the problem in a fragmented way, that is, focuses exclusively on the effects that a given thermal environment produces in the different areas (health, safety or productivity) considered separately.
On the other hand, published information tends to be qualitative. Doesn't providing results that can portray the true extent of the problems. Recently, in mining, the exceptions are some studies that deal with diseases and health problems (Donoghue, 2005), (Gancev, 2006) or the work on the health risks associated with the practice of effort in extreme heat conditions (Guedes, 2011). It should also be noted that the generality of the works in mining industry that relate causes and effects of thermal environment do not address the instruments of action available for their improvement when in adverse conditions.
The aim of this work is to develop a model that consider elements of the thermal environment, controllable through the ventilation system, considering that it is intended to achieve the best conditions of safety, comfort and productivity at minimal cost.

2. APPROACH

The recognition of involved factors and their impact on occupational variables, together with the identification of the technical means available to change and control the thermal environment, allow a concerted action to obtain the desired safety conditions, health and performance in mining activity and thus maximize the benefit of their interaction with individuals.
It is this integrated approach that supports the described model. For their implementation several resources and measuring equipment will be used to evaluate the real life situations. Among the different ways provided to collect data can be mentioned: measuring equipment to the environmental variables, opinion surveys and techno-scientific information. Given the specificity of each of these 'tools', the 'modus operandi' to data collection will be described in the following paragraphs.

3. CONCEPTUAL ISSUES

3.1. Environmental Control in Underground Mining

In underground mining, the changing of the environmental conditions is held essentially by control and manipulation of the ventilation system. The thermal environment inside a mine is conditioned by the flow and distribution of air introduced, or extracted, in line with the set of requirements for its distribution (Vutukuri, 2010). A suitable dimensioning of the ventilation conditions can prevent thermal discomfort and consequently also the thermal stress of the worker (Talaia, 2006).
The architecture of ventilation systems (VS) within an underground mine must be adaptable to a changing geometry over time. To address these changing requirements, is done a subdivision into two distinct but complementary systems, which will be designated as Flow-through Ventilation System (FVS) and Auxiliary Ventilation System (AVS):

- The FVS is constituted by a group of fans that provide the amount of air necessary to the requirements inside the mine. It is usually a large dimension system, So, frequent changes in their operating parameters are not desirable, neither effective, considering three kinds of reasons:
  - Technical level - the inertia associated with a large electromechanical system and to a large volume of a compressible fluid (air) inside the mine, results in a system response delay.
  - Facilities - the change in the amount of air blown through FVS, is reflected in mine galleries with delay, which is greater the greater the distance to the fan.
  - Distribution of the flows - inside the mine, different places need distinct air flow rates. On each of those places there should be an independent ventilation system (AVS) to enable environmental control of each specific work place.
- The AVS is responsible for air supply in quantity and quality in locations outside of its direct influence, such as the *working faces* in *dead end*. In those places, the air supplied directly by the FVS is not sufficient, requiring the use of supplementary aids that leads the air to the *working faces*.
  The AVS is comprised by auxiliary ventilation fans attached to ventilation ducts that carry air to the places where is needed. Thereafter the air returns to the main gallery, downstream. This system is light, easy to control and with quick response. It is installed on site in order to adjust the amount of air necessary to the establishment of the appropriate environmental conditions in critical areas of work.
  It should be noted that the places in question are the most critical points of the installation in terms of concentration of environmental pollutants and needs for air exchange. Therefore, measures to ensure compliance with the minimum standards for air quality and thermal comfort of workers are more critical compared with other areas of the mine. In addition to this fact, there are a high percentage of workers who remain in these places for long periods, making the problem unavoidable.

The previous categorization of ventilation systems can identify the main functions associated with each one of the two identified types. In summary:
- The FVS is responsible for ensuring the global exchange of air between underground and surface. Also should ensure the overall flow of air introduced inside the mine, in a continuous and stable way.
- The AVS consists of small equipment with quick responsiveness, placed near to where they act. They are, therefore, suitable to the environmental control of confined areas with rates of air exchange most demanding and changeable. The operation of these systems does not change the value of the global air flow (in charge of the FVS), but just redirects the air locally.

Following the description of the characteristics and scope of the FVS, and AVS and knowing the main goal of this work, only AVS will be considered. It is the one that affects directly the environmental conditions in the most critical working places in mining. In this sense, it’s fundamental monitor the environmental variables and their impact on productivity and safety on "working faces", through the control of local work conditions. So, as only the AVS is involved, should be the prioritary instrument of action.
Obviously, this approach assumes that the primary system ensures, in a stable way, the global flows necessary for the overall needs of the mine. The definition of these values will be subject to careful consideration and analysis at later points of this paper, when' discussed the issues related to the thermal environment and air quality.

3.2. Air Quality
The kind and the concentration of pollutants inside a mine changes according the ore, the characteristics of the exploration, the technical resources used on the *working faces* and the equipment used to transport the ore to the exterior (Gancev, 2006).
The safeguard of an acceptable air quality for the presence of workers in these spaces is mandatory and arises of the fulfilment of the requirements in current regulations on the subject. Is important here to note that the renewal of air, essential for reducing concentrations of pollutants and ensure the required conditions, is guaranteed through the ventilation system and it is similar to the aforementioned in section 3.1 for the temperature and humidity.
To know the air quality, are planned measuring particulate matter and gases (CO, NO, NO_2, CO_2, O_2, ...) in the places considered the most sensitive, namely:
- In the *working faces*, where environmental conditions are worse and works a large number of workers;
- Entries and exits of the air.

These measurements will be performed through from available data acquisition equipment, such as the model EVM-7 of Quest whose description of technical features are accessible on 'website' of the manufacturer (Quest, S.D.a). This equipment has as an advantage the possibility of measurement of toxic gases, dust and volatile organic compounds (VOCs) associated with air quality. At the same time can also measure, the temperature, the relative humidity and the air velocity, related with thermal environment, all through a single portable device.

3.3. Conditions of Thermal Stress

Workers' exposure to conditions of thermal environment of great severity (in particular with high temperature and humidity) causes intolerable situations for human health. In extreme situations it can even lead to the collapse of the organism and cause death. Even the simple exposure without any activity in a very hot and humid environment can cause thermal stress. When to these conditions is added some kind of physical effort, the stress situation and the risk of injury are enhanced (Guedes, 2011).

In order to prevent such conditions on *working faces* is necessary monitorise and control temperature and humidity values and assessing the risk of thermal stress production. This can be made through the use of index *'Wet Bulb Globe Temperature'* (WBGT) - ISO 7243:1989 (E).

3.4. Safety and Productivity

The relationship between thermal environment, safety and productivity, in qualitative terms, is intuitive and widely recognized by scientific community. Several references appear in that sense, for instance:

- Thermal comfort in underground mines is directly related to productivity and also associated to work accidents (Gancev, 2006, p. 4.);
- When in heat stress, human being undermines their health, changes their psychosensorial reactions and loses work capacity (Lamberts and Xavier, 2002, pp. 71);
- The occurrence of heat stress conditions is common in industrial environments. In these situations, the capability of concentration and physical performance of workers is affected, compromising productivity and, not least, creating favourable conditions for accidents (Sa, 1999, pp. 1).

The increased exposure to heat implies a reduction of production capacity (Kjellström, 2009). In a study that relates the temperature value with workers performance in the automotive industry, was concluded that up to the quality of the product depends on the workers comfort and that the temperature is one of the environmental factors that have a more significant effect on their performance (Ismail, 2010).

The productivity is affected by a multiplicity of factors. Since many years factors such as climate changes, high temperatures, metabolism and cognitive aspects are studied in order to verify their relationship. However, few studies have been conducted in order to quantifying them in a real context (Costa, 2011).

There are some difficulties in the establishment of the cause / effect relationships between productivity and the above mentioned aspects. This results from the complexity and diversity of the issues involved. However, another important component has not a consensual approach on published information: it is the way how should be measured both productivity and safety.

Starting with productivity, it can be measured in different ways:

- *Direct*: is the usual way of measurement adopted in production management. The productivity is measured by the 'amount of product' produced by worker or working group, per unit of time. In applying these criteria to mining, can be measure the amount of *mined ore* (tons) or the value of the *advance* (m) both referenced to a pre-defined period of time (day / month / year)
- *Indirect*: measurement of idle periods, ie, where there's no production. These periods, also known as 'time out', can occur as the result of the need for rest cycles over the period of work arising from the application of WBGT index (Costa, 2011). In this case the productivity is analysed through the loss of production compared with what could occur if the worker were operating continuously.
- *Temporal horizon*: the direct quantification of productivity (exemplified above) takes place during or immediately after the completion of work. In this situation, the data allow us to evaluate the performance at the time or within a short lag. Instead, if it is considered the loss of productivity as the result from absenteeism caused by diseases contracted by workers, whose causes are related with the exposure to adverse thermal environments (hot and humid), those falls in productivity can only be accounted if it is considered a collection data long enough, in order to identify and incorporate these effects.

Despite the difficulty to incorporate the different results in the business context, the measurement of the productivity must be global, taking into account all the factors on which it depends and be addressed to the world business. Thus, the model will work together all the parameters that were reported above..

A similar approach should be implemented to safety parameter, combining the set of direct and short-term indicators (eg accidents), with medium / long term (eg, accident rates, injuries / illnesses associated with the thermal environment). It is intended, therefore, that the model allows for a phenomenological reading about reality modelled. It should be noted that the absence of information of medium/long term, at boot time, do not derails the implementation of the model. The strategy consist in develop two functions, productivity and safety, updating them in a successive and systematic way , according to the data flow and information available over time. This process of dynamic updating will lead to an increase of robustness of the model in a process of sustained evolution.

4. INTEGRATED MODEL

Below will be summarized the main problems concerning the quantification of relationships between the functions:

- Lack of enough quantitative studies, in number and scope, to assess the interactions sought;;

- In general, existing studies are focused only in partial aspects, not considering the necessary integration with the different relevant elements to a global analysis of the problem.

In addition, it should also be noted that:

- In studies that quantify the dimensions of the parameters under analysis, the units systems are not consistent either uniforms, making impossible to compare results among themselves. See in this regard, the impossibility of comparing the results of analysis of risks and work accidents in mines, by counting the days lost, proposed in Kukic (2009) with the rate of occupational injuries (serious and mortals) in the Spanish mining industry, reported in Sanmiquel (2010), or even with the death rate in American industry of coal mining (Hendryx, 2009)
- In occupational safety the indexes available are a result of a whole combination of factors. By that, it is not possible to identify the contribution of each isolated parameter and, therefore, the one of thermal environment. (Kukic, 2009; Hendryx, 2009; Sanmiquel, 2010).

Given the diagnosis presented, is proposed a new approach. It consists in develop a model of management of the conditions of thermal environment by the control of ventilation systems (AVS), in order to optimize, in an economic perspective, the safety, the productivity and the energy efficiency, after to have ensured the minimum conditions required for the human use of these spaces.

The overall structure of this model is presented with reference to their basic components and to the purposes to be achieved in each one of its development stages..

4.1. Functions safety and productivity

Safety (*S*) and productivity (*P*) are defined as functions dependents on thermal environment conditions (*ThE*) to relate *ThE* with *S* and *ThE* with *P*. After establish these relationships, their conversion will be done in currency which will harmonize all the measurement units. Consequently, it will allow the design of a global cost function to minimize.

The methodological process to be used to accomplish this conversion will have as base the results obtained by Eston (2005). This author focused his study on mining drilling workers. The results showed a 75% loss in yield when the temperature reaches 37 º C. The economic loss associated to this problem can be determined using different approaches and relationships:

a) The percentage loss on income, η (%), translates into an equivalent yield calculated by the ratio P (%) = 1-η . In the example considered, P = 1 - 0.75 = 0,25.
b) The income loss computation can be based, for instance, on the reduction of the number of hours effectively worked, in decreasing of work rhythm or in the amount of ore produced. However, whatever the process of performance measurement, data can be converted in an equivalent monetary value, balanced by the availability of working hours or by the overall production level. These values can be estimated for the reference situation, considered for a productivity of 100%.

The described procedures allow to achieve the aim of measuring productivity in currency, taking as starting point the percentage of yield loss for thermal environment' given situation. The same methodology is applicable in determining economic value of safety function. Must, however, be taken into account the differences in the available information (number of hours lost by accident, accident rates, frequency, etc.).

As a consequence of the application of economic conversion will result the functions f(S) and f (P), both expressed in currency.

4.2. Energy efficiency function

In underground mining the ventilation control is the available tool for changing environmental parameters. So it has direct influence on the amount of energy needed for its operation. In this study the energy efficiency (EE) will be calculated from the optimization of energy consumption associated with the AVS. Its translation in monetary units will establish the function f (EE).

4.3. Cost function

The cost function, f (C) is achieved by minimizing the sum of the three previous instalments, resulting in:

$$f\ (C) = f\ (EE) + f\ (S) + f\ (P)$$

which determines a total cost for each AVS's operational regime and corresponding levels of safety and productivity.

The minimization of f(C) leads to the establishment of a more economical regime for ventilation system operation. It takes into account the effects of the thermal environment over the variables of both functions (safety and productivity) inside the galleries where work is performed.

The functions f (S) and f (P) have an inverse evolution to the function f(EE). To increase safety and productivity it is necessary to control WBGT index value in work place. To do this it is necessary to control the air flow provided by AVS. Therefore, the minimization of f (C) will indicate the operating regime that leads to the best economic balance taking into account the variables involved..

The scope of the identified function will be restricted to situations where air quality will ensure the minimum conditions of health and safety to the workers in the galleries and *working faces*.

In summary, this model brings together the variables safety, productivity and energy efficiency to give an integrated response to initially formulated problems.

5. CONCLUDING REMARKS

The proposed model presents an innovative approach to the influence of thermal environment on safety and productivity. The relationships between functions are performed considering not only their own variables, but also the conversion of their values to currency. This allows an easy assessment of the impact for technicians, managers and general public.
The integrated model in development has a particular interest, since it is directed to productivity and safety applied to an industry of great importance and high risk, particularly in relation to environment thermal conditions in which are developed mining activities ..
From another perspective it is intended that the contribution of this work goes beyond the academic area. The intention is to provide businesses with an instrument to improve operating profitability and comfort for its employees through the implementation of the proposed model.

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Balanced Scorecard in an OHS Management System through Imprecise Ratio Statements: a case study

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ABSTRACT
This paper describes a case study of implementing a Balanced Scorecard focused on an OHS Management System according to the OHSAS 18001 standard in a group of 15 companies belonging to an industrial corporation present on the international market, specialized in the execution of turnkey projects for the energy and industrial sectors, as well as in the manufacture of capital goods. The definition of the different perspectives used in the model, and of the strategic objectives, and the choice of indicators and the weightings are based on and developed using results from a bibliographical research and interviews with the personnel involved. This study offers an interesting example of the weighting decision using the propagation of imprecise preference statements in hierarchical weighting, leading to several important conclusions offering managerial insights and guidelines for similar implementations. Four perspectives and eighteen main indicators are proposed to better evaluate the performance of the strategy and its related policy measures.

Keywords: Management System; Balanced Scorecard; OHSAS 18001.

1. INTRODUCTION

Firms' ability to measure, consistently and continually, the performance of the fundamental processes in their OHS Management Systems developed following the OHSAS 18001 specifications is critical to achieve a situation of continuous improvement, but is seriously in doubt if managers only consider the content of the procedures explained by it.

Although the standard recommends qualitative measures, there is an imbalance between short- and long-term objectives, between measures directly related to the OHS Management System and those that are not, between provisional and historic indicators, and between external and internal perspectives.

Moreover, the results required in the review process do not allow the adoption of strategic decisions based on a long-term view. Consequently, managers lack a clear list of key performance indicators in their OHS Management Systems.

Hudson, Smart & Bourne (2001) state that within Small and Medium Enterprises there is widespread acceptance of the value of strategic performance measurements among the managers, but almost none had taken steps to redesign or update their current performance measurement systems.

This suggests that there are substantial barriers to strategic performance measurement system development (Koper, Moller & Zwetsloot, 2009): too resource intensive and too strategically oriented as, for example, a human resources strategy that should be aligned with -or rather embedded in- the enterprise´s general competitive strategy.

From its introduction, Kaplan & Norton's (1992) Balanced Scorecard has rapidly become a central management system in firms around the world. Kaplan & Norton (2001) argue that the Balanced Scorecard is a dynamic tool that translates the organisation's strategy and mission into a large number of performance measures.

The Balanced Scorecard provides the necessary structure for a management system and strategic measurement. It stresses compliance with objectives but also includes drivers of performance so it is an ideal tool to evaluate the performance of the strategy and its related policy measures within a Management System.

The literature has recognised that implementing a safety management system is the most efficient way of allocating resources for safety, since it not only improves working conditions, but also positively influences employees' attitudes and behaviours with regards to safety, consequently improving the safety climate.

The safety climate and the safety management system are considered basic components of the firm's safety culture in various models. However, the literature has focused more on measuring the safety climate, while few studies have correctly tested the psychometric properties of the instruments used to measure how advanced the firm's safety management system is.

2. MATERIALS AND METHOD

We defined and weighted the perspectives and the indicators used in the model on the basis of the results of a bibliographical research and interviews with the staff of the OHS Departments in each of the participating firms.

Big attention was focused on the work done by Fernandez-Muniz, Montes-Peon & Vazquez-Ordas (2007) in which they describe a measurement scale that puts into operation the safety management system concept, and subsequently calculates its reliability and validity. This scale provides organisations with a tool for evaluating their situation with regards to safety management, as well as guidance about which areas they must improve if they wish to reduce occupational accidents.

Fernandez-Muniz et al. (2007) observed that the evaluation of the measurement scales' psychometric properties was deficient in some studies, fundamentally with respect to the safety management system.
This is why they opted to build specific measurement scales, adapted to the theoretical model developed in their study, taking into account not only existing scales but also international standards and guidelines in safety management systems.
Previously, we defined the strategic objectives with the participation also of managers from the Human Resources area of the group of firms as the need for companies to align their performance measurement systems with their strategic goals is well documented in the literature (Kaplan, 1983; Eccles, 1991; Gregory, 1993).
We computed the relative weights of the different performance measures using the WINPRE software (Hämäläinen & Helenius, 1998), a decision-support program that was developed using techniques based on the propagation of imprecise preference statements through the Analytic Hierarchy Process (Salo & Hämäläinen, 1992).

3. STRATEGIC OBJECTIVES AND PERSPECTIVES

The first step was to establish, in agreement with the parties involved, the strategic priorities, defining the following ones:

- Guarantee the staff's safety and protect their health
- Create and effective preventive culture
- Increase the value of the service for the owners and customers

The performance measures were organised on the basis of four perspectives that together reflect the strategic priorities and their preventive culture: Business Perspective, Customer Perspective, Internal Process Perspective and Worker's Perspective.

3.1. Business Perspective

There is a lack of straightforward financial indicators measuring the economic consequences of past actions, so we opted to measure essentially quantitative data to monitor the performance of the management systems from the perspective of the group's overall business, following Gallagher et al.'s (2001) approach.
Measures of sick leave due to incidents, accidents and professional illnesses can in fact be regarded as a proxy for financial indicators. They indicate whether the firm is achieving its goals efficiently, that is, minimising costs.
Carrying out prevention activities that reduce the number of accidents, incidents, and so on, requires the use of economic resources that will result in an improvement in the working conditions. Clearly though, these resources are limited. Thus the firm cannot let its concern for safety go too far, since it needs resources for other activities that are more directly involved in the competitive dynamic.
From the economics perspective, then, it is logical to measure the level of compliance with the budget, as well as how well the budget is managed (Fernandes, Raja & Whalley, 2006), which would be equivalent to develop a productivity strategy that includes the effective execution of operational activities that support existing customers, and that is based on cost reductions and efficiency and consistent with the strategic priority "Increase the value of the service for the owners and customers".
Finally, it was decided to introduce a reactive measure of the lack of compliance with one or more of the legal requirements of the prevention system.

3.2 Customer Perspective

Since this perspective constitutes the firm's value proposition to its customers, we needed to include a unique mix of product, service, relationship and image that the firm, as provider, offers to its customers.
Remaining therefore in the same strategic priority as in the previous perspective, that is, "Increase the value of the service for the owners and customers", the value proposition finally chosen was "Relationship with the customer", following Treacy and Wiersema's (2000) description. This value proposition involves putting maximum effort into the quality of the relationships and into ensuring that the solution the customers obtain is total, with a view to building lasting relationships.
Moreover, and since one of the group's most important activities in operational control is the coordination of business activities, we adopted an indicator to measure this aspect specifically.
Finally, benchmarking techniques involve comparing the firm's accident indices with those of other organisations from the same industrial branch that use similar productive processes, and comparing management techniques and practices with those of other organisations from any industrial sector. There is a specific indicator for it since benchmarking is also considered in the monitoring and control measures corresponding to the "Checking and corrective actions" stage proposed in OHSAS 18002.

3.3 Internal Process Perspective

This perspective includes the critical processes in which the organisation must be excellent in order to, in the words of the first strategic priority, "Guarantee the staff's safety and protect their health". For this we defined a complete value

chain of the internal processes in the OHS Departments, developed on the basis of the firm's Occupational Health and Safety management system model.
The art of implementing a successful and sustainable strategy will ensure an alignment between the firm's internal activities and its value proposition to its customers. Since the organisation's activities are incorporated in the internal processes that make up the value chain, it was useful to segment the value chain to this effect, as shown in Figure 1.

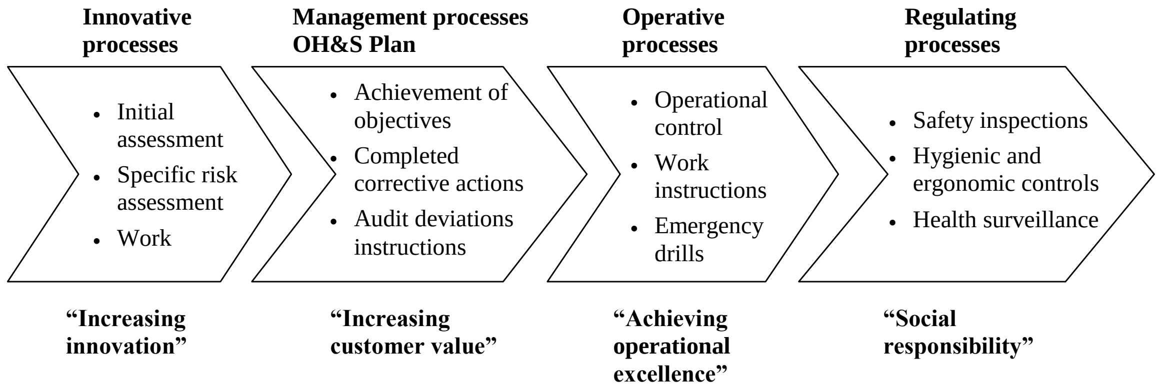

Figure 1 – Value chain of internal processes.

3.4 Worker' Perspective
This perspective identifies the structure that the firm should build to create improvement and growth in the long term, since the firm is highly unlikely to be able to achieve its long-term objectives for its internal processes, customers and business using only its current capabilities.
This perspective includes the critical processes in which the organisation must be excellent in order to "Create an effective preventive culture".

4. MEASUREMENT OF STRATEGIC SUCCESS

4.1 Indicators of Business Perspective
A set of five indicators were built to translate part of the strategic priority "Increase the value of the service for the owners and customers": "Accidents", "Illnesses", "Incidents", "Legal" and "Efficiency".
The first three indicators aim to summarise the economic consequences of actions already carried out, although without quantifying them economically due to the extreme complexity of that process, as mentioned before.
The indicator "Legal" is designed to measure the risk of suffering sanctions from the labour authorities, although it simultaneously measures how good the management system is in terms of its compliance with the requirements of the relevant legislation. Finally, "Efficiency" measures the efficiency with which the operational objectives established are met.
The methodology used to weight each of the indicators was to carry out a graphical weighting starting from one of them settled as a reference based on the average of the opinions of the OHS Departments in each of the participating firms.
In this case the "Accidents" indicator was set as the reference, and using the graphical interface of the WINPRE program the other four indicators were compared with it. The resulting graphical weighting appears in Figure 2.

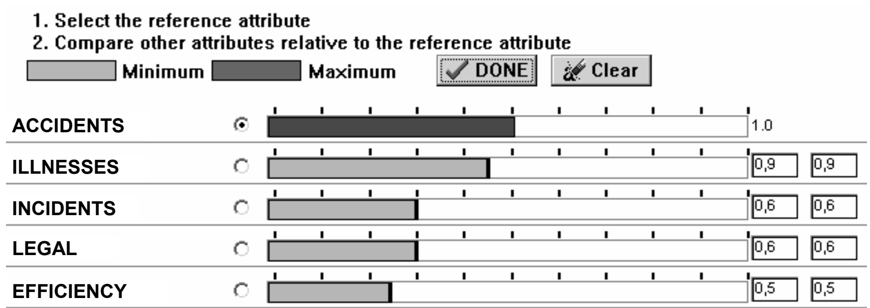

Figure 2 – Graphical weighting of the Business Perspective.

As an example of the process carried out we now describe the definition of the indicator "Accidents": analyses of workplace accidents should eliminate the effect of differences in the number of people exposed to this risk, so, as is common in this area, we use an index that considers the number of working days not worked because of accidents in the workplace with resulting sick leave per million hours worked by workers exposed to the risk.

This index is the result of multiplying two very common indices in studies of accident rates: the frequency index and the mean duration of sick leave. Then, a correction was introduced to obtain a performance measure out of 10 points based on the firm's historic accident rate.
Finally, the indicator needed to be adjusted to account for the number of working days not worked because of accidents resulting in death or retirement. It was adopted the criterion of considering the remaining time on sick leave as estimated by the medical services in the case of the sick leave extending over the change in year. In the event of death or retirement 220 work days were considered to be lost, equivalent to an entire year's work.

4.2 Indicators of Customer Perspective

A set of three indicators was built to translate part of the strategic priority "Increase the value of the service for the owners and customers": "Satisfaction", "Coordination" and "Benchmarking".
Since the value proposition chosen was "Relationship with the customer", which involves putting maximum effort into the quality of the relationships and into ensuring that the solution customers obtain is total in order to build lasting relationships, the aim of the first two indicators is to measure the compliance with this objective; a good coordination of activities is essential as Suarez, Riesgo, Sanchez, Cos & Garcia (2011) relate subcontracting with accidents occurrence.
"Benchmarking" is considered in the monitoring and control measures corresponding to the Checking and Corrective Actions stage proposed by OHSAS 18002.
Mearns & Havold (2003) are of the opinion that although the benchmarking exercise reveals relative strengths and weaknesses in safety climate and health and safety management, more data is required to determine the mechanisms that may be operating to give rise to these effects. They point out investment in health promotion and surveillance as another indicator of management commitment or as an indicator that an organisation is good at assessing risks and putting measures to mitigate against those risks, but finally we rejected to set an specific indicator on this point due to the intrinsic difficulties for its calculation.

4.3 Indicators of Internal Process Perspective

In the translation of the strategic priority "Guarantee the staff's safety and protect their health" on the basis of a definition of a complete value chain of the internal processes in the OHS Departments, five indicators were identified: "Management", "Inspections", "Drills", "Operations", and "Specialties".
The indicator "Management" measures the level of compliance with the objectives and goals in Occupational Health and Safety set in the Annual Plan of Preventive Activity and the indicators "Inspections" and "Drills" measure the results in the safety inspections and in the drills programmed in the Emergency Plans.
Finally, "Operations" and "Specialties" measure the number of deviations or non-conformities detected in the monitoring activities of Operational Control and in Hygienic, Ergonomic and Health Surveillance Control respectively. "Operations" does not include the coordination of business activities, which, because of its importance, has an indicator in its own right in the Customer Perspective.

4.4 Indicators of Worker's Perspective

Finally, five performance measures were designed for the critical processes in which the organisation must be excellent in order to "Create an effective preventive culture": "Suggestions", "Training", "Committee", "Culture", and "Incentives".
The indicators "Suggestions" and "Committee" measure the number of resolutions adopted based on suggestions coming from the workers and from the firm's Health and Safety Committee, respectively. The aim is to quantify the level of commitment of these two groups (Health and Safety Executive, 2001). The indicator "Training" measures the number of day's training the employees receive and their perception of the training quality. "Culture" refers to the firm's level of preventive culture according to the perception in the external audit (Grote & Künzler, 2000).
Finally, the aim of "Incentives" is to measure the extent of application of the policies of incentives based on the performance outcomes in the area of OHS.
Although DeJoy, Schaffer, Wilson, Vandenberg & Butts (2004) support that communication may be an important mechanism through which employees come to believe that the organization is supportive of their needs and values their input, we decided to measure it in a indirect way through "Suggestions" and "Committee".

5. BALANCED SCORECARD FOR AN OHS MANAGEMENT SYSTEM

Figure 3 shows the Balanced Scorecard developed during the current research work including the weights of the different perspectives and indicators. At the present moment it is being tested in the group of companies in which it was developed.

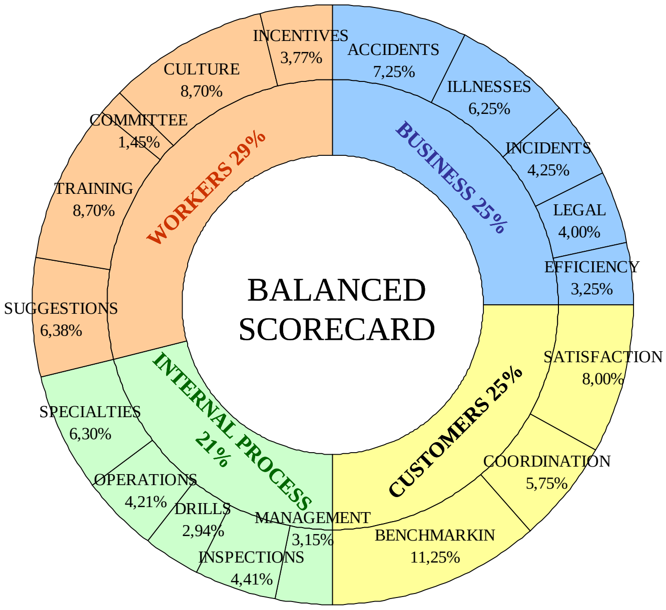

Figure 3 – Balanced Scorecard for an OHS Management System.

6. CONCLUSIONS

The OHSAS 18001 standard simply states that the firm's OHS policy should be consistent with its vision of the future. Thus the Balanced Scorecard proposed here, since it takes the firm's strategic objectives into account, constitutes a dynamic tool that translates the firm's strategy and mission in this area into a set of performance indicators and so provides the structure that management system needs.

We have not regarded Kaplan and Norton's (1992) four perspectives as a straitjacket but as a point of reference, but nevertheless the perspectives developed here seem to fit the OHS Management System perfectly.

In place of the Financial Perspective we use the Business Perspective, and in place of the Learning and Growth Perspective we use the Workers' Perspective. The aim behind these two changes is simply to reflect the characteristics of this particular system more closely.

The perspective with the greatest weight is the Workers' Perspective, which is consistent with the strategic priorities defined and with the ultimate aim of an Occupational Health and Safety Management System.

The indicator with the highest weight in this Balanced Scorecard is "Benchmarking", which reflects the need to make comparisons with the rest of the firms in the sector to be able to determine how good the firm's management system and its results are.

Finally, only the practical application of this Balanced Scorecard will enable us to refine and test the measures used, determine how adequate the perspectives are, and hopefully generalise its use as an indispensable tool for testing how good these management systems are.

7. ACKNOWLEDGMENTS

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Analysis of the Risk of Accidents in Construction Activities in the Foundation works of a Shopping Center

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ABSTRACT
The European Agency for Safety and Health at Work (2003) states that, globally, construction workers are three times more likely to suffer injuries than workers in other areas. The agency highlights that the main dangers at work are working at height, excavation work and cargo handling. Among the accidents reported by the Brazilian media in recent years, three employees were killed and six injured in the construction of shopping centers as a result of the activities highlighted by the European Agency. This work aims to study the risks involved in excavation/foundation work in the building of a shopping center in the Metropolitan Region of Recife/PE. In order to do this, we prepared a checklist based on Brazilian Health and Safety Legislation, which details compliant and non-compliant activities related to the construction process. Following this, monthly technical visits were made to the construction site, where photographic records were made of conditions found at the site and the checklist applied. Using this information, a report containing an analysis of the collected data was then made, using four tabulated indicators called the Quantitative Safety Indicator, the general qualitative indicator, the detailed qualitative indicator and Economic Indicator. After analyzing the data, it was found that with the increasing amount of activity in the construction process, there was a corresponding increase in the amount of non-conformity. Within the general qualitative indicator, activities, such as cargo handling, working at height and the use of scaffolding, could be analyzed. Finally, the implementation of the Health and Safety indicators allowed the company to continuously monitor the situations where there was a risk of accidents and thus take preventive actions in order to improve the lives of workers.

Keywords: Construction, Foundation, Safety Management and Occupational Health, Safety Indicators and Occupational Health.

1.INTRODUCTION

On average, around 5,000 people die every day due to accidents or work-related illnesses. In one third of these cases, illness causes the loss of at least four working days. The construction industry stands out as one in six fatal accidents occur in construction and every year there are at least 60,000 fatal accidents on construction sites around the world, with an estimated one fatal accident every ten minutes (ILO, 2010).

The European Agency for Safety and Health at Work (2003) states that globally, construction workers are three times more likely to suffer injuries than workers in other areas. The same agency points out the main hazards as being working at height, excavation work and cargo handling. With regards to these activities, in recent years the media have reported accidents in which three employees were killed and six injured in the construction of shopping malls.

A shopping mall or commercial center can be defined as a structure that contains businesses such as shops, cafes, restaurants, movie theaters, amusement parks, playgrounds and car parks, which is characterized by being closed off from the rest of the urban area. The first shopping mall opened in Brazil was Iguatemi in Sao Paulo in 1966. According to the Brazilian Association of Shopping Centers - ABRASCE (2011) the proposal of the malls was to offer a safe and easy way to find everything in one place, together with the idea of representing modernity and progress, and these were the biggest attractions for Brazilians in electing such centers as favorable places for shopping and leisure.

With all these favorable factors, the shopping mall industry has become a major driver of development, promoting urban growth, and increasing the value of real estate, developing local commerce and increasing career opportunities. According to the Brazilian Association of Shopping Centers (2011), in Brazil there are 416 malls, and it is planned to inaugurate 11 more malls by December 2011 and 42 others in 2012. In Recife/PE, 11 shopping centers have been built, in which one is the second largest mall in Latin America.

The construction of buildings in the Metropolitan Region of Recife/PE - RMR is quite unique in terms of characteristics because the city is situated on a plain bounded by the Atlantic Ocean and at an altitude close to sea level, creating a shallow water table. These features are crucial for determining the type of foundation to be used.

Indirect or deep foundations are the most widely employed in the metropolitan area of Recife/PE, mainly the continuous flight auger, which is used in concrete piles cast "in situ", and which is performed by continuous drilling and the injection of concrete through the central shaft of the drill, whilst at the same time expelling the earth. Afterwards, the area where the foundation blocks are to be cast is excavated, the blocks then being attached to the already treated piles.

The work undertaken in foundations/excavations carries the potential risk of serious or fatal accidents due to burial landslides as a consequence of upsetting the natural balance of the soil.

This work aims to study the risks involved in excavation/foundation work in the building of a shopping center in the Metropolitan Region of Recife/PE. This mall is unique due to its location, and has had an environmental impact caused by the landfill of the mangrove region; a social impact due to the relocation of residents who lived on the banks of the river Capibaribe; and an economic impact with the interference in the routine of the fishermen, who use the location for their occupational activities.

2. THEORETICAL REFERENCE

2.1. Foundations

Foundation work has been keeping up with the process of technical and technological development that has affected almost all construction processes in Brazil.

The foundation is part of the building structure which carries the load of the proposed building onto the site, or the plane on which the foundations of a building lie (Rousselet, 1986). There are several types of foundations and the choice of the most appropriate type depends on the load of the building and the depth at which a resistant layer of soil capable of supporting the required loads is found.

The load demands of the building are calculated by means of architectural and structural surveys, in which the weights of the structural elements and the extra weight of the slabs are considered. The load capacity of the soil is the permissible weight that the soil can withstand without breaking up or suffering large deformations. Preliminary analysis of the soil through field and laboratory tests is undertaken to establish these limits.

Field trials begin with an investigation of the surface and search for local experiences through contact with residents or technical staff who have constructed buildings nearby. Later drilling and sampling are undertaken to determine the soil characteristics, such as identification of the underground strata and its position, thickness, slope, water level and the materials that compose it (Gehbauer, 2002). Finally, tests are made of geotechnical parameters, such as the Cone Penetration Test, the Standard Penetration Test, the Reed test, Dilatometry trials, and Pressionmetric and Cross-Hole trials.

The laboratory tests determine particle size distribution, moisture content, specific gravity, porosity and degree of soil saturation, as well as defining the effective parameters of vertical resistance and deformability of soils, such as cohesion, angle of internal friction and soil consolidation.

At the end of the tests, the weight of the structure and capacity of the soil are determined, and the type of foundation to be used will be chosen. According to Caputo (1987), the main types of foundation can be divided into two groups: shallow foundations and deep foundations. Shallow foundations are used where the subsoil immediately below the structures is capable of withstanding the weight. In turn, deep foundations are used when deeper layers are needed for the safe transfer of the weight.

The superficial foundation, which is direct and on the surface, is one in which the load is transferred directly to the ground, spread predominantly by the pressure on top of the base of the foundation and in which the depth of the base in relation to adjacent land is less than twice the smallest dimension of the foundation (Yazigi, 2003). That is, one in which the base of the foundation does not exceed twice its smallest dimension. Shallow foundations can be: blocks, foundation stones and slabs.

A deep foundation is one in which the foundation transmits the load to the ground through the base (tip resistance), on its lateral surface (frictional resistance of the stem) or a combination of two, and which is laid deeply in relation to adjacent land, at least twice as much as its smallest dimension (Yazigi, 2003). Deep foundations can be: box girders, pillars, piles.

Foundation piles are elements which are elongated, cylindrical or prismatic and which are embedded with a machine, the pile driver, or are molded in place.

There are now a wide variety of foundation piles. New types of piles frequently enter the market and techniques are constantly evolving.

In relation to driving piles, they can be introduced by strokes of a hammer or pestle acting on gravity, explosion, steam or compressed air. Piles can be made of timber, steel, precast concrete, concrete cast in situ, or a mixture of these.

Amongst the piles cast in situ is the continuous flight auger – CFA, which is inserted into the ground through a rotating tubular shaft equipped externally with a continuous auger and the injection of concrete into the tubular shaft itself, and its withdrawal without rotation (Yazigi, 2003).

Continuous auger foundations allow for operations in compact and sandy terrain, above or below the water table, and through layers of resistant soil. When the determined depth is reached, the concrete is pumped through the central tube of the shaft, filling the cavity left by the auger, which is extracted from the ground without turning or turning slowly in the same direction as the drill.

A concrete pump connected to the drilling equipment with a flexible hose is usually used. The filling of the pile with concrete is normally undertaken at the work surface. The method of setting up a continuous flight auger pile requires inserting an iron structure after its concretization.

A steel structure, in the form of a cage, is introduced into the pile through gravity or with the aid of a pestle with a small charge or vibrator. In the case of long steel structures, the "cages" should be composed of thick bars and spiral welded brackets on the frame to avoid longitudinal deformation during insertion of the pile shaft (Yazigi, 2003).

The equipment used to embed the auger in the ground consists of a crane, whose tower is mounted at a vertical height appropriate to the depth of the pile. To control the pressure when pumping the concrete, a digital meter is used, which provides all the details related to the pile, such as: the tilt rod, drilling depth, torque and rotation speed of the auger, injection pressure, loss and consumption of concrete. The parameters indicated on the digital display are recorded and supplied to a microcomputer software application that prints a report on the pile with the information obtained in the field.

This type of pile is currently widely used in the Metropolitan Region of Recife due to the geotechnical characteristics of the region and the fact that it does not produce vibrations or disturbances to neighboring land. Figure 1 presents an outline of the steps in the undertaking of continuous flight auger foundations. In Figure 1.a, the structure of the drilling equipment for the auger can be seen, whereas in Figure 1b we can see the hose pumping concrete into the center tube of the shaft that is then removed from the soil. Finally, figure 1.c shows the steel structure installed inside the shaft filled with concrete.

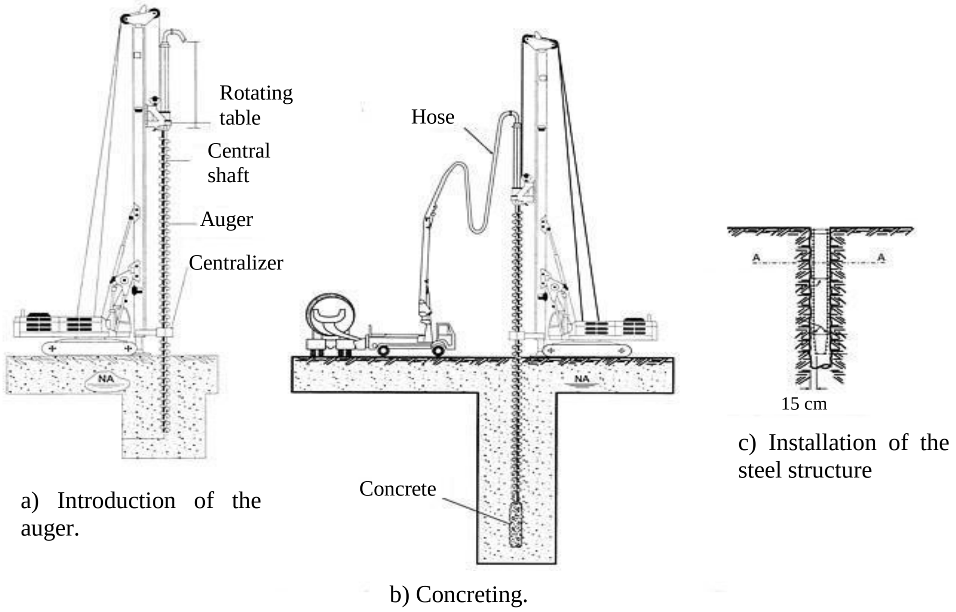


Figure 4 – Diagram of the stages of a continuous flight auger foundation
Source: Adapted from http://cafelaranjahost.com.br/drilling/servicos-helice-continua.php

After the treatment of the pile is completed, the digging for the laying of the foundation blocks begins, which clusters several piles in the same block. In order to make the connection between the block and the pile, it is necessary to remove any excess concrete to fit the dimension of the block. This is undertaken by hand or with a light hammer depending on the diameter of the pile. Finally, the fixtures of the block are connected to the fixtures of the pile in order to finally concrete the block to the foundation.
Therefore, earth moving, excavation, concreting, handling, installation and the operating conditions of drilling equipment for the laying of foundation blocks must comply with relevant Work Health and Safety regulations-HSR, and basic premises about accident prevention.

2.2 The prevention of Accidents in Foundation Work
Among the possible causes of accidents that occur during the foundation work, it is believed that the fast pace of work leads to situations which can result in accidents if the security requirements are not met. Consequently, there will be several simultaneous activities occurring at the construction site, such as the carpenters who are fabricating the moulds for the concrete blocks, the metalworkers are constructing the mesh for the foundation blocks, and the equipment for drilling the piles, trucks with materials and people are always moving around.
Due to the diversity of variables that may result in an accident, and given that accidents have multiple causes, it is clear that the prevention of occupational hazards must involve the observance of all working conditions that may affect the physical and mental health of the worker, as well as knowledge of all possible variables that exist in the workplace (Barkokébas Jr, 2009b).
Prevention employs a set of techniques which identify, evaluate and thereby study ways to control situations, so that they do not harm the physical and/or mental health of the worker. It can be argued that the prevention, as well as elimination/control of occupational hazards, reflects the company's profitability, maximization of production and the quality of life of the worker and his family (Vasconcelos, 2010).
Under law, Regulatory Standard No.9 (Brazil, 2011) establishes the obligation of preparing and implementing the Program for the Prevention of Environmental Risks - PPER, through anticipation, recognition, evaluation and consequent control of the occurrence of risks that exist or will exist in the work environment. Figure 2 shows a schematic representation of the basic steps for the prevention of accidents, with the identification of risks, their assessment, and control of identified risks involving continuous monitoring of the activities performed for the identification and evaluation of new risks along with the constant control of them. Risk identification is the pinpointing and localization of possible sources of risks, the means of disseminating agents in the workplace, determining the number of exposed workers, determining the activities and type of exposure, obtaining data on the company, indicating possible impairment to health arising from work and possible health hazards related to the risks identified in the available literature. While the evaluation can provide evidence

of exposure control, the inexistence of risks already identified, the measurement of workers' exposure and support for control measures, control measures are necessary for the elimination, reduction or control of environmental risks whenever they are identified as hazardous to health.

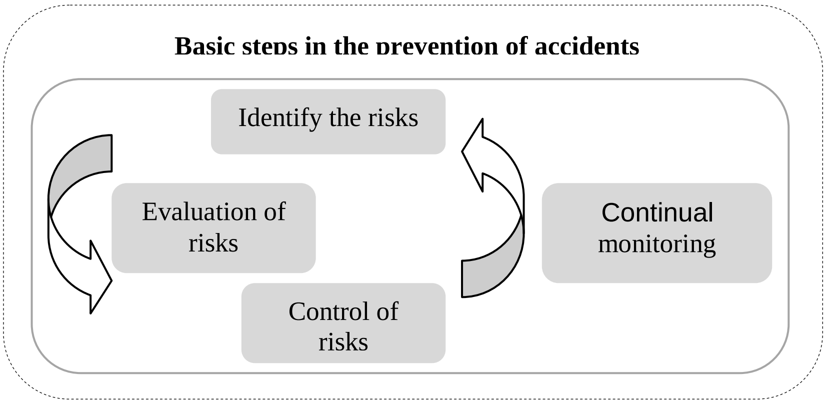


Figure 2 –Basic steps in the prevention of accidents
Source: Barkokébas Jr., Vasconcelos e Monteiro (2009).

Continuous monitoring is also essential due to the fact that the work environment is always changing, machinery and equipment wears out, that manpower is always rotating and people assimilate information differently (Barkokébas Jr. Et al ., 2009).

One of the tools used for monitoring are indicators that, according Barkokébas Jr et al. (2009a), quantify information generated from the measurement and evaluation of a form of production, the stages that produce and / or final products, the control, forecast, and identification of problems and their solutions, and finally, assessment and proposals for improvement.

According to Costa (2003) apud Sink and Tuttle, through the measurement process, it is possible to identify the organization's capabilities and expected performance levels, both within the process and organizational systems. It also enables the identification of the needs of feedback, which can be improved by focusing attention and in the allocation of resources.

This is to say that performance measurement is stimulated mainly by focusing on results, since the indicator is a tool for identifying business needs, and therefore can orientate the prioritization of goals and strategies of the company (Barkokébas Jr et al, 2008).

However, so that prevention becomes an integral and daily part of production processes and corporate goals there must be the will and commitment of management to adopt a Management System for Safety and Health at Work, and to see it as a promising approach to improving working conditions and having a positive impact on overall business performance and a reconciliation to producing a climate of well-being (Melo, 2001).

3. MATERIALS AND METHODS

The mall under study is being built in Recife / PE, and is scheduled for completion in November 2012. This project has created 878 direct jobs, plus 472 indirect jobs in 37 companies providing outsourced services, totaling 1,350 employees involved in daily activities.

The building has a total area of 286,000 m², in which 1082 foundation blocks were laid, a total private area of 47,816 m², with 6,200 parking spaces; and a green area of 40,000 m² to be planted.

Initially, we reviewed the literature related to the subject. In the subsequent step, the study used the "method of evaluation and control of risks", proposed by Barkokébas Jr. et al. (2004) and was validated through scientific and technological research on health and safety of work developed by the Safety at Work Laboratory- LSHT, Polytechnic School of the University of Pernambuco/Brazil, and cited in diverse publications. This method was based on a checklist that provides the data to generate the indicators of HSW.

The method was based on drawing up a checklist based on Brazilian Health and Safety Legislation, with an emphasis on Brazilian Safety and Occupational Health Legislation, and paying particular regard to Regulatory Standard No. 18 - Working Conditions and Environment in the Construction Industry (Brazil, 2011).

In accordance with the situation encountered, the checklist lists the situations as (CO), when the situation is in conformity with the standard; non-conformance (NON), when it does not meet the standard, and grave and imminent risk (GIR). According to Regulatory Standard No. 3 - Prohibition and Embargo (Brazil, 2011) grave and imminent risk is considered to be any condition in the working environment that can cause accidents or occupational illnesses which can result in serious injuries to the worker.

Monthly technical visits were then made to the construction site, from the start of activities until the end of the foundation stage, a total of seven technical visits. Photographic records of situations found in the area were taken and the already referred to checklist was applied. The visits were unannounced in order to analyze what really occurs in the construction process, and to thereby generate indicators to monitor the development of the building, and to prioritize corrective actions and preventive actions to systematize the Health and Safety of Work in the construction of shopping malls.

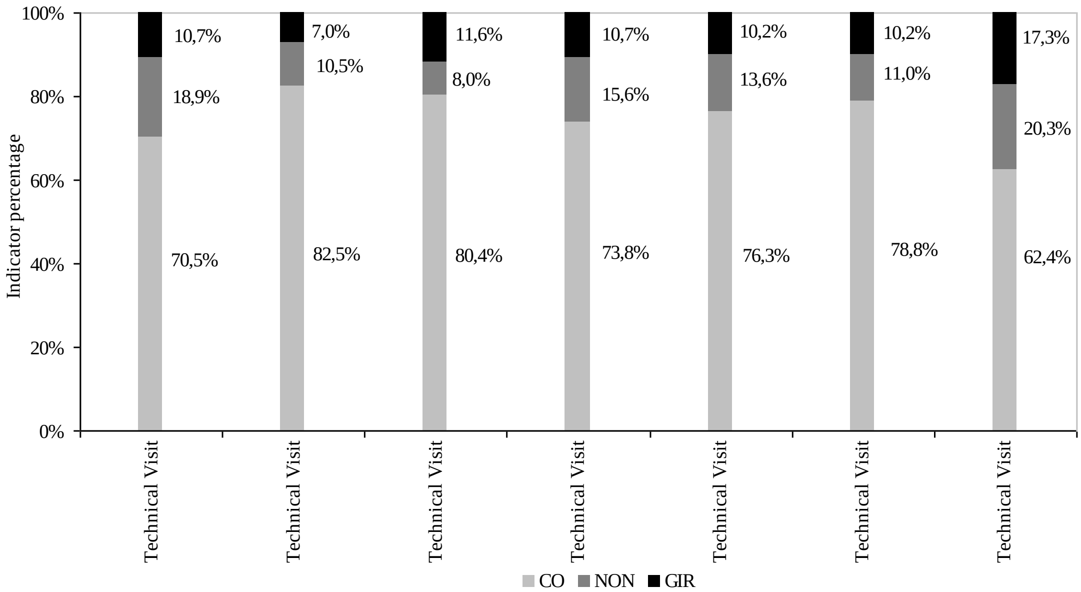
We developed the following indicators: the Safety Indicator, Qualitative Indicator, Detailed Qualitative Indicator and the Economic Indicators. The Safety indicator shows the company's performance in relation to the safety standards applied by the checklist, using the percentage of those cases in compliance, non-compliance, and those at grave and imminent risks. The Qualitative Indicator permits us to identify the number of items in non-compliance and at grave and imminent risk, and those items that represent higher incidences. The Detailed Quantitative Indicator identifies specific sub-items at the foundation stage using percentage values. Finally, the Economic Indicator, which shows the monitoring of costs resulting from the simulation of potential safety liability of work during the visits, with reference to the NR 28 - Inspections and Penalties.

Finally, with the accumulated data, specific goals and objectives of an operational and organizational character were established and applied throughout the construction process of the mall.

4. RESULTS AND DISCUSSION

The Quantitative Safety Indicator (Figure 1) shows the items in Compliance - CO, Non-compliance - NON and Grave and Imminent Risk - GIR, in percentages, which were verified using the checklist during the visits. It can be observed that the columns maintain steady rates despite the fact that on the last technical visit the items in NON and GIR had increased compared to the previous visits. It was found that on the last visit, the foundation stage was nearing completion and the initial stage of the structure was causing a divergence in results.

Graph 1 – Quantative Safety Indicator



The General Qualitative Indicator (Table 1) presents a general qualitative analysis of the items with the highest number of irregularities on the construction site, classified as NON and GIR according to Brazilian Health and Safety legislation.

Observe that the item NR 18.06 Excavations and foundations shows the highest rate of GIR in all the items surveyed, followed by item NR 18.15 Scaffolding at 19.57%, and item NR 18.23 Personal Protective Equipment - EPI at 15%.

Table 1 – General Qualitative Indicador

General Qualitative Indicador	NON (%)	GIR (%)
NR 18.37 Final Provisions	3,03	0,00
NR 18.29 Order and cleanliness	3,03	0,00
NR 18.28 Training	2,02	0,00
NR 18.27 Safety signaling	6,06	0,00
NR 18.24 Warehousing and storage of materials	9,09	0,00
NR 18.23 EPI	6,06	15,00
NR 18.22 Machines, equipment and tools	3,03	1,09
NR 18.21 Electric installations	9,09	9,78
NR 18.18 Roofing services	0,00	1,09
NR 18.15 Scaffolding	6,06	19,57
NR 18.14 Movement and transport of materials and people	2,02	5,43
NR 18.13 Protection against falls	6,06	9,78
NR 18.12 Stairs, ramps and walkways	12,12	2,17
NR 18.11 Operações de soldagem e corte a quente	2,02	1,09
NR 18.8 Steel frames	2,02	7,61
NR 18.7 Carpentary	2,02	1,09
NR 18.6 Excavations and foundations	2,02	26,09
NR 18.4 Áreas of experience	24,24	0,00

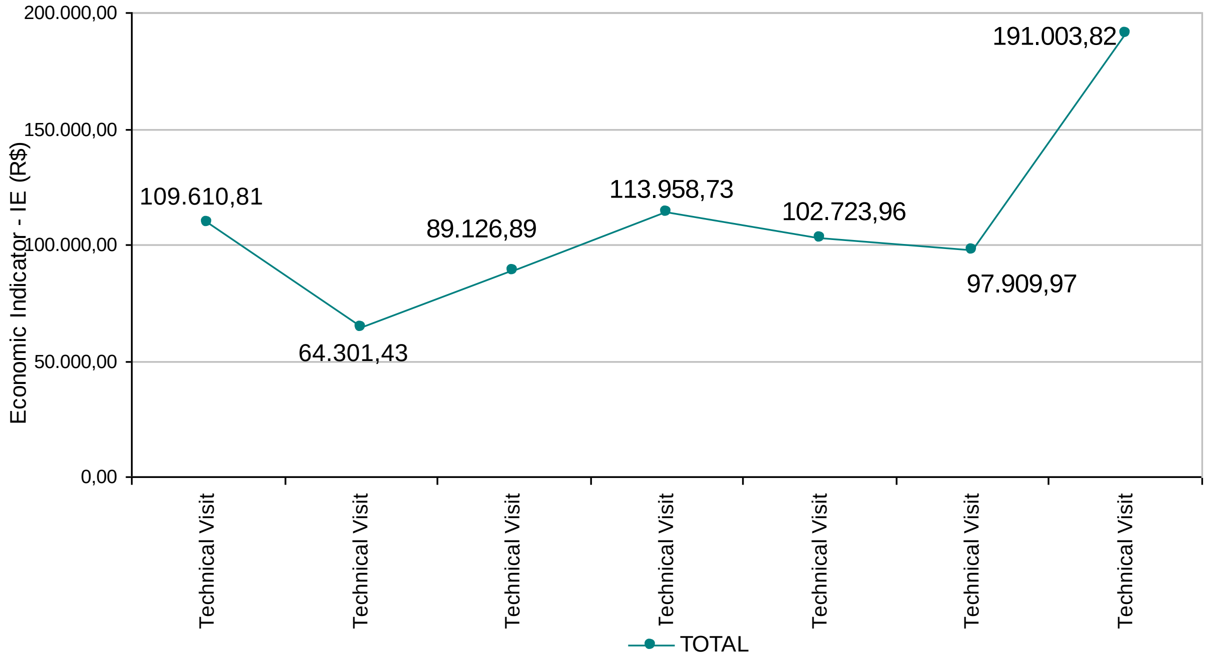
The detailed qualitative indicator (Table 2) shows a breakdown of items that occurred in visits at the construction site. It was found that items relating to the activities of foundation work are mainly GIR and they occur simultaneously. That is to say, excavations deeper than 1.25 m are not having their stability secured, are not being provided with means of access, and do not have warning signs and barrier isolation.

Table 2 – Detailed Qualitative Indicator – Excavations, Foundations.

Item NR	Descriptions	NON (%)	GIR (%)
18.6.5	The unstable gradients of excavations deeper than 1.25 m (one meter and twenty-five centimeters) must have their stability secured by the structures designed for this purpose.	0,00	24
18.6.7	The excavations over 1.25 m (one meter and twenty-five centimeters) deep must be provided with stairs or ramps, placed next to the work stations in order to allow, in the case of emergency, the quick exit of workers, independent of that laid down in sub-section 18.6.5.	0,00	24
18.6.8	Materials from the excavation must be deposited at a distance of more than half that of the depth, measured from the edge of the gradient.	100	16
18.6.9	Gradients with a height above 1.75 m (one meter and seventy-five centimeters) must have their stability secured.	0,00	12
18.6.11	Excavations carried out on public roads or on construction sites must have warning signs, including at night, and separation barriers around the perimeter.	0,00	24

The Economic Indicator (Figure 2) showed a significant difference between the first two visits, in which it is possible to observe the actions of the safety sector. From the third visit, and after the handing-in of the report, there was no improvement in the items on the checklist, with a peak on the fourth technical visit and a further reduction which was less significant than that which occurred between the first two visits. The last visit showed an evident increase in the non-implementation of new activities in the development stage of the structure and a relaxation in the safety sector. On the day of the last visit, it was announced that the Occupational Safety Engineer had left the company, which may have contributed to the demotivation of the safety team, which culminated in the increase of items in non-compliance and at grave and imminent risk.

Graph 2 – Economic Indicator.



Comparing Graph 1 with Graph 2, it can be seen that the percentage of GIR and non-compliance items are stable, with a peak occurring on the last visit where we found new activities being undertaken in the structure phase. On the last visit several items in the GIR, in activities with scaffolding, were found which raised the potential safety liability on this visit considerably.

5. CONCLUSION

It was observed that there were situations in the activities on foundation work which, according to the Quantitative Safety Indicator and General Quantitative Indicator, produced the highest risk situations in the initial stage of the work. However, the detailed qualitative indicator found that the items in the GIR occur in different and simultaneous situations.

An important consideration is the use of the checklist, which assists the development of safety indicators in that it functions as a tool for evaluating and planning the activities of foundation work. This analysis will allow for the prioritization of corrective actions and the systematization of preventive actions in the sector of shopping center construction.

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The synergism between the Occupational Health and Safety Management and Environmental Management – A case study

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ABSTRACT
Although presenting different performances, Environmental Management and Occupational Health and Safety Management (OHSM) have common and interrelated elements that must be combined to improve the overall process effectiveness, allowing a decision make that preserves the environment, health and worker safety. The possibility of simultaneous association and coordinated action between these two management purposes is called synergism, whose ultimate goal is that the combined performance (each management purpose) is greater than both acting singly. This paper presents a scientific investigation on a construction company aiming at identifying how it is treated the synergism between the OHS Management and Environmental Management. As a technique of data collection was used the interview and documental research. The interview was standardized type, ie, was used a previously established routine, where the questions asked of respondents were prepared based in the items of Chapter 4 of ISO 14001 (requirements of the Environmental Management System) and in the items present in the same chapter of OHSAS 18001 (Element Management System Occupational Health and Safety) in order to identify the commonalities between the Environmental Management and OHS Management. The documental research aimed to verify the accuracy of answers during the interview. By analyzing the synergy between the Environmental Management and OHS management in selected company, it was come to the conclusion that it is neutral type, ie, purposes of OHS and environment managements do not interact with each other, acting separately. In this scenario, the performance scope of management purposes becomes limited, not being established a cause-effect relationship between them. Finally, managers of this company still need to be aware of the synergy between OHS management and Environmental Management and benefits arising from management of these purposes simultaneously and coordinated.

Keywords: Synergism; Occupational Health and Safety Management; Environmental Management; Construction Industry.

1. INTRODUCTION

With the need for better management and in order to adapt the business to the global scenario, whose environmental and social issues have significantly affected the way of acting of companies, were created voluntary standards to help the organizations management to balance their economic and financial interests with impacts or risks generated by their activities, and should be implemented with the specific purpose of providing environmental and health protection and worker safety in the company (CERQUEIRA, 2006). ISO 14001:2004 (Environmental Management) and OHSAS 18001:2007 (Occupational Health and Safety Management Systems) are updated versions of standards that were developed for this purpose.

For Cerqueira (2006), these standards are specifications or sets of requirements for the objective audit of Environmental Management Systems (EMS) and Occupational Health and Safety Management Systems (OHSMS). These standards are focused on the continuous improvement of management, seeking to ensure, through planned and systematic actions, fulfilling legal and regulatory requirements applicable to their activities, compliance with their policies and commitments to all stakeholders, and meeting their goals and objectives related to the environment or occupational safety and health.

According to Capelas (2002), "an organization that prevents and minimizes the risks and impacts associated with its activities and makes it sure (according to a recognized reference) will offer a greater confidence and improved image, either for their investors or their customers."

Although they have different ways of action, Environmental Management and OHS Management have common and interrelated elements that should be combined to improve the effectiveness of the overall process, allowing a decision-making preserving the environment and health and worker safety (MACIEL, 2001; MEDEIROS, 2003; BOBSIN, 2005). This possibility of simultaneous association and coordinated action between these two management purposes (Environmental and OHS) is called synergism, whose ultimate goal is that the sum of the parts (each management purpose) is greater than the isolate performance of each one. Clark (2007) defines synergism as two or more agents working together to produce a result not obtained by any of the agents independently (separately).

The production process of construction industry is known by the existence of risks of accidents and occupational diseases and also the impact on the environment. According to Felix (2007), given the nature and intrinsic characteristics of the construction industry (such as the nomadic nature of works, high turnover of labor, poor working conditions, significant number of accidents at work, large number and variety of wastes generated, etc.), it is necessary to create and adapt new forms of management for occupational safety and environment in order to allow these companies to better adaptation to the new emerging social values.

This paper presents a scientific investigation on a construction company aiming at identifying how it is treated the synergism between the OHS Management and Environmental Management.

2. THE SYNERGISM BETWEEN ENVIRONMENTAL MANAGEMENT AND OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT

The synergism between OHS Management and Environmental Management is due to several inherent and similar characteristics in both management systems. Issues such as scope and interdependence in control of impacts on the OHS and environmental impacts, complementarity of implementation between OHSAS 18001 and ISO 14001 standards, their common structure based on the PDCA and the complete mirroring of requirements are some aspects in common.

2.1 Scope of impacts to health and occupational safety and environmental impacts

Impact, from the Latin *impactu*, refers to the effects or consequences, positive or negative, directly or indirectly produced after performing a certain action or activity.

On the Impact of Health and Occupational Safety is understood as the consequence or result of workers exposure to the risks present in the workplace, which can result in loss or damage to both employees and companies (CHAMPOUX, BRUN, 2003; MEARNS *et al.*, 2003, ROBSON et al. 2007).

The Environment National Council (CONAMA), through the Resolution No. 001/86, defines Environmental Impact as "any change in physical, chemical and biological properties of the environment, caused by any form of matter or energy resulting from human activities that directly or indirectly affect: (i) health, safety and welfare of the population, (ii) social and economic activities, (iii) the biota (iv) aesthetic and sanitary conditions of the environment; or (v) quality of environmental resources.

The impacts occurring in the internal organization, which correspond to its physical limits defined by the wall surrounding it, correspond to the impacts on the OHS. In turn, impacts related to the environment outside the plant, ie, outside the physical boundaries of the organization (walls limiting it) are considered Environmental Impacts (SEIFFERT, 2008).

For the aforementioned author, this issue of scope is very important when it comes to environmental monitoring. OHS monitoring must always occur within the organization boundaries, within the plant or surrounding terrain and the environmental monitoring should occur inside or outside these limits (Figure 1).

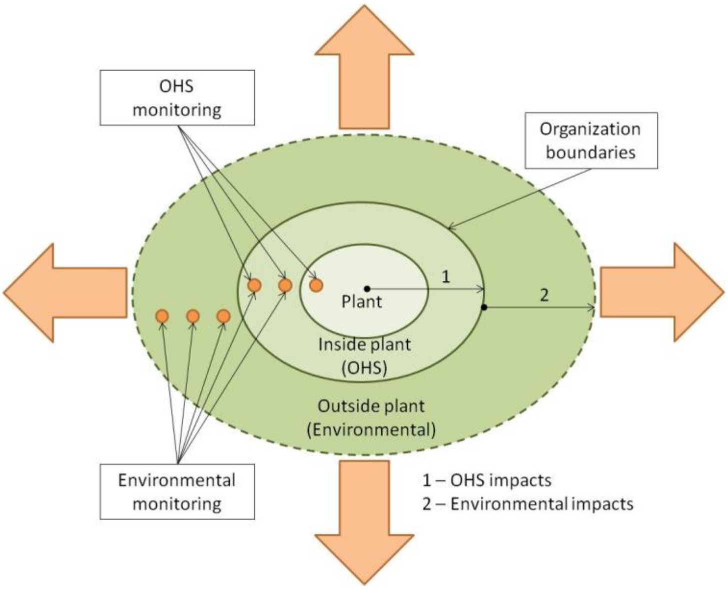

Figure 1. Scope of Impacts on the OHS and Environment. Source: Seiffert (2008).

This notion of limits for performance becomes a little more complex when one considers the strong synergy between man and environment. For example: (i) an employee dies or becomes permanently incapacitated due to an WA (OHS impact) and can no longer contribute to the society (environmental impact); (ii) an organization that simply removes the pollutant agent from the indoor environment (OHS impact) and throws it in the environment without prior treatment (environmental impact); (iii) an operator working without IPE (OHS impact) and exposed to the action of toxic agents: the operator faints. The activity control is temporarily lost and come to generate serious environmental impacts; and (iv) a company adequately protects its employee against accidents at work (OHS impact), but improperly releases pollutants in the environment (environmental impact). When leaving work, the employee is contaminated by pollutant agents and does not work the next day.

One can then realize that the Impacts on the OHS and the Environmental Impacts are interrelated with each other keeping a strong relationship of cause and effect. And any attempt to limit the scale of operation inside or outside the company can be a serious mistake, since the OHS Management and Environmental Management should work together with synergy to the attainment of organizational goals.

2.2 Implementation complementarity of ISO 14001 and OHSAS 18001 standards

Thus, it becomes clear the need to implement management systems effective in ensuring a good organizational performance. The management of environment, occupational safety and health are basic in the management of all and any company seeking growth and even survival. However, its non-articulated operation, without synergism, makes the potential use of these management principles is not total. The integration of this operation, then, is essential for the actual use of these systems (SEIFFERT, 2008).

The integration of two or more management systems will result in an Integrated Management System (IMS), whose specific purposes of each system will be respected; however, seeking the integration of common elements (equivalent) between them (MAFFEI, 2001).

Based on the concept of Cerqueira (2006), the Integrated Management System (IMS) can be defined as a set of interrelated elements (processes, procedures and practices) that must be implemented to ensure the establishment of policies in the organization, their deployment into objectives and allowing these objectives being achieved more efficiently than when there are several overlapping individual systems.

The implementation of an Integrated Management System helps the organization meet the challenge of proving its commitment to the environment and life quality, health and safety of its employees, facilitating the identification, removal or control of problems' causes related to risk, hazards, aspects and impacts associated with their processes, products and services.

ISO 14001 and OHSAS 18001 standards provide basic guidelines for the implementation of an integrated management system based on a structured process, generic and complete, aimed at the adoption of continuous improvement of its performance with the environment, health and safety of the organization (CASTRO, 2007). ISO 14001 and OHSAS 18001 which provide guidelines for structuring of a Environment, Health and Safety Management System respectively have the same base (principle of continuous improvement and PDCA cycle) and requirements mirrored and highly interrelated, presenting a great synergy, thus being possible the process of integrated deploying.

The interrelationship between these areas leads to an Integrated Management System of Health, Safety and Environment, which allows the development of joint management actions and consistent and, a clearer and more efficient decision-making process.

2.3 Requirements mirroring of ISO 14001 and OHSAS 18001 standards

Each Management System standard (Environmental and OHS) presents the main/common requirements (Policy, Planning, Implementation and Operation, Performance Evaluation, Improvement and critical analysis of direction) established in the ISO Guide 72:2001 (Guide for Standards Preparation) and can thus be adopted as basis for integration.

The essential difference between ISO 14001 and OHSAS 18001 is that the first focuses on managing the impact of the organization on the external environment, while the second focuses on managing the organization's internal environment to ensure a safe and healthy work environment. Structurally, the two standards are nearly identical. The requirements are almost identical. Consequently, processes and documentation necessary to implement and certify both management systems are essentially the same, only the intent and focus of the standards are different

According to Castro (2007), the structure of ISO 14001 and OHSAS 18001 management systems provide the ease of control and system development, this ease is due to the fact of maintaining the same documentation control, the same audit program, survey and control of compliance with applicable law to the same training program and the same practices for management systems certification. The homogenization of procedures allows controlling the system without generating distortions and inadequacies, ensuring understanding and compliance with internal and external demands in the organization.

The requirements of each theoretical basis are specific to each approach, being environment or health and safety; however, their correspondence is clearly defined in their terms, alternating by analysis of risks and hazards, meeting the OHSAS 18001, or aspects and impacts, meeting the ISO 14001. This being the main focus of an integrated management system; thus ensuring the achievement of continuous improvement of the organization and the completion of its goals and previously established objectives (CASTRO, 2007). Table 1 shows the correspondence between requirements of ISO 14001 and OHSAS 18001 standards.

Table 1. Correspondence between the ISO 14001 and OHSAS 18001. Source: Castro (2007).

Section	OHSAS 18001	Section	ISO 14001
1	Goal application field	1	Goal application field
2	Reference publications	2	Normative references
3	Terms and definitions	3	Definitions
4	Elements of the OHS Management System	4	Environemntal management system (EMS)

			requirements
4.1	Overall requirements	4.1	Overall requirements
4.2	OHS Policy	4.2	Environmental policy
4.3	Planning	4.3	Planning
4.3.1	Planning for identification of hazard, risk assessment and risk control	4.3.1	Environmental aspects
4.3.2	Legal and other requirements	4.3.2	Legal and other requirements
4.3.3	Goals	4.3.3	Goals and objectives
4.3.4	OHS management program	4.3.4	Environmental management program
4.4	Implementation and operation	4.4	Implementation and operation
4.4.1	Structure and responsibility	4.4.1	Structure and responsibility
4.4.2	Training, awareness and competence	4.4.2	Training, awareness and competence
4.4.3	Consultation and communication	4.4.3	Communication
4.4.4	Documentation	4.4.4	EMS documentation
4.4.5	Documents and data control	4.4.5	Documents control
4.4.6	Operational control	4.4.6	Operational control
4.4.7	Preparation and emergency response	4.4.7	Preparation and emergency response
4.5	Checking and corrective action	4.5	Checking and corrective action
4.5.1	Monitoring and measuring performance	4.5.1	Monitoring and measuring
4.5.2	Accidents, incidents, nonconformities and corrective and preventive actions	4.5.2	Nonconformities and corrective and preventive actions
4.5.3	Records and records management	4.5.3	Records
4.5.4	Auditing	4.5.4	Auditing of environmental management system
4.6	Management review	4.6	Management review

It is evident the synergy between ISO 14001 and OHSAS 18001 and these rules can be unified into a single and comprehensive policy guidance.

2.4 Correspondence of management systems models

The synergy between the EMS and OHSMS is facilitated due to both being designed from the method PDCA - Plan, Do, Check, Act (Plan, Do, Check and Critically Analyze- Cycle for Continuous Improvement). This method allows for planning, control and improvement of what is intended to play, depending on the requirements identified or imposed as essential from policies, objectives and targets aiming at being achieved. For Patricio (2003), the principle of continuous improvement is an effort that enables organizations to keep pace with market requirements from the continuous improvement of the management systems effectiveness.

The way PDCA cycle is deployed on the OHSAS 18001 requirements is very clear in Figure 2, presenting a full mirroring (Table 1) in relation to the ISO 14001 requirements, which allows from small changes in some expressions fitting the requirements for the environmental issue (SEIFFERT, 2008).

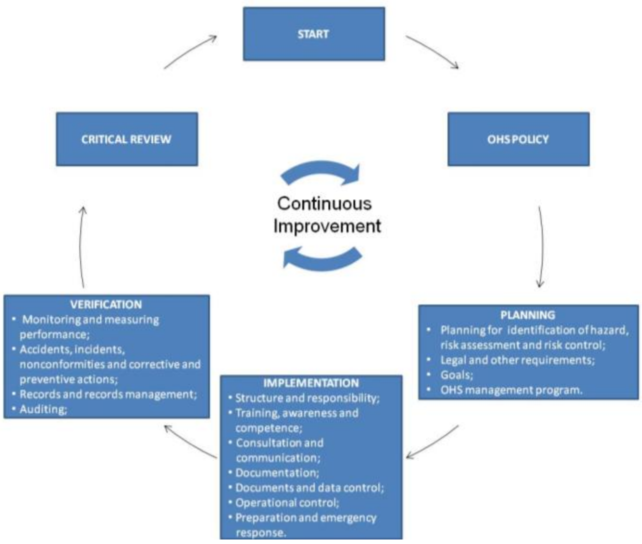

Figure 2. Structure of OHSAS 18001 standard and PDCA cycle. Source: Seiffert (2008).

Both management systems are presented identically allowing this synergy between them, considering their guiding principles based on the PDCA cycle. This synergy ensures an integrated management system where many benefits can be achieved maybe ranging from cost savings in the implementation and certification to system maintenance (CASTRO, 2007).

3. MATERIALS AND METHOD

The presented research was performed in a medium sized construction company (sub-sector buildings), that acts for fifteen years in the states of Paraiba and Rio Grande do Norte (Brazil). The fact that the company has, since 2003, the certification of ISO 9001 (quality certification) and the certification level A of the Brazilian Program of Quality and Productivity in Habitat (PBQP-H), is indicative of the existence of a coherent management model and means that the company adopts good practices to the operation of this model. Since 1998 the investigated company has no work accidents with employees removal and develops a very efficient management of construction and demolition waste.

As a technique of data collection was used the interview (in the company office, with people from the management level) and documental research (in the documents provided by the company, such as procedures, records, reports, etc.). The interview was standardized type, ie, was used a previously established routine, where the questions asked of respondents were prepared based in the items of Chapter 4 of ISO 14001 (requirements of the Environmental Management System) and in the items present in the same chapter of OHSAS 18001 (Element Management System Occupational Health and Safety) in order to identify the commonalities between the Environmental Management and OHS Management. The documental research aimed to verify the accuracy of answers during the interview.

4. RESULTS AND DISCUSSION

Based on the similarity of these requirements, it has been identified the synergism between management purposes considered in this study, ie, requirements shown Table 1 served as a source of evidence to establish the synergism between the purpose of Environmental Management and OHS Management in a construction company from Joao Pessoa.

4.1 Pollicy

The policy sets out the general sense of command and provides a framework for action, being used as a basis for planning the actions of management purposes. This is the stage where the organization sets policy and shows its commitment to respect the environment and health and safety.

In the interviewed company the management policy was appropriate to the nature and scale of impacts of activities and services on the OHS and environment, it is noteworthy that its policy text beginning with brief idea of the business sector, an interesting practice, since it allows the reader to better understand the assumptions made below. The company had commitment to continuous improvement explicit in the policy text itself, but there were no provisions constituting foundation for the establishment and review of objectives and goals. The company stated performing periodically reviews or at regular intervals, their environmental and OHS management policies as continuous guarantee of compliance and effectiveness. However, was not specified exactly the intervals in this review.

4.2 Planning

After being set a policy that states what is desired, the next logical step is to plan how it should be put in practice. The structure of the standards of the management purposes considered in this paper lists the following issues to be covered: identification and evaluation of aspects, impacts and risks; identification of legal requirements and other requirements; objectives and goals; and integrated management program.

The company has submitted the documents requested: Program of prevention of environmental risks (PPRA), Program of Conditions and Work Environment (PCMAT), Study of environmental impacts (EIA) and Report of impacts on the environment (RIMA). While the company has tools to identify and assess the risks to OHS, such as the PPRA and PCMAT, and the environment risks, such as the EIA and RIMA, thus demonstrating concern for the health and worker safety and environmental preservation, these programs were not integrated or made reference to each other.

Company interviewed did not have a document with the legislation (local, state, federal, international and collective agreements) and/or normative instructions (Regulating Standards from the Labor Ministry and CONAMA/SISNAMA norms) to which company is subject.

Despite of the company did not show evidence in its management policy that can represent foundation for setting objectives and targets, the company presented documents proving the existence of goals and targets of OHS and environment. This fact illustrates the difficulty in organizing the company's management purposes jointly and thus achieve more consistent results in its interface with society.

As stated before, in company was found OHS and environmental management programs in isolation (PPRA and PCMAT, for example). When asked about the existence of a RCD Management Program, the company had such a program, but issues related to OHS are not addressed.

4.3 Implementation and Operation

The next step is to implement and operate the management purpose. Is part of this step the following items: structure and responsibility, awareness and training, consultation and communication (internal and external), documentation and document control, operational control and preparation and treatment to emergencies.
It was reported the presence, and presented documents proving the existence, of professionals responsible for environment and health and safety of workers in the company functional framework.
The company mentioned training and educating their employees regarding health and safety issues and also conducting training and awareness of their regarding the environmental issues. About the content of this training and awareness, the company covered the following topics: individual protection equipments use; care during course of activities; existence of occupational hazards in the worksite; cleanliness conditions and organization in the workplace; and waste management (conditioning, transport and reuse and construction and demolition waste recycling). Company showed documented training procedures and also demonstrated they were actually carried out through properly signed records of attendance.
The company stated conducting consultation and notification regarding the OHS and environment issues. It is noteworthy that the company did not have records of these activities. Regarding the periodicity, the company did not state having a specified period to carry out these consultations and notifications. Concerning to how these consultations and notifications were performed, the company pointed out performing meetings with all employees and applying questionnaires to their employees.
When asked about the existence of documentation for their management purposes, the company reported having documentation regarding the OHS and Environmental Managements. Regarding the registration, the company stated that documents are printed and are also available in electronic form. Regarding the update, the company stated that their documents are updated, but was not mentioned the frequency of this update.
The company has concern on the control of access and use of documents relating to environmental and OHS issues. It was also stated by the participating company that such documents are filed in a specific sector and disseminated to stakeholders. During this research was not realized the integration of documents relating to OHS and environmental issues, thus generating a higher volume of documents.
The company had operational control of OHS and environment, developed by qualified professionals and stakeholders. The company stated that procedures are available for inspection by stakeholders When required, procedures were presented by company. Regarding the periodic review of these procedures, the company stated performing it regularly, but was unable to state for sure the time period in which this review is carried out.
The company had emergency plans related to OHS and environment. Company was asked for proving review and testing. The company stated conducting regular reviews; however, did not state for sure how often the review is performed. And regarding the test in these plans, in order to verify its effectiveness, the company did not state performing tests or simulations with their employees.

4.4 Verification and Critical Analysis

The next major aspect of the implementation and operation of a management purpose is to verify and monitor the system, find problems and fix them. It is part of this stage the monitoring and performance measurement and auditing of management purposes. The final step in the basic process of managing a purpose of management is the critical analysis of their own management purposes. This analysis is critical to ensuring implementation of continuous improvement.
The company reported performing the monitoring and performance measurement for purposes of OHS and environmental management and showed documents that proving the monitoring and performance measurement in management purposes.
Asked about the audits in management purposes considered in this study, the company stated only audit issues related to the OHS and internal to the organization. In the company was presented documents proving the completion of internal audits. It is noteworthy that the company was not able to inform the frequency or timing of audits.
Asked about the involvement of senior management in the critical analysis management purposes, the company stated that purposes of OHS and environment were critically analyzed by senior management. As regards timing, the company was unable to inform for sure the date which the analysis is performed; however, when required were presented documents proving this activity completion.

4.5 Discussion

This research identified that the synergism is neutral, ie, purposes of OHS and environmental managements do not interact with each other, acting separately. In this scenario, the performance scope of management purposes becomes limited, not being established a cause-effect relationship between them.
With the information obtained from this study we can draw some conclusions:
(i) this construction company certified by the PBQP-H still has a number of shortcomings in the purposes management of health and occupational safety and environment;
(ii) this construction company still begin to take the first steps towards achieving a transparent, effective and consistent management;
(iii) synergism between OHS Management and Environmental Management is still not clear to the company interviewed.

In this construction company is notorious the lack of knowledge about some management procedures, such as: identification of legal and other requirements, establishment of goals and objectives in the policy and existence of an integrated management program.
It can be observed through the results obtained, the managers' ignorance about the interrelationship between OHS and environment and therefore, the synergism between management purposes in this study.
Results showed that company, but not all management procedures, seek to work on the management purposes (OHS and Environmental) in combination. This shows that business executives and decision makers in the construction company are not prepared or aware of consequences of ways and means to produce on the health of workers and environment.
The information presented and analyzed in the development of this research suggest that even being in the XXI century, this construction company of Joao Pessoa/PB still begin to take its first steps towards a more efficient and integrated model.

5. CONCLUSION

Currently the market began to demand that products and services bring the commitment of companies responsible for them in meeting the international standards of quality, environmental sustainability and protection of physical integrity and health of their workers. Thus, the management of environment and health and occupational safety focusing on accident prevention and treatment of potential problems is now the management of enterprise's viability and survival.
According to the market progress, it requires a systemic view of companies, where business performance should be assessed to cover the elements incorporating the commitment and responsibility towards the environment and health and safety of the company. In the current corporate scenario in which organizations are inserted, the need for a systemic approach to the subject of management systems seems to be increasingly present.
ISO 14001 and OHSAS 18001 standards are presented identically, based on the PDCA cycle, which allows the synergism between the purpose of Environmental Management and OHS Management. This synergy ensures an integrated management system where many benefits can be achieved: costs reduction for certification and maintenance of management systems, documentation simplification (manuals, operating procedures, work instructions and records); structured and systematic attention to the environmental legislation relative to health and safety at work, etc.
Thus, the search for performance and/or development of productive activities guided towards this new trend that the market is looking for imply organizations adopting practices for integrated management systems.
The finding that there is a tendency for management systems to integrate is a reflection of the new reality, although there is little integration of existing management systems in companies, especially regarding the environmental and health and occupational safety managements.
The reflection of this research was developed from the basic concern on identifying and treating the synergism between OHS and Environmental Managements in a construction company. Motivation was the perception that the construction company has some notion of the need for preventing the labor risks and environmental impacts, usually by high costs they represent and the own social responsibility. However, it was not known how the synergism between Occupational Health and Safety Management and Environmental Management is handled by the company.
The use of a synergistic vision allows an articulated operation between management purposes, enabling a full exploitation of these principles, in addition to contributing to organizational sustainability through a series of interconnected policies and through organizational operations and decision-making processes aimed at ensuring that companies will maximize the positive impacts of their activities in relation to society.

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Risk analysis of accidents in activity mining: The case of mining Serra Branca/Brazil

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ABSTRACT
The city of Pedra Lavrada-PB/Brazil, concentrates most of its economic activities in mining. However, it is mostly composed of small mines, with methods and techniques of artisanal mining, which makes the most gruelling work. This paper aims to outline the profile of risk present in the unit operations of mining production process of Serra Branca, belonging to the Cooperative Miners of Pedra Lavrada (COOMIPEL), where mining activity is carried out in the open and involves operations: drilling of rocks, loaded with explosives and detonation, disassemble, manual separation, loading and transportation. The work is characterized as a descriptive field research and qualitative, held between March and June. The survey was conducted with a universe of 10 miners, who work in mining Serra Branca, which are exposed to the risks classified in five NR-9. Although the risks are: physical, chemical, ergonomic and the accident that are present in all the operations of mining activity. The risks are associated with these agents: heat, dust, excessive physical exertion and falls. At the end of the study we can obviate the need for awareness of the miners in the use of PPE and COOMIPEL to provide adequate PPE's. The risk of accidents along with the lack of safety procedures, contribute to an inadequate working environment, with poor mining techniques in living workers belonging to the Serra Branca.

Keywords: Mining; Risk of accidents; Safety at Work.

1. INTRODUCTION

Minerals provide the most essential raw materials used by society, but their extraction and processing activities are accompanied by high risk to the health of workers. Even with the scientific and technological advances over the centuries, the mining environment remains unhealthy, and potential risks of morbidity and mortality. According to the International Labour Organization (ILO) in 2001, more than 1.3 million people died from workplace accidents worldwide, and the sectors that have the highest accident rates in the world are agriculture, construction and mining.

The risk environment becomes even more damaging when mining is in rudimentary and lack of technological development satisfactory. In the study environment, the miners often operate in dangerous working conditions, and work under high local temperatures associated with high reflective land mines, which raises the temperature too in the workplace. It is clear that the risk of accidents, along with poor hygiene in the workplace and lack of use of protective equipment collectively and individually, contribute to an inadequate work environment, site of the development of many diseases and accidents related to mining. According to Martins et al. (2004), mineral extraction activities in pegmatite bodies Seridó region, the states of Paraiba (which includes the Cooperative Miners, located in hewn stone) and Rio Grande do Norte last for more than half a century within the cycle involved informality, illegality, by the use of inappropriate techniques, the low investment capacity, the low productivity and low added value.

Concerning the city of Pedra Lavrada-PB/Brazil, it appears that focuses most of its economic activities in mining, predominantly small mines, with methods and techniques of artisanal mining, which makes the work more strenuous. This article aims to outline the profile of accident risks present in the unit operations of the production process of the Serra Branca mining, owned by the Cooperative Miners of Pedra Lavrada (COOMIPEL), whose mining activity is carried out in the open and involves the following operations: rock drilling, loading explosives and detonation, disassemble, manual sorting, loading and transportation of rocks.

1.1. Measures to prevent accidents in the mining based on legal requirements

To adopt appropriate prevention and protection are ways to minimize / eliminate the generating agents of accidents and occupational diseases, and thus protect the integrity of workers. To reduce accidents at work in the mining industry, is stepping up legislation by the government, which, besides being obeyed, should promote awareness of employers and employees who seek safe practices in the workplace.

1.2. Occupational Health and Safety in Mining - NR-22

Specifically for the mineral sector in December 1999, the MTE published NR-22, Occupational Health and Safety in mining, determining the existence of the mandatory program in Mining Risk Management (MRM), in which we can highlight aspects to:

a) physical, chemical and biological agents;
b) atmoferas explosive;
c) ventilation;

d) respiratory protection in accordance with Instruction (IN) No. 1 of 04.11.1994 of the Secretary of Health and Safety at Work.
e) research and analysis of occupational accidents;
f) ergonomics and work organization;
g) risks from work at height, depth and confined spaces;
h) risks from electricity, machinery, equipment, vehicles and crafts;
i) equipment mandatory use of individual work;
j) stability of the mass;
k) emergency plan, and
l) due to other changes and introductions of new technologies.
Compliance with the Regulatory Standard NR-22 becomes relevant in the prevention of accidents in the workplace, as a measure to stop or eliminate the risk of accidents inherent to activities undertaken by the miners.

1.3. Program for the Prevention of Environmental Risks (PPER)
For purposes of this NR, environmental risks are considered the physical, chemical and biological environments in existing work, due to its nature, concentration or intensity and exposure time are capable of causing damage to workers' health.
The NR-9 set forth in this aims to prevent accidents and diseases through the Program for the Prevention of Environmental Risks (PPER). The objective of PPER is to preserve the health and integrity of employees by anticipating, evaluating and controlling environmental hazards that exist or will exist in the work environment. Considering the protection of the environment and natural resources. by which the assessed risks are detected, made plans for thus measures will be implemented to eliminate, prevent or protect workers, among others.
Among one of the measures to be adopted in order to make the workplace safer, is the implementation of the risk map. In one of the objectives is to identify risks at the site analyzed, according to the classification in Table 1 below:

Table 1 – Classification of the main risks in occupational groups according to their nature and the standardization of corresponding colors. Adapted from NR – 9 (2005).

Group 1	Group 2	Group 3	Group 4	Group 5
Green	Red	Brown	Yellow	Blue
Physical risks	Chemical risks	Biological Risks	Ergonomic Risks	Risk of Accidents
Noise	Dust	Virus	Physical exertion	Inadequate physical arrangement
Vibrations	Smoke	Bacteria	Manual lifting and carrying weight	Machinery and equipment without protection
Ionizing Radiation	Mists	Protozoa	Requirement of poor posture	Tools inadequate or defective
Non-ionizing	Gases	Fungi	Strict control of productivity	Inadequate lighting
Radiation	Vapors	Parasites	Imposition of excessive rates	Electricity
Cold	Substances, compounds or chemicals in general	Bacilli	Shift work and night	Probability of fire or explosion
Heat			Long working hours	improper storage
Abnormal pressures			Monotony and repetition	Venomous animals
Moisture			Other conditions causing "stress" physical and/or psychic	Other risk situations that could contribute to accidents

In order to eliminate or reduce the risk of accidents in the workplace, should develop and implement collective protective measures. Since these measures obey the following hierarchy:
a) measures to eliminate or reduce the use or the formation of agents harmful to health;
b) measures to prevent the release or dissemination of these agents in the workplace;
a) measures to reduce the levels or concentrations of these agents in the workplace.

These protection devices, groups usually require design changes and/or production process (machinery and equipment), before being installed. It is through such programs as you get to a healthy working environment and thus the awareness of workers and employers about the risks. For the worker is not reached by the various aggressive agents, it is very important that the environment is protected, and when it is not possible, the employee uses a personal protection.

2. MATERIALS AND METHOD

From the methodological point of view, the work is characterized as a descriptive and qualitative field research, carried between March and June 2010. Data collection was through visits "in situ". The research covered the miners associated with COOMIPEL. More specifically, all workers who wished to participate in the survey, a total of 10 respondents in that amostra. O goal was to travel throughout the mining and monitor all activities undertaken by workers, providing a more detailed identification of the work process, the types of tools and operations procedures developed by the miners. We sought to understand the whole process of mining and the conditions for the development of the tasks performed there, as well as identifying the main risks associated with drilling operations, dismantling, loading and transportation.

2.1. Data collection instrument

From an literature review of books, theses, dissertations, research papers, legislation, course handouts and materials related to the subject of accidents in opencast mining, it was possible to know the main physical, chemical, biological and ergonomic inherent in mining activity. Based on field observations and literature search was possible to prepare a questionnaire, which has divided into three parts according to the order of questions.

The first part-versed in personal questions, the second part focuses on the identification of risks and impacts of these operations carried out by mining. The third and final part discusses the safety procedures in working with availability and use of Personal Protective Equipment (PPE). For photographic recording, we used a Kodak camera, model C613, and measures in the workplace used a tape measure.

3. RESULTS AND DISCUSSION

This research was conducted in the city of Pedra Lavrada-PB, where mining is the most profitable economic activity. According to Andrade (2009), the municipality has a great number of pegmatite bodies, potentially mineralized in: feldspar, quartz, granite graph (nail), tantalite, beryl, mica and gems.

The low purchasing power of the miners of the municipality, together with the lack of instructions and a very low level of education put these workers in the informal condition, before the organs that regulate mining activity. Given this, many workers are motivated to legalize mining activity, uniting in order to found a cooperative.

On August 21, 2006 founded the Cooperative Miners of hewn stone (COOMIPEL) in which today has 42 members, among whom they work mostly in mining recorded as Alto Serra Branca with an area of 67.24 hectares granted. The mineral extractions are performed in the open mines. Figure 1 shows the location map of the mining area and Serra Branca (the maps are out of scale, so that I could do the proper presentation).

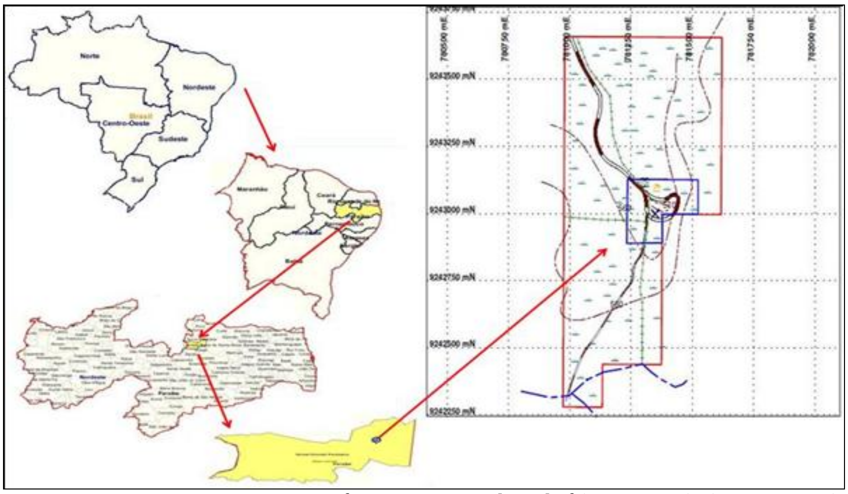

Figure 1 - Location map/mining area of Serra Branca. Adapted of (IBGE, 2010); (COSTA, 2010).

In the search for mineral prospecting activities are presented in accordance with the following operations: rock drilling, loading explosives and detonation, disassemble, manual separation, loading and transportation of rocks.

3.1. Drilling of the rocks

Drilling dust releases from the mineral that is being drilled, where the drill is held by a miner during the entire operation. It is observed in this operation, the dust is the chemical risk from drilling mineral, besides the existence of other risks such as excessive noise, poor posture and the use of tools in bad condition. In addition, the miner does not make use of PPE required for this operation. In Table 2, then there is the main risks associated with this operation.

Table 2 – Major risks identified in the drilling of rocks.

Agents / Risks	Noise	Vibration	Heat	Dust	Falls	Landslide	Explosion	Inadequate posture	Excessive physical	Presence of microorganisms
Physical										
Chemical										
Biological										
Ergonomic										
Accidents										

From the above table it is clear that the rock drilling process exposes workers to risks of all types, except the biological risk. The exhibition is intensifying as the operator approaches the sources of dust and noise.

3.2. Loading of explosives and detonation

After drilling of the mineral, the miner handles the explosive drilled into the mineral, where it is found that this activity usually does not follow safety procedures established by the army (the regulating body of the use of explosive). After loading, the prospectors lit the fuse and then escaped immediately from the blast site.

At the moment they run fast, scream for all workers in neighboring stools know that explosion will occur and thus can protect yourself from shattering stone that will be dispersed with the explosion. But not always detonate the explosives, because of ocorrerência fault, causing the mineral prospector comes to find out what the problem occurred. On the other hand, sometimes, not a true failure occurs, but a delay in the explosion, resulting in an imminent risk of accident, and chemical risk from the large amount of dust at this time. In Table 3, highlights the main risks associated with this operation.

Table 3 – Major risks identified in the operation load of explosives and detonation.

Agents / Risks	Noise	Vibration	Heat	Dust	Falls	Landslide	Explosion	Inadequate posture	Excessive physical	Presence of microorganisms
Physical										
Chemical										
Biological										
Ergonomic										
Accidents										

The risk of explosion and accidents in general is mainly linked to the handling of chemicals and explosives. As a security for this type of operation, it is essential for communication devices and procedures specific sound, as a warning that the area is about to explode, so it should be available fire plan, in which one of the recommendations is the minimum time return after the detonation.

3.3. Disassemble

This operation is performed for the breakdown of minerals in the interior of stools through the use of explosives described in the previous step. After the detonations are used hand tools such as shovels, picks and levers that have the purpose of facilitating the breakdown of minerals.

The venue for the detonation does not conform to any previous study that seeks not collapse after the blast barriers. The choice of the place of mining, where the explosion will take place depends on the expertise of employees. This fact often leads to barriers in any falls and /or generate instabilities in the field, with the imminent risk of collapse. Even doing this at a certain point, there is no point in the use of seat belts, as shown in Figure 2.

Figure 2 – Prospectors perform the operation without the use of PPE.

In this situation, the use of seat belts is essential for demonstrating that one of the miners is located at a height greater than 2m from the ground. Besides the lack of seat belt use, the miners do not use any type of PPE. Thus, in Table 4, then there is the main risks associated with this operation.

Table 4 – Major risks identified in the disassemble.

Risks \ Agents	Noise	Vibration	Heat	Dust	Falls	Landslide	Explosion	Inadequate posture	Excessive physical	Presence of microorganisms
Physical	X		X							
Chemical				X						
Biological										
Ergonomic								X	X	
Accidents					X	X				

The risks of accidents and are directly linked to ergonomic work techniques used in this operation.

3.4. Manual Separation

After the dismantling of the rocks, the bench itself is made a manual separation of minerals that have commercial value and will be rejected, as can be seen in Figure 3.

Figure 3 – Workers making a manual separation.

The use of appropriate PPE is not observed regarding the protection of solar incidence, since the miners wear a shirt to protect the head and neck. In Table 5, it is evident below the main risks associated with this operation.

Table 5 – Major risks identified in the operation manual separation.

Risks \ Agents	Noise	Vibration	Heat	Dust	Falls	Landslide barriers	Explosion	Inadequate posture	Excessive physical exertion	Presence of microorganisms
Physical										
Chemical										
Biological										
Ergonomic										
Accidents										

The process of manual separation exposes the worker to all types of risks, emphasizing mainly the physical risk from the heat and ergonomic risks, as evidenced in Figure 3.

3.5. Loading and transport

The ore and tailings are transported from the lower base of the stool through a transport system lift (mechanical winch - powered by diesel engine or winch (system comprising a handle and a reel coupled with a spear in movement rotating from the manual effort) to the top of the bench. As can be seen in Figure 4, below.

Figure 4 – Working man doing the loading and transport.

The risk of accidents along with the absence of security procedures contribute to an inadequate working environment, with poor mining techniques. In Table 6, below, are seen the main risks associated with this operation.

Table 6 – Major risks identified in the operation loading and transport.

Risks \ Agents	Noise	Vibration	Heat	Dust	Falls	Landslide barriers	Explosion	Inadequate posture	Excessive physical exertion	Presence of microorganisms
Physical										
Chemical										
Biological										
Ergonomic										
Accidents										

In loading and transportation of minerals, there is the risk of falling debris, as is also evident ergonomic risks.

3.6. The table of risks

The main risks involved in mining operations of Serra Branca, can be seen in Table 7 below.

Table 7 – Risks assessed by mining operation in Serra Branca.

Operations \ Agents	Noise	Vibration	Heat	Dust	Falls	Landslide	Explosion	Inadequate posture	Excessive physical	Presence of microorganisms
Drilling of the rocks	■	■	■	■	■	■		■	■	
Loading of explosives and detonation			■	■	■		■		■	
Disassemble	■		■	■	■	■		■	■	■
Manual Separation			■	■	■	■		■	■	
Loading and transport			■	■	■	■		■	■	

Workers who work in mining Serra Branca, and who develop any of the operations necessary for such activity, are exposed to the risks classified in five NR-9. However, agents are: heat, dust, excessive physical exertion and falls that are present in all operations.
Dust is an agent that is present in all activities, since the generation of particulate matter is intrinsic to mineral production. The thermal overload on activities in the open, due to the exposure of workers to the sun throughout the workday, a fact compounded by the local thermal conditions.
Ergonomic problems occur mainly due to poor posture in performing the tasks and prolonged stay in the same position. Falls unstable rock fragments or even trips may occur throughout the workday.

4. CONCLUSIONS

Through the issues raised about the conditions of work safety in mining Serra Branca, it was possible to identify the main risks of accidents related to the operations of mining and classify them according to the RN-9. It was found that workers are exposed to physical, chemical, ergonomic and accidents in all operations involving the mining activity. The risks are associated with these agents: heat, dust, excessive physical exertion and falls.
Operations that the miners claim to have knowledge to develop them, 60% of those classified as more dangerous, the operation "loading and detonation of explosives." The other 40% point to the operation "dismount." Even if these operations are considered more dangerous, it is clear that the miners do not make use of PPE, even those claiming to be provided by the cooperative.
Based on information collected in the survey, one can obviate the need for awareness of the miners in the use of PPE and the cooperative to provide the appropriate PPE to mining activity. Thus, it appears that the risk of accidents along with the absence of security procedures, contribute to an inadequate work environment, poor mining techniques. Moreover, the results of this work can be used as a basis for analysis of other mines in the city referenced, where miners have associated with the cooperative, emphasizing the need for adjustments to the reality of each mining. Finally we present a series of recommendations to improve the manufacturing environment, namely:

- It is essential to create a Risk Management Program (RMP) by the cooperative in order that this program covers all the risks present in the mineral sector and should include actions to control or eliminate such risks;
- Technical procedures should be adopted in order to control the stability of mining and mineral extraction methods, observing the engineering criteria. Therefore, it is essential to hire a mining engineer by COOMIPEL;
- Implement a policy of awareness in the use of PPE provided by the cooperative, since even the cooperative offering, there is not in routine use by miners;
- Install audible devices at the time of the explosions, as set forth in RN-22;
- The acquisition of mechanized equipment will be instrumental in reducing the physical effort by the miners in some operations, for example, the dismantling and loading and transportation;
- Finally, in the case of manual sorting operation, you can build a shelter to protect the miners from the sun, since this operation requires the miner to stay in the same place for hours.

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Barriers to organizational learning with work accidents

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ABSTRACT
Organizations must develop capabilities to learn with work accidents and occupational diseases. These kind of events do not have positive effects for the different parts involved (victims, company, insurance companies, etc.), so when they do happen, they must be rigorously analyzed and widely discussed. They are situations that require behavioral and procedural changes. In others words, they require organizational learning, but in some cases there are obstacles that inhibit the achievement of that learning. This article seeks to understand and demonstrate how these conceptualizations are materialized in the area of health and safety at work, and help characterize the ability of organizations to learn from accidents at work. It also seeks to identify practical examples of barriers to an effective learning with workplace accidents in the case study conducted in a metal industry company. Cultivating the phenomenon through specialized literature and the case study, stressing both their assumptions and barriers, it was possible to register that were essentially three types of barriers to organizational learning from work accidents: structural barriers (related to the organizational system), interindividual barriers (related to the interpersonal relations system) and intraindividual barriers (related to the individual scheme of representations).

Keywords: work accidents, organizational learning, barriers.

1. INTRODUCTION

This paper results from investigations developed with the aim of understanding the ways and circumstances how the process of social and organizational construction of health and safety at work (HSW) occurs in organizations. This aim led us to develop a methodology that highlights the more visible and less visible aspects in personal and organizational management of risk and safety. The methodology proposed allows the development of a Socio-Organizational Portfolio of HSW for each organization under study. A portfolio of this nature represents "a personal file of an organization that holds a organography portrait with multiple angles, dimensions and elements about the working conditions in matters of health and safety" (Neto, 2011:1). It is an analysis that fosters the description of a set of features that specify and project the organizational domains of HSW into the past, present and future (idem).

The application of this methodology allows us to highlight different social and organizational dimensions of professional risk and safety (idem). One of these dimensions concerns the strategies and capabilities of organizations to learn from work accidents. Using a case study conducted in a metal industry company located in the district of Porto, we tried to cultivate the phenomenon of organizational learning from accidents, stressing both their assumptions and barriers.

Over the past decades, several authors have discussed the issue of organizational learning. Based on the assumption that organizational practices were privileged spaces of confluence of production, exchange and application of knowledge, authors started to think and theorize about the organizations' ability to learn. This issue appears as a capacity, because it is related to the existence, creation and development of attributes related first to information management, and second to knowledge management in organizational practices [knowledge can be regarded as information for action (Tiwana, 2000)].

The organizational domains from where knowledge and learning can arise are diverse, the variation depending on the number of functional areas that an organisation considers. HSW should be one of these areas, especially due to issues related to accidents at work. Accidents and occupational diseases are not events that organizations wish to occur, much less reoccur, so they must be rigorously analyzed and widely discussed when they do. That is, these are situations that require learning and to withdraw knowledge for further action. The first objective of this article is to understand and demonstrate how these conceptualizations are transposed to the area of HSW and help characterize the ability of organizations to learn from accidents at work. The second objective involves the analysis of the main barriers to organizational learning identified in the case study, and the disclosure of the assumptions that underlie the barriers signalled.

To meet these objectives, section two will discuss the theories on organizational learning from work accidents that have operated as a theoretical and methodological reference for reflection and empirical research. Sections three and four will demonstrate how the conceptions presented were transposed to the study of concrete organizational realities. Section three will characterize the methodological approach developed, and section four will be present and analyze the results obtained from the application of this approach in the case study mentioned. To conclude, an assessment will be made on the issues analyzed and the results obtained, and opportunities will be pinpointed for future research.

2. ORGANIZATIONAL LEARNING WITH WORK ACCIDENTS

Learning refers to a specific process through which knowledge is developed, resulting from specific actions and interactions with information and information sources. Learning is not only possible, but is a natural process (Senge, 1990), because human beings love to learn regardless of the social context in which they live. Learning can manifest itself at individual, collective and organizational level, making it a process that can occur under any circumstances and social situations. When it occurs in organizational contexts, it assumes the designation of organizational learning. However, it is important to bear in mind that when it comes to organizational learning, it is considered necessarily learning at the individual and collective level, that is, it assumes that it occurs also at these levels. However, even within organizations there can be individual and collective learning without organizational learning. This is because organizational learning is more than the sum of the individual and collective learning recorded in organizational contexts (Argyris and Schön, 1996).

At the basis of the concept of organizational learning are conceptualizations and forms of action related to knowledge production, interiorization, management and sharing within organizations and in the relationships they establish with their surrounding environment. It also presupposes that knowledge is shared by "socialized subjects" whose action and knowledge are influenced "by the work organization type of models or by the properties of products and technical devices" (Veloso, 2009:257).

An organization that learns has the capacity and resources to create, acquire and transfer knowledge, and also to modify behavior to reflect the new learning that arises in the course of their action (Garvin, 1993). These abilities and resources apply to all organizational dimensions, including accidents at work. Learning from accidents, according to the Swedish Rescue Services Agency, "is to extract, put together and analyse, and also to communicate and bring back knowledge on accidents and near-accidents, from discovery to course of event, damage, and cause to all who need this information" (Lindberg, Hansson and Rollenhagen, 2010:714). It is a process that includes steps that go from the discovery of the course of the event to the identification and characterization of damage and causes. The final aim is always to refer these elements to all who need this information, because only then can there be learning with the purpose of preventing similar occurrences, limiting damage and improving work safety (idem).

Organizational learning with accidents at work is a process, and, as such, may also be subject to the existence of situations which limit or hinder successful completion of the procedural cycle. There are several examples analyzed in scientific literature showing the existence of a diverse set of situations that may act as barriers to organizational learning from work accidents. The following paragraphs identify some of these examples.

Perrow (1984) showed that the technical feedback from the accident experience is sometimes ambiguous, or simply is not done (deficits in communication), that accidents at work can also be a highly politicized context (set of interests) and the secrecy or concealment of events, for reasons of guilt, responsibility and punishment, prevents many situations from being known and discussed.

Hopkins (2000a) through the analysis of two mining tragedies that happened in Australia during the 1990s came to the conclusion that there were sociological similarities between them, although they occurred in different moments. Above all, the analysis showed the impact that the lack of organizational capacity to learn with premonitory events of accidents can have on workers safety. The explosion in the central Queensland mine of Moura in 1994 and the flooding in the Gretley mine in 1996 were the cases analyzed by Hopkins. The two accidents have in common the prior existence of "several warning signs of danger that were dismissed or ignored" (idem:31). "These events develop and accumulate unnoticed or not understood" (idem:36). The rationalisations for ignoring these signs were essentially the same in both cases. A "culture of denial" has been developed, since a whole series of beliefs was internalized and "had the effect of nullifying the early warning signs" (idem). The belief that the mine was not vulnerable to some hazards allowed management to continue with production, when all indicators pointed that the mines were "headed for disaster" (idem).

In same year, Hopkins (2000b) published another work about major accidents occurred in Australia. In this case, the author focused the Longford gas explosion occurred in 1998 at the Esso natural gas plant at Longford in the Australian state of Victoria. He demonstrated that the accident had a complex causal network and part of that causes may be associated with a reduced learning ability. The author indicated that the causal network considered failure from operators, company, governmental entities and society itself. From the several situations appointed by Hopkins, two obstacles to organizational learning from work accidents can be underlined: (i) Esso measured safety by its lost–time injury rate. The incident reporting system was used only to point out situations which have caused or might cause injuries. It did not served to report aspects which had the potential to generate dangerous events; (ii) one month before the gas explosion, there was an incident that originated loss of warm oil flow and abnormally low temperatures in the pipes (ice was formed, when traditionally the temperature are very high), but the incident was not registered and analyzed within the reporting system. If it had been registered, the anomaly which led to the explosion could have been detected. These aspects are related and indicate that the company was unable to withdraw substantive lessons from past events, since the organizational procedures of incidents and accidents report and analysis were not adequate and did not favor the accumulation of organizational knowledge.

Vaughan (2005), through the analyze of the accidents with NASA[1] shuttles Challenger and Columbia, has demonstrated similarities between the accidents seventeen years apart, showing how organizational learning was, to some extent, inhibited by the characteristics of the organizational system of the company. Ballesteros (2007) described the barriers to learning from work accidents in terms of system characteristics: (i) regulatory hypertrophy, i.e., existence of pressure to follow rules to a degree that may induce risks; (ii) emphasis on responsibility of workers, (iii) excessive automation, making the intervention and process control by the workers difficult, (iv) personal limitations of the workers (e.g., lack of

[1] National Aeronautics and Space Administration – United States of America.

motivation, concentration difficulties); and (v) dysfunctional role of the regulatory entity (e.g., lack of political will, functional disorganization). Again Hopkins (2008), through the analysis of BP refinery disaster in Texas City, showed that companies can suffer from "learning disability" due to various situations, such as the nature of safety management model, the need to cut costs, the type of reward system, the decentralization structure policy or the type of leadership advocated.

These are the situations that can act as barriers to organizational learning from work accidents. This paper aims to demonstrate, through the case study conducted in the metal industry company mentioned, other practical examples of obstacles to an effective learning with workplace accidents. The next section summarizes the methodological procedures which have made it possible to achieve the results.

3. METHODOLOGICAL APPROACH

To understand how the organizational learning processes with work accidents are established in an organization, we need to analyze how each organization (and its different parts) perceives, interprets and uses the volume of information that is intrinsic to any hazardous event. This situation implies that these events can be subject to reflection and analysis at both individual and institutional level.

It is believed that organizational learning from work accidents incorporates six main dimensions: (i) the accident itself and its characteristics (type of event, type of impact, type of people involved, etc.); (ii) the evaluation of the accident or illness and the event report production (likely to include the overview of the victims and witnesses and the technical opinion about the causes of the event and the ways to avoid it in the future); (iii) communication and discussion of the analysis process results to all interested parties; (iv) implementation of corrective measures to rectify the anomalies detected, and preventive measures to avoid recurrence (may include, for example, procedures such as training, change of work processes, change of work equipment); (v) medium and long term monitoring and evaluation of the impact of implemented measures; (vi) repair the damage of the accident.

These dimensions reflect two different learning timelines, a short-term (which is associated with the need to make prompt interventions, covering essentially the first three dimensions identified) and a medium and long term (associated with projecting in time the response to events to prevent recurrences and to repair the damage occurred, reflecting essentially the last three dimensions identified).

As a whole, the dimensions listed also serve as basis for guiding the study of organizational contexts, especially for the analysis and characterization of the ways how these occurrences are treated in the organizations under study. Moreover, this is the reason why they were conceptualized. However, to make its operation more feasible and to allow a more clear understanding of how they are portrayed and what kind of learning and knowledge they promote in organizations, five analytical extensions were designed. These extensions are meant to guide the procedures for collecting, processing, analyzing and interpreting data obtained in each case study. They also favor the obtaining of the elements needed to empirically substantiate the six dimensions indicated. The analytical extensions defined were: (i) framework of legislative requirements (what they define and how the organization under study considers them); (ii) sector level of accidents (what kind of contrasts are made with the internal results and how they influence organizational options); (iii) workers accidents experience (the extent to which past events are indicative of levels of learning); (iv) analytical process of the incidents and accidents in the organization (how the accidents are regarded and what kind of expedients they imply); and (v) workers representations about how the company deals with the possibility of learning from work accidents.

In short, the methodological approach is underpinned by the assumption that knowledge and organizational learning from work accidents can be studied from six dimensions. The empirical operationalization of these dimensions is realized through the five analytic extensions considered in the previous paragraph. This methodological approach can be applied to any organization; however, some adjustments may be needed. In any case, this flexibility is implicit to the approach.

One of the case studies already completed where this methodology was applied refers to a manufacturing company of metal structures which has its headquarters in the district of Porto. In order to preserve the identity of the company, we used the fictitious name of Stigma. This company metal industry company has national and international projection. On December 31, 2009 the company had 343 employees[2].

The data collection was carried out based on four central procedures:

(i) documental analysis, focused on documents such as the manual of the HSW managing system, the HSW policy, reports from the HSW services activity, balance sheets, the company's reports on the identification and risk assessment processes, reports from the workers consulting procedures, the internal plan of HSW information and training, statistics of accidents and reports from the workplace accidents analysis;

(ii) structural diagnosis of the working conditions in matters of HSW, based on the application of a scorecard for HSW management systems [SafetyCard - Performance Scorecard for Occupational Safety and Health Management Systems (Neto, 2009; Neto, Arezes & Sousa, 2008)]. The instrument also analyzes the performance and results in the area of work accidents;

(iii) interviews with organizational agents to specify the performance of the organization. The interview scripts considered a segment of questions about the topic under analysis. Eight semi-direct interviews were conducted.

[2] Since the field work took place in the second half of 2010, the company's latest official data available were from 2009.

Interviews included an administrator, the director of the HSW services, the occupational physician, the head of production, the head of human resources management, a HSW professional and two workers indicated by the organization, because Stigma does not have any workers commission elected; and
(iv) survey to company workers. The instrument incorporated some scales adapted from OSCI - Organisational and Safety Climate Inventory proposed by Silva, Lima & Batista (2004) and from the Risk Perception Inventory proposed by Rundmo (2000). One of the scales developed concerned the perceived organizational learning from work accidents. In addition, a section of the survey focused on the personal experience of accidents and the performance of HSW services on these occasions. The distribution and collection processes were assured by the company. We knew that this situation could lead to a lower response rate, but it was the only option to ensure the survey application. The supposition was confirmed; however, we were still able validate 130 surveys, representing a response rate of 37.9%.

4. PRESENTATION AND RESULTS DISCUSSION

Stigma is a manufacturing industry of metal structures founded in 1971. In that year, it had three employees and a factory area of 50sq.m. In 2009, the area had increased to 44,000sq.m and a total of 343 employees. The company registered a significant development, even at HSW level. The analysis of the interviews and the company's strategic documents showed that HSW is an important part of the organization's daily activity. The company has an integrated management system of quality, environment and safety. It is viewed by the company directors as the basis for stabilizing practices and the continuous improvement of working conditions. The management system is structured around five principles, active safety being one of those principles (continued promotion of working conditions through the prevention of hazardous events).
The "safe work maximum" manifests itself by this assumption of active safety. However, work accidents represent a constant threat to this principle. The only positive aspect of this kind of events turns out to be the opportunity to withdraw lessons that will enhance the level of HSW and help prevent recurrences. The five analytical extensions previously described were used to understand how Stigma projects and empowers itself to gain insight and behavioral change in relation to incidents, accidents and illnesses.
To contextualize the analysis it is important to first characterize the reality of the company in terms of work accidents. The Stigma internal service of HSW usually performs a statistical control of this kind of events. The main indicators used are the number of accidents, the number of workdays lost by workers injured, the frequency rate, the incidence rate, the severity rate and the severity assessment rate.
The data related to these indicators are available in Table 1. Data from 2008 were also considered to offer a benchmarking with the sector's reality. The indicator that will allow the comparison of sectors is the incidence rate. The only available data refers to 2008, because it was in that year that the last official issue about accidents at work was published[3].
Table 1 confirms that in 2008 38 accidents were registered, corresponding to a total of 996 working days lost. In 2009, 18 accidents were registered, corresponding to a total of 1,187 working days lost. An important fact to note is that the company, because of work accidents in 2008 and 2009, had a loss of 2,183 days of work. If take into account a standard time of 8 hours daily work, it shows that, in the last two years, there were 17,464 working hours that did not generate productivity, only salary and/or compensation costs.
In 2008, the accident frequency rate was very high (50.5 accidents per million man-hours worked), while in 2009 it was the severity rate (1.73 days lost per thousand man-hours worked) and the severity assessment rate (each accident involved an average loss of 74.3 days of work) that showed high values. This indicates that in 2008 there were more accidents, but had less serious consequences that the accidents registered in 2009.
Given the sector records and the company data, the incidence rate of accidents in Stigma was significantly lower than that registered in the field of metal structures manufacturing. In 2008, the sector registered an incidence rate of 149 accidents per 1,000 workers potentially exposed, while Stigma index stood at 98 accidents.
This data supports the idea put forward by the interviewees, but also happens to be the reason why the degree of concern about the level of internal accidents varied. Respondents devalued the intensity and severity of the accidents recorded at Stigma, because the company results are much better than those of the sector. It is an attitude that influences the readiness to intervene and to learn from the accidents, limiting the will and the actions to correct and to prevent anomalies in the safety system.

Table 1 – Stigma Accident Indicators

Indicators	2008	2009
Number of workers	378	343
Work accidents	38	16
Workdays lost	996	1.187
Frequency rate	50.5	23.3
Severity rate	1.32	1.73
Incidence rate	97.9	44.9
Severity assessment rate	26.1	74.3

Sources: Unified Report 2009; 2008 HSW Activities Report (internal documents).

[3] Edited by the Office of Strategy and Planning from the Ministry of Solidarity and Social Security (GEP-MSSS)

Statistical indicators helped confirm that there have been accidents in the company, so it becomes important to understand how they are handled and what impact these events have in the production of organizational knowledge. It was possible to verify the existence of an “occurrence assessment practice" and the tradition of accidents analysis (either accidents with sick leave or without). With these elements reports were produced concerning the analysis conducted. Work accidents were registered, but not work incidents; focus fell only on the situations that entailed damage reported that could prevent workers from doing their work. Although the head of HSW services defended that this situation had been thought through, and that the evolution of services could allow the integration of a procedure of that nature, its absence at the present moment appears as an obstacle to knowledge production and the improvement of procedures.
Work accidents registered were analyzed and subject to a report of occurrence. The services sought to understand what happened and what failed in the safety system for the existence of the event in question. The services collect information about the occurrence by analyzing the scenario and the testimonies (victims and witnesses). Although there is a whole *modus operandi* in terms of evaluating the events, the existence of a formal procedure of dissemination and discussion of the reports with the victims did not exist. Still, it was possible to retain occasional interventions that were performed: (i) during the process of interviews with people involved in an accident, there were some informal interventions of analysis and comments on the occurrence, where the technicians tried to provide information and to raise awareness in order to prevent recurrences; (ii) some occurrences forced the scheduling of training and information actions for the workers subject to similar situations. The nature of the intervention depended on the type of occurrence, defined according to that context. In practice, the combination of approaches in some way safeguarded organizational learning from the accidents, but it was not a systematic practice, meaning that its effects were limited.
The survey applied to workers also provided important elements about two analytic extensions mobilized. First, it allowed us to note that a significant proportion of workers had been, at least once, victims of work accidents and/or occupational disease throughout their career. This created a particular scenario, in that about 40% of the sample showed a history of accidents (49 workers), and a portion of these workers have had accidents in Stigma and in other places where they worked. That is, there was a significant history of accidents in the sample, even more relevant if we were to take into account the fact that a portion of these victims have reported that there was not a evaluation of the accident they were involved in (26.2%), and they did not received any information or training about the situation (32.3%), in other words, these workers continued to have the same resources to avoid similar events in the future. The underestimation of events such as these is a major barrier to improving working conditions and to the prevention of accidents.
The same can be said for workers not reporting small accidents. Table 2 lists a set of items used to assess perceived organizational learning by the survey respondents. One item that stands out because of the results it presents is precisely the item that analyzes the behavior of workers in this situation. Most respondents indicated that they avoided reporting small accidents (70.7%), which shows a "learning antagonism". This is so because, on the one hand, the majority defended that when an accident happened, it was discussed and they learned from it (62.7%) that accidents registered in the company had served to increase the HSW conditions (82.2%), that when an accident occurred the safety standards were readjusted (73%), and that superiors were willing to learn from accidents (84.5%). But, on the other hand, they themselves did not contribute to organizational learning. As much as the workers recognized that the company had learning ability, in practice, that learning was very relative, because part of the accidents were used at most for individual learning, since the majority of the accidents were not reported and there was not a shared reflection. A positive aspect of the conduct of the workers questioned relates to the fact that the majority argued that accidents are not inevitable (79.2%); however, 20.8% of respondents reported that little could be done to prevent accidents. This attitude represents another example of a constraining attitude to an effective organizational learning from work accidents.

Table 2 – Organizational learning from work accidents at Stigma

Items		Valid Cases						Total
		TA	SA	A	D	SD	TD	
When an accident occurs, it is discussed and we learn from it	n	11	10	53	26	8	10	118
	%	9.3	8.5	44.9	22.0	6.8	8.5	100.0
The accidents have served to increase the safety conditions in the company.	n	13	27	61	16	2	4	123
	%	10.6	22.0	49.6	13.0	1.6	3.3	100.0
When an accident occurs, the safety standards are readjusted.	n	2	15	67	16	8	7	115
	%	1.7	13.0	58.3	13.9	7.0	6.1	100.0
My superiors are willing to learn from accidents.	n	9	24	60	15	0	2	110
	%	8.2	21.8	54.5	13.6	0.0	1.8	100.0
Accidents happen, little can be done to avoid them.	n	2	3	21	50	23	26	125
	%	1.6	2.4	16.8	40.0	18.4	20.8	100.0
We avoid reporting small accidents.	n	14	15	53	24	3	7	116
	%	12.1	12.9	45.7	20.7	2.6	6.0	100.0

Legend: TA – Totally agree; SA – Strongly agree; A – Agree; D – Disagree; SB – Strongly disagree; DT – Totally disagree.
Note: In all items there were omissions in the responses, therefore the total can never correspond to the overall size of the sample (n = 130).

We applied multivariate statistics to the items listed on Table 2. Using the analysis of principal components, we extracted a factorial index on the perceived learning from work accidents (Table 3). Through the results of the Kaiser-Meyer-Olkin test (KMO), the Bartlett Sphericity Test and Cronbach's Alpha, we checked the validity of the factorial procedure performed. The first two statistical procedures "allow an evaluation of the quality of correlations between variables in order to proceed with factor analysis" (Pestana & Gageiro, 2005:489). The Bartlett test showed a statistically significant result (QQ = 115.5; df = 6; p. < 0.001), suggesting the existence of a correlation between the variables which form the factorial. Based on the KMO statistics, we confirmed that the correlation had quality (KMO = 0.749). Through Cronbach's Alpha, we confirmed that the factorial index had internal consistency.
Not all items were integrated in the calculated index, since they challenged the validity of the factorial procedure. The items considered were four and are listed in Table 3. The proportion of variance explained by the index is 60.6% (eigenvalue = 2.425). The factorial has a reasonable internal consistency (α = 0.781) and the analysis of the column regarding alpha value variation when an item is removed shows that the elimination of the last item would increase the internal consistency of the scale. However, it is an item that shows a strong correlation level (score = 0.602) and its elimination would entail a significant analytical loss, so we decided to keep it in the index.

Table 3 – Factorial index on organizational learning from work accidents (α = 0.781)

Items	Scores	Variance Explained	Alpha if Item Deleted
When an accident occurs, it is discussed and we learn from it.	0.865	60.6%	0.662
The accidents have served to increase the safety conditions in the company.	0.764		0.738
When an accident occurs, the safety standards are readjusted.	0.854		0.673
My superiors are willing to learn from accidents.	0.602		0.808

The constitution of this factorial led to an analytic deepening of the workers representations about the ability of Stigma to learn from work accidents. With the use of a multiple linear regression analysis, we were able to confirm that the model determined had explanatory power regarding the variation of the dependent variable (F = 31.677; p. < 0.001). That is, the variation in the perceived learning degree was explained by the perceived quality of the safety communication system (t = - 2.258; p. = 0.027), by the perceived quality of the safety training plan (t = 3.704; p. < 0.001) and by the perceived effectiveness of safety implementation within the company (t = 3.270; p. = 0.002). Together, these three independent variables explain 57.2% of the variation in the degree of perceived learning from work accidents.
The existence of explanatory capability derives also from the fact that these three variables are correlated with the degree of perceived learning from work accidents. It was verified that: (i) between the perceived learning degree and the perceived quality of the safety communication system there was a weak negative linear association (R = - 0.273; n = 70; p. = 0.011), indicating, for a confidence level of 95%, that the perceived learning degree evidenced by the workers tended to decrease with increase of the perception about the lack of quality in safety communications; (ii) between the perceived learning degree and the perceived quality of the safety training plan there was a strong positive linear association (R = 0.702; n = 70; p. < 0.001), indicating, for a confidence level of 99%, that the perceived learning degree evidenced by the workers tended to grow with the increase of perceived quality of training interventions in terms of HSW; and (iii) between the perceived learning degree and the perceived effectiveness of safety implementation there was a strong positive linear association (R = 0.679; n = 70; p. < 0.001), indicating, for a confidence level of 99%, that the perceived learning degree evidenced by the workers tended to grow with the increase of perceived effectiveness of safety implementation within the company.
This data informs us, on the one hand, that aspects such as a communication system, a training plan and an effective implementation of safety procedures appear to be essential for an effective perceived organizational learning from accidents. On the other hand, it shows that these matters can act as barriers to organizational learning from accidents and occupational diseases when they are not properly designed and systematized in an organization.

5. FINAL NOTES

Organizational learning from work accidents requires an organization to have mechanisms to create and leverage knowledge, and be able to elicit behavioral changes via that knowledge (Neto, 2011). When these capabilities and mechanisms are not fully implemented, the barriers to learn can be significant, perhaps even definitive.
With this case study, we were able to show a set of factors that acted as a barrier to organizational learning from work accidents, explaining how a set of resources and wills are required to develop successfully this type of processes. Through the case study of Stigma, we saw that there were several aspects that were limiting the company ability to learn from work accidents, although the company wished to take advantage of the unwanted events to improve and prevent recurrences. For example, the lack of a generalized habit of reporting certain accidents, the inexistence of a registry and technical analysis of smaller incidents and accidents, the lack of systematic procedures for disclosure, and the discussion

of events with the interested persons, the lack of systematic procedures for training and/or information on how to avoid recurrences, and low self-learning ability of some agents.

Situations such as those indicated reveal that barriers to organizational learning from work accidents may be of different nature. With the elements explored in this case, we realized there were essentially three types of barriers: structural barriers (related to the definition and functioning of organizational system), interindividual barriers (related to the interaction and sharing system of experiences and knowledge) and intraindividual barriers (related to the representation about the internal accountability mechanisms, the effective importance of own practices and the status held).

The identification of a typology such as this has the advantage of favoring a possible methodological framework that supports the theoretical development and the realization of further studies on the empirical phenomenon of organizational learning from work accidents and barriers to its fulfillment.

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Molecular biology *versus* conventional methods – Complementary methodologies to understand occupational exposure to fungi

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ABSTRACT
Fungal contamination in occupational settings is one of the main factors affecting workers health. It is known that the exclusive use of conventional methods of fungal quantification (fungal culture) may underestimate the results due to different reasons. This study aimed to determine fungal distribution and understand the occupational exposure to fungi belonging to *Aspergillus flavus* and *Aspergillus fumigatus* complex in a poultry farm. Conventional and molecular methods were used for this purpose, in order to obtain results that will allow a more complete intervention and, therefore, more effective improvements of the working conditions in this setting. A descriptive study was conducted in a poultry farm in order to ascertain the fungal air contamination using conventional and molecular methods. In order to perform conventional methodologies, six air samples of 25 liters were collected with the Millipore Air Tester (Millipore) by impact method at a velocity of 140 l / minute and at one meter height. After laboratory processing and incubation of the collected samples, quantitative (cfu/m^3) and qualitative results were obtained, with identification of isolated fungal species. For molecular analysis, air samples were collected using the Coriolis µ air sampler. Each sample, consisted in 300 L of air collected at 300 L/min. For molecular species identification, DNA from *Aspergillus* belonging to section Flavi and section Fumigati was detected by Real Time PCR using an iQ Real Time PCR Detections System (Bio-Rad) based on TaqMan fluorescence methodology. Regarding the obtained results we can conclude that the use of complementary molecular methods allows the suppression of some limitations of the cultural methods, detecting the presence of non-viable particles and identifying potential mycotoxin producers' strains.

Keywords: Fungal contamination, conventional methods, molecular methods *Aspergillus flavus* complex, *Aspergillus fumigatus* complex.

1. INTRODUCTION

Fungal contamination in occupational settings is one of the main factors affecting workers health. Implementation of measures aiming to limit its spread is therefore essential (Lugauskas *et al*. 2004).

Evaluation of health risks associated with exposure to biological agents is a very complex issue not only because of differences in individual susceptibility, but also because it must take into consideration microorganisms' biological, physiological and genetic diversity. Therefore, the adoption of universal guidelines for quantifications of fungal exposure and its impact in human health is a challenge (Sigler *et al*. 1996). Although limit values for fungal air contamination have already been proposed, these values are not consensual also because of the lack of uniformity in the environmental monitoring procedures (Green *et al*. 2006) and laboratory methods among laboratories.

It is known that the exclusive use of conventional methods for fungal quantification (fungal culture) may underestimate the results due to different reasons. The incubation temperature chosen will not be the most suitable for every fungal species, resulting in the inhibition of some species and favouring others (Zorman & Jerseck, 2008). Differences in fungi growth rates may also result in data underestimation, since the fungal species with higher growth rates may inhibit others species' growth. Finally, underestimated data can result from non-viable fungal particles that may have been collected, or fungal species that do not grow in the culture media used, although these species may have clinical relevance in the context (Bartlett *et al*. 2004; Strachan *et al*. 1990).

The use of molecular methods in the detection and quantification of fungal DNA has been increasing in the past years. However, despite molecular methods being more sensitive, specific and fast (Stetzenbach *et al*. 2004), conventional methods are still needed when it is necessary to characterize the fungal distribution in poorly studied settings.

The use of molecular methods requires a prior knowledge of the genome of the target species/ strains (Douwes *et al*. 2003). Driven by the demonstration of the practical utility of this application in clinical context and occupational health, highly significant advances have been achieved in this area in the past few years. Nevertheless, available genetic information is still scarce and scattered for many species (Horner, 2003), essentially regarding species-complexes. In addition, costs associated with molecular biology techniques are still high, which reinforce the use of the conventional methodologies. Therefore, and in parallel with molecular biology, the use of conventional methods is still recommended for fungal species confirmation (Borman, 2009).

Thus, both methods have advantages and limitations when applied to characterize occupational exposure to biological agents in different settings. However, when applied together and through technical intervention of biologists and environmental health technicians, they become complementary tools useful in the evaluation of the setting.

Regarding the determination of biological contamination in environmental samples and according to American Industrial Hygiene Association (AIHA) in 1996, the confirmed presence of the *Aspergillus flavus* and *Aspergillus fumigatus* species requires implementation of corrective measures.
It should be noted that as the most common saprophytic fungi in the air, *Aspergillus fumigatus* is responsible for severe aspergillosis, sometimes leading to affected individuals death (Yao & Mainelis, 2007). On the other hand, *Aspergillus flavus* is a complex of species known to produce mycotoxins (e.g. aflatoxin) (AIHA, 1996), some with proven carcinogenic potential.
The dispersion mechanism of spores of these species is very simple, as the conidia are released into the environment through air currents. The conidia range between 2-3 µm in diameter (Latgé 1999, 2003). On average, humans inhale hundreds of these infectious propagules daily, yet inhalation of the conidia by immunocompetent hosts rarely shows adverse effects since their immune systems are able to eliminate the fungus. Disease occurs, however, when the host response is either too strong or too weak, causing asthma, allergies or even more serious diseases (Duarte-Escalante *et al*. 2009). In highly loaded fungal environments, the exposure to fungal spores can be deleterious to human health.
This study aimed to determine fungal distribution and understand the occupational exposure to fungi belonging to *Aspergillus fumigatus* and *Aspergillus flavus* complex in a poultry farm. Conventional and molecular methods were used for this purpose, in order to obtain results that will allow a more complete intervention and, therefore, more effective improvements of the working conditions in this setting.

2. MATERIALS AND METHODS

A descriptive study was conducted in a poultry farm in order to ascertain the fungal air contamination using conventional and molecular methods. Measurements were carried out in January 2011 in two pavilions (P1 and P2) of the referred poultry.
In order to perform conventional methodologies, six air samples of 25 L were collected with the Millipore Air Tester (Millipore) by impact method at a velocity of 140 L / minute and at one meter height, using malt extract agar supplemented with chloramphenicol (0.5%) to inhibit bacterial growth.
After laboratory processing and incubation of the collected samples, quantitative (cfu/m^3) and qualitative results were obtained, with identification of isolated fungal species. Whenever possible, filamentous fungi were identified to the species level, since adverse health effects may present variations according to fungal species amongst the same fungal genus (Rao *et al*. 1996; Hoog *et al*. 2000). Identification of filamentous fungi was carried out by macroscopic examination of the culture and microscopic observation of the fungal material mounted in lactophenol blue stain and achieved through morphological characteristics listed in illustrated literature (Hoog *et al*. 2000).
For molecular analysis, air samples were collected using the Coriolis µ air sampler. Each sample consisted of 300 L of air, collected at 300 L/min, was taken into a conic sterile tube containing 10 mL of sterile phosphate buffered saline and 0.05% Triton X-100. Five mL from the collection liquid was centrifuged at 2500g for 10 min and the supernatant was carefully removed to leave a 250 µL pellet that was subsequently used for DNA extraction. DNA was then extracted using the ZR Fungal/Bacterial DNA MiniPrep Kit (Zymo Research) according to the manufacturer's recommendations. Confirmation of fungal DNA extraction was obtained by amplifying a fragment of the 18SrDNA gene with universal fungal primers (Wu *et al*., 2002). For molecular species identification, DNA from *Aspergillus* belonging to section Flavi and section Fumigati was detected by Real Time PCR using an iQ Real Time PCR Detections System (Bio-Rad) based on TaqMan fluorescence methodology. Specific primers and TaqMan probes used are described in Table 1.

Table 1: Specific primers and TaqMan probes used in Real Time PCR for DNA amplification of isolates belonging to Aspergillus fumigatus complex and Aspergillus flavus complex

		Sequence	Reference
A fumigatus complex	F	CGCGTCCGGTCCTCG	
	R	TTAGAAAAATAAAGTTGGGTGTCGG	Cruz-Perez *et al*., 2001
	P	FAM-TGTCACCTGCTCTGTAGGCCCG-TAMRA	
A flavus complex	F	GTCCAAGCAACAGGCCAAGT	
	R	TCGTGCATGTTGGTGATGGT	Mayer *et al*., 2003
	P	FAM-TGTCTTGATCGGCGCCCG-TAMRA	

For amplification of isolates belonging to *A. fumigatus* complex, reactions were prepared using iQ Supermix (Bio-Rad), 0.375 µM of each primer and 0.375 µM of TaqMan probe in a total volume of 20 µl. Amplification followed a three step PCR: 40 cycles with denaturation at 95 °C for 30 min, annealing at 53 °C for 30 min and extension at 72 °C for 30 min.

For amplification of isolates belonging to *A. flavus* complex, reactions included iQ Supermix (Bio-Rad), 0.5 µM of each primer and 0.375 µM of TaqMan probe in a total volume of of 20 µl. The same amplification protocol was used, with 52 ºC for annealing temperature. In both cases, the specificity of the primers was confirmed by testing pure cultures of different species from the same genera (*A. fumigatus*, *A. flavus*, *A. terreus*, *A. niger*, *A. versicolor* and *A. ochraceus*) and 14 other species corresponding to different fungal genera.
Samples used for the two laboratory approaches, were collected simultaneously in the two pavilions of the studied poultry farm, indoors and outdoors. Outdoor samples were considered as the reference samples.

3. RESULTS AND DISCUSSION

From the six analyzed air samples collected from the poultry unit, conventional and molecular methodologies were performed in order to detect fungal presence. Confirmation of the presence of fungal DNA was obtained by the amplification of a 425 bp (base pair) fragment of the 18S rDNA gene, using universal fungal primers, as shown in Figure 1:

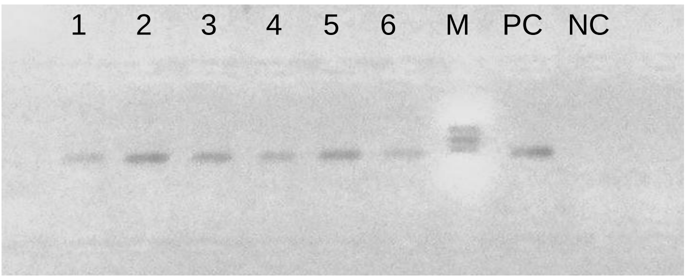

Figure 1: Electrophoresis of the fragment amplified from fungal 18S rDNA gene

M: Molecular size ladder; 1 - 6: 425 bp fragment from 18S rDNA gene amplified from the six air samples analysed; PC: positive control; NC: negative control

Specific detection of *Aspergillus* isolates belonging to section *Flavi* and section *Fumigati* is shown in Table 2.

Table 2 – Comparison between conventional and molecular detection of species belonging to Aspergillus fumigatus and Aspergillus flavus complexes in the studied poultry

		A. fumigatus complex		*A.flavus* complex	
#	Sample description	cfu/m^3	RT-PCR	cfu/m^3	RT-PCR
1	Inside P1, 1st floor entrance	0	-	>2000	-
2	Inside P1, 1st floor	0	-	>2000	-
3	Inside P1, ground floor	0	+	1600	-
4	Outside P1	0	-	+1040	-
	Other samples	+	N/A	+	N/A
5	Inside P2	0	+	200	+
6	Outside P2	0	+	20	+
	Other samples	+	N/A	+	N/A

P: Pavilion; N/A: Not Applicable

Regarding the results obtained by conventional methods, and from all the fungal species detected in cultures, 72.0% of the isolates belong to *Aspergillus flavus* complex. *A. flavus* were isolated in all the air samples collected. Using molecular methods, however, only two of the six analyzed air samples were positive to species belonging to *Aspergillus flavus* complex, corresponding to in the indoors and outdoor air samples from Pavilion 2. This apparent discrepancy in the results obtained using different methodologies can be explained by the molecular strategy adopted, since only toxigenic strains (aflatoxin-producing) were investigated within the group of species belonging to *Aspergillus flavus* complex. Actually, *A. flavus* specific primers and TaqMan probe used in this study were designed targeting nor-1 gene (Mayer *et al*. 2003), which codes a protein that takes part in the aflatoxin biosynthetic pathway. While some species belonging to the section Flavi complex present a complete functional nor-1 gene, and are therefore aflatoxin producers, others are atoxigenic because they either lack nor-1 gene or have an incomplete gene sequence (Cary & Ehrlich, 2006). Also, there are a number of *Aspergillus* species that produce aflatoxin but are not classified as section Flavi (Bhatnagar *et al*. 2006).

The use of both methodologies allowed us to establish a strategy for identifying a potential exposure of the workers (in this case of the poultry farm) not only to fungal particles, but also to the possible presence of mycotoxins produced by aflatoxin-producing species. Thus, these two methodologies used in parallel provide additional information useful in the evaluation of occupational exposure.

Considering the *Aspergillus fumigatus* complex, conventional methods failed to isolate any species in all of the collected samples. Nevertheless, the use of molecular methods showed positive results in three of the samples. The lack of positive cultures belonging to Fumigati section, may be due to growth inhibition caused by other species present in culture with higher growth rates (Bartlett *et al*. 2004; Strachan *et al*. 1990). This situation does not apply when using molecular methodologies, since in this last case any fungal particles in the sample can be detected, regardless their state of growth or even viability. This allows the sampling of a larger air volume, obtaining a more representative sample regarding fungal composition of the environment.

It is also important to note that although isolates belonging to *A. fumigatus complex* were not detected by conventional methods in the six air samples collected, its presence was confirmed inside the two pavilions in other types of samples (coating of rice husk and wood chips) (other samples - Table 2). We can therefore speculate that these isolates located on different surfaces may release to the air small amounts of spores or even non-viable fungal particles impossible to detect by conventional culture, but likely to be identified by molecular methods.

Amongst the filamentous fungi, *Aspergillus* species have been strongly linked with exacerbations of asthma and other respiratory allergic diseases. Over 80% of *Aspergillus*-related conditions, such as extrinsic allergic alveolitis, asthma, allergic sinusitis, chronic eosinophilic pneumonia, hypersensitivity pneumonitis, SAFS, and allergic bronchopulmonary aspergillosis (ABPA) are most frequently caused by *A. fumigatus* (Chaudhary & Marr, 2011).

In the case of a possible fungal occupational exposure through inhalation, conventional methods offer the advantage of enabling identification and quantification only of viable microorganisms and, therefore, the ones causing higher risk for workers health (Samson *et al*. 2000).

It is suggested that fungal levels found indoors should be compared, quantitatively and qualitatively, with those found outdoors, due to the strict influence of the last one on the first (Gelincik *et al*. 2005; Bush & Portnoy, 2001). In this study, samples from outdoor air next to the pavilions were obtained and it was possible to quantitatively (CFU/m^3) compare indoor air fungal composition with the outside air. In one of the pavilions, three indoor samples had a higher fungal burden than outdoor, (in accordance with the study by Plewa & Lonco (2009)) and the other pavilion's outdoor sample presented higher levels of cfu/m^3. Regarding qualitative comparison of both environments, only one species was different from the ones isolated from outdoors (*Rhizopus* sp.). Qualitative comparison between indoor and outdoor air samples aims to identify possible sources of contamination within the premises. When different species are detected between indoor and outdoor air, molecular biology can complement the conventional methods used to identify potentially toxinogenic strains and to confirm results of a possible fungal contamination from internal sources. In the poultry farms case, these sources may be various, including birds (Scheff *et al*. 2000), floor cover, food or other specific activities as changing the floor covering.

4. CONCLUSIONS

Application of conventional methods allows the characterization of the composition of fungal flora in a poultry farm. By comparing data, quantitatively and qualitatively, with the reference site (outdoor air sample), this method allows the assessment of air fungal contamination in the studied setting. The use of complementary molecular methods allows the suppression of some limitations of the cultural methods, detecting the presence of non-viable particles and identifying potential mycotoxin producers' strains.

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Influence of ventilation type in microbial volatile organic compounds exposure – Poultry case

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ABSTRACT
Agricultural workers especially poultry farmers are at increased risk of occupational respiratory diseases. In poultry production volatile organic compounds (VOCs) presence can be due to some compounds produced by fungi that are released directly into the air. These are known as microbial volatile organic compounds (MVOCs).
Some studies have demonstrated that a better control of ventilation could reduce workplace exposure to contaminants and thereby, diminish the occupational risk of respiratory diseases in agricultural workers.
The purpose of this study was to know the influence of ventilation resources (natural or mechanical) present in pavilions of poultry establishments in MVOCs concentrations.
Eleven pavilions from different poultry farms were studied. MVOCs concentrations were measured in all of them and ventilation resources existed in pavilions were listed and define as natural or mechanical.
It was used a direct-reading equipment (Multirae) to measured MVOCs concentration with a 10.6 eV lamps. The measurements were done near workers nose and during some of the activities developed inside the pavilions.
There wasn't found statistical difference in MVOCs concentration values between pavilions with natural and mechanical ventilation (Mann-Whitney Test). However, concentrations results shows a tendency to pavilions with natural ventilation have higher concentrations.
Ventilation of lifestock buildings can be an important factor influencing exposure to MVOCs. Probably also influence exposure to other contaminants existing in this occupational setting.
Further studies are necessary to know specific MVOCs present and, also, investigate ventilation influence in contamination by other risk factors present in this occupational setting.

Keywords: Poultry; MVOCs; Fungi; Ventilation.

1. INTRODUCTION

Agricultural workers especially poultry farmers are at increased risk of occupational respiratory diseases. Epidemiological studies showed increased prevalence of respiratory symptoms and adverse changes in pulmonary function parameters in poultry workers (Iversen et al., 1989; Linaker & Smedley, 2002; Radon et al., 2001; Radon et al., 2002; Rylander & Carvalheiro, 2006; Cormier, 2007; Rimac et al., 2010; Rask-Andersen, 2011).
Agricultural operations, such as animal feeding, increase farmers' risk of exposures to airborne dust and microorganisms like fungi (Dinis et al, 2007). Besides that, in Portugal there is an increasingly industry of large facilities that produce whole chickens for domestic consumption. Although much research has been done on microbial contaminants associated with the various stages of processing poultry and meat products (Dinis et al., 2007; Culvenor et al., 1989), only few investigations have reported on the indoor air of these plants (CAST, 2003).
In this occupational setting, volatile organic compounds (VOCs) presence can be due to some compounds produced by fungi that are volatile and are released directly into the air. These are known as microbial volatile organic compounds (MVOCs) and are produced in the metabolism of microorganisms such as fungi and bacteria. MVOCs are formed during both the primary metabolism (from the synthesis of DNA and amino and fatty acids, for example) and the secondary metabolism (from intermediates of the primary metabolism) as side-products, mainly in the metabolic oxidation of glucose from various intermediates (Korpi et al., 2006). Thus, the production of MVOCs is greatly affected by microbial species, growth phase and conditions such as nutrients, pH, humidity and temperature (Larsen and Frisvad, 1994; Whillans and Lamont, 1995; Pasanen et al., 1996; Korpi et al., 2009).
Concern about possible health risks related to MVOCs exposure in indoor environments was raised in the 1990s. As eye and upper-respiratory-tract irritation was frequently reported by occupants in buildings with moisture and mould damage, these symptoms were concluded to be associated with exposure to irritative substances of microbial origin (Burge, 1990; Korpi et al., 2009).
Korpi et al. (1999) determined the potential of three microbial volatiles, 1-octen-3-ol, 3-octanol, and 3-octanone, to decrease the respiratory frequency of mice by 50% (RD50 value). The data supported the conclusion that a mixture of MVOCs may have synergistic effects, which constrains the interpretation and application of recommended indoor air levels of individual MVOCs (Fischer and Dott, 2003).

Nevertheless, much less attention has been paid to MVOCs and their possible adverse health effects in work environments with productive microbial sources or high levels of contamination, like in poultry, where the occurrence of at least some MVOCs is obviously more abundant than in indoor environments (Korpi et al., 2009).
The identified and most common MVOCs are alcohols, ketones, terpenes, esters, lactones, hydrocarbons, aldehydes, sulphur and nitrogen compounds (Table 1) (Larsen and Frisvad, 1995; Wilkins and Larsen, 1995; Jelen and Wasowicz, 1998; Korpi et al., 2006; Korpi et al., 2009).

Table 1- A compilation of relevant MVOCs (Adapted from Korpi et al., 2006)

Group	Chemical
Alcohols	1-Butanol ;4-Decanol; Ethanol; 2-Ethyl-1-hexanol; 2-Heptanol;1-Hexanol; 2-Methyl-1-propanol;2-Methyl-1-butanol;3-Methyl-1-butanol; 3-Methyl-2-butanol;1-Octanol; 3-Octanol;1-Octen-3-ol; 2-Octen-1-ol;1-Pentanol; 2-Pentanol;1-Propanol
Aldehydes	Acetaldehyde ; Acrolein ; Benzaldehyd;Decanal; Formaldehyde; Heptanal; Nonanal; Octanal; Phenylacetaldehyde
Hydrocarbons	Benzene; Ethylbenzene;1-Heptene; Toluene;1-Methyl-4-methylethyl benzene; 2-Methyl-1,3-butadiene;1-Nonene;1,3-Octadiene; 1-Octene; Styrene; Xylenes
Acids	Acetic acid; Octanoic acid
Ethers	Anisole; 1,3-Dimethoxybenzene;2,5-Dimethylfuran; 1-Methoxy-3-methylbenzene;1-Methoxy-3-methylbutane; 2-Methylfuran;3-Methylfuran; 2,3,5-Trimethylfuran
Esters	Ethyl acetate; Ethyl-2-methylpropionate; Ethyl propionate; Methyl acetate; 3-Methyl-1-butylacetate; Methyl-2-methylpropionate; Propyl acetate
Ketones	Acetone; 2-Butanone; Cyclopentanone; 2-Heptanone; 2-Hexanone; 3-Hydroxy-2-butanone; 3-Methyl-2-butanone 3-Methyl-2-pentanone; 4-Methyl-3-hexanone; 2-Nonanone; 2-Octanone; 3-Octanone; 2-Pentanone; 3-Pentanone; 2-Undecanone
Lactones	γ-Decalactone
Terpenoids	Acoradiene; β-Bisabolene; Cadinene; Δ3-Carene; Camphene; β –Caryophyllene; β –Chamigrene; α-Curcumene; β –Elemene; α –Farnesene; Geosmin; α –Gurjunene; Limonene; Longifolene; 2-Methylisoborneol; β –Phellandrene; α –Pinene; β –Pinene; Thujopsene; Trichodiene
Sulphur and nitrogen compounds	Dimethyl disulphide; Dimethyl trisulphide; 2-Isopropyl-3-methoxy-pyrazine; 2-Methoxy pyrazine

The production of certain fungal MVOCs has also been suggested to be associated with mycotoxin production. Evidence of such relations has been reported between the sesquiterpenes and aflatoxins, between monoterpenes, sesquiterpenes and trichothecenes, and between ketones and ochratoxins (Zeringue et al., 1993; Jelen et al., 1995; Pasanen et al., 1996; Demyttenaere et al., 2003, 2004; Wilkins et al., 2003). Chemical reactions in the environment may further convert the produced MVOCs into other compounds. For example, alcohols are easily oxidised to aldehydes and further to carboxylic acids (Wilkins et al., 1997), and ketones may react with hydroxyl radicals in the air to form aldehydes (Atkinson et al., 2000). Chemical reactions may also produce MVOCs in the atmosphere; the reactions between ozone (and other oxidants) and unsaturated hydrocarbons (isoprenes/terpenes) have recently been investigated experimentally. The main products in these reactions are aldehydes, ketones, and organic acids, but the intermediate products formed

during the reactions have been suggested to be much more irritating than the corresponding original reactants and end-products (Wolkoff et al., 1999, 2000; Weschler, 2000).
Ventilation is the process by which indoor air is replaced by the admission of fresh air and the exhaustion of stale air, by natural or mechanical means. Some studies (Radon et al., 2001; Radon et al., 2002) have demonstrated that a better control of ventilation can reduce workplace exposure to contaminants and thereby, diminish the occupational risk of respiratory diseases in agricultural workers.
The purpose of this research was to know the influence of ventilation resources (natural or mechanical) in MVOCs concentrations and, consequently, in poultry workers exposure.

2. MATERIALS AND METHODS

Eleven pavilions from different poultry farms were studied between January and May 2011. MVOCs concentrations were measured in all of them. This assessment was carried out in the winter, when usually ventilation rates (natural and mechanical) are lower, in order to measure the highest extent of exposure. Ventilation reduction is a common measure applied to avoid disease in birds.
It was used a direct-reading equipment (Multirae - RAE Systems with isobutylene as calibration gas) to measured MVOCs concentration by photo ionization detection, with a 10.6 eV lamps. Every VOCs that have ionization energy below this value were measured by the equipment. The measurement range is 0 to 2,000 ppm with 0.1 ppm resolution.
Before each measurement a detailed observation was made to pavilions and nearby zone to identify possible VOCs emissions sources. Taking into a count that there wasn't observed any direct emission source of VOCs, all the results were consider as MVOCs. During measurements ventilation resources existed in pavilions were listed and classified as natural or mechanical.
Measurements were done continuously and had the duration of 5 minutes at least. It was consider the higher value obtained in each measurement.
All measurements were performed near workers nose and during routine management of the facility, activity done frequently (2 a 3 times per day) and, cover a range of tasks performed sometimes at the same time. Some of the tasks are inspection, removal of unhealthy birds, weighing, beak trimming, vaccination and others. The presence inside the pavilion to perform each routine management has normally the duration of 30 minutes to 1 hour. During measurements, in all poultry units, workers were not using respiratory protection devices.

3. RESULTS AND DISCUSSION

There wasn't found statistical difference in MVOCs concentration between pavilions with natural and mechanical ventilation after applying statistical test (Mann-Whitney Test). However, concentrations results demonstrated a tendency for pavilions with natural ventilation have higher MVOCs concentrations (Table 2).

Table 2 - MVOCs concentrations results (ppm)

		VOCs concentration			
		Minimum	Maximum	Mean	Standard Deviation
Ventilation Type	Natural (n=11)	0.00	1.70	0.48	0.57
	Mechanical (n=7)	0.00	0.50	0.27	0.21

According to data obtained by several studies, fungi e.g. *Candida albicans, Aspergillus niger, A. nidulans, Penicilium sp.* and *Mucor sp. Penicillium sp., Candida sp. and Cryptococcus sp.* are prevalent in poultry houses (Agranovski et al., 2007; Crook et al., 2008; Lonc & Plewa, 2009; Soliman, 2009; Viegas et al., 2011) and all these fungi are known as MVOCs producers (Fischer et al., 1999; Frisvad et al., 2007).
Recently, industrial hygienists are beginning to use VOC analysis to search for MVOCs as markers of microorganism overgrowth indoors (Ammann, 1999, Gao et al., 2002). To date, researchers have identified a number of VOC that are unique to fungi and bacteria. The most frequent and unique compounds are: 2-Hexanone, 3-Methyl-1-butanol1-Butanol, 2-Methyl-1-propanol, 3-Octanol, 2-Octen-1-ol, Dimethyl disulfide, 2-Pentanol, Geosmin, 2-heptanone, 3-methylfuran, 2-methyl-2-butanol, 3-octanone and 1-octen-3-ol (Wessén and Schoeps, 1996).
For instance, in the case of *Aspergillus*, specie mentioned as common in this occupational setting, nine of these chemicals are associated with *Aspergillus* presence, namely 3-Methyl-1-butanol, 2-Methyl-1-propanol, Terpineol, 2-Heptanone, 1-Octen-3-ol, Dimethyl disulfide, 2-Hexanone, 3-Octanone and 2-Pentylfuran (Gao et al., 2002).
Considering *Penicillium* species, other common specie in this setting, there are also some related MVOCS, in particular terpenes, specifically iso-longifolene, (+)-thujopsene, 10-epi-β-acoradiene, β-chamigrene and widdra-2,4-diene (Karlshoj and Larsen, 2005; Jeleń, 2002).
Although in our study was not possible to determine the precise MVOCs present, because insufficient sensibility of measurement equipment, it's important to consider that these substances are significant indicators for air pollution caused by fungi. Moreover, an estimate of exposure is a basic prerequisite for an evaluation of a possible health risk. Moreover,

analyses of MVOCs in air and dust, in addition to fungal spores and mycotoxins, allow a more precise evaluation of possible health risks (Larsen and Frisvad, 1994; Fischer et al.,1999; Fielder et al., 2001).

Nevertheless, is important to reflect that MVOCs possess an unspecific nature in field settings, because the same compounds may also originate from other sources, like building materials, human metabolism, cleaning, traffic, foodstuffs, smoking, vegetation and others depending of the studied setting and activities developed (Helmig et al., 1999; Phillips et al., 1999, Schleibinger et al., 2003, Korpi et al., 2006). However, during each field measurements none of these sources were identified.

In addition, taking into consideration measurement equipment use in the study, it’s necessary to deal with uncertainty because of the non-specificity of the response for chemical mixtures. So, for knowing the relative concentration of the mixture components a number of measurements by a specific method (e.g. charcoal tubes with chromatographic analysis) should be carried out. Furthermore, a 10.6 ev lamp only detected gases with lower ionization potential values and, therefore, there is a possibility that some mixture components were not consider.

As in other studies, our study demonstrated that the type of ventilation resources influences exposure to VOCs. In this case, mechanical ventilation probably contributes to reduce MVOCs concentration. There are many options but it seems that mixing natural with mechanical ventilation have the best results to reduce exposure and guarantee animal health (HSE, 2009). Moreover, using temperature and humidity as ventilation control sensors is associated with reduced exposure to fungi, MVOCs and other contaminants resulting from microbial presence (Radon et al., 2001).

Many of the tasks develop in poultry pavilions cause exposure to airborne contaminants (MVOCs, particles, microorganisms, mycotoxins) and involve significant physical activity, often in areas of restricted access. This combination of factors imposes limitations on what respiratory protection device can practicably be worn, and many tasks are at present performed without any kind of protection. To prevent exposure to these contaminants workers need to be encouraged to wear respiratory protective equipment, particularly when developing activities inside of pavilions.

4. CONCLUSIONS

Ventilation of lifestock plants has been demonstrate to be an important factor to prevent exposure to MVOCs and also to other contaminants existing in this occupational setting. Although of small dimension, our study corroborates this influence.

Further studies are necessary to know specific MVOCs present to estimate potential health effects and more accurate risk assessment. Until now, there has been no evidence that MVOCS are toxicologically relevant, but additional epidemiological research is necessary to elucidate their role on human’s health, particularly in occupational settings where microbiological contamination is common.

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Usability principles applied to the design of a social benefit internet portal

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ABSTRACT
It is commonly know that many times technology can stop users from doing things more easily, and becoming annoying and frustrating. The World Wide Web is a source of many examples of poor usability, where the lack of it is especially important in users with low literacy and computer use. Social exclusion of poor peripheral metropolitan neighbourhoods gets larger with the lack of opportunities, in part due to the fact of having limited access to the information necessary to improve the quality of life. A group of housewives and students from poor peripheral neighbourhoods of metropolitan Chile participated in a user center design process to get optimum usability out of the design of an internet portal. Three test were performed, two with a low fidelity prototype (T1, T2) and one with a high fidelity prototype (T3) using a netbook. Efficiency, efficacy, satisfaction and ease of use were measured. The housewives group was the one that got better results regarding efficiency (29% improvement) however students had a deterioration of (7%). Efficacy was kept during T1 and T2 for both groups; however during T3 one housewife out of four had an unassisted completion rate of 70%. Satisfaction and ease of use was kept as at least easy and at least satisfied during T1 and T2, but during T3 while rating ease of use 4 out of 8 subjects found it not too easy and not too difficult to use, while the other 4 found it at least easy. These findings show that usability can be achieved using low cost methods, however good presentation for some user might not be ideal for others and also that using netbook devices with low computer skill user might have a negative impact in user experience.

Keyword: Usability, user centered design, low literacy users.

1. INTRODUCTION

The segregation of public housing in developing countries brings as a consequence a socio-spatial exclusion, where large areas of the population are barely provided with the necessary services and products, being the more important the lack of active social support nets, such as quality educational and health facilities, good and stable work opportunities, legal and social advice, among others; all of them considered a source of wealth for their own (World Bank, 2007). This segregation it is increased by the digital gap due to the lack of access to web connectivity by the population living in peripheral urban areas, thus putting further away those valuable opportunities to the people that need it most (Mideplan, 2006).
It is well known that new technology can confuse people rather than helping them, up to the point of making tasks more difficult and irritating (Hall, 2001). For that reason if a successful design it is to be achieved, both easiness of use, efficiency and a pleasant experience must merge into a determined system (Nielsen, 1994a; Norman, 2002; Shackel, 1989).
Usability can be defined as how well users can use the different functions of a product (Nielsen, 1994). In order to succeed with Nielsen´s statement it is necessary to account for the huge diversity present among people such as skill level, social background, motivations, personality, culture and working stiles, making a fundamental step in developing virtual systems focusing the process early on end users (Schneiderman, 2004).
The aim of this study was to generate a web based social integration tool for the most impoverished neighbourhoods of Chile applying principles of usability and participatory user centered methods, in order to achieve optimum performance and systems´ use.

2. METHOD

2.1. Sample

In the three tests, 24 users from small peripheral urban area in the Santiago region were tested (18 female, 6 male) with ages ranging from 14 to 48 years old (mean 27.1±11.7). The best results come from testing no more than 5 and no less than 2 user, and running as many small tests as possible (Nielsen et al., 1993). After giving written and verbal information about the study to the participants, written authorization was obtained from them. It should be noted that the sample was a sample of convenience.
Their educational level was diverse: from school students and housewives with unfinished elementary school. The selection was based on the information that housewives run the critical operation of the house and that secondary students use the most the computer, and not many go to tertiary education due to the lack of opportunities (Centro Innovación, 2009). These groups had diverse needs regarding computer and internet use, as well as computer skill level. The housewives group had low literacy and computer skills than the students group, in fact from the whole housewives group 5 out 12 had never used a computer before, this difference was present mainly during T3 where 3 out of 4 (75%) had never used a computer. This was actually more valid since many house wives had the lower computer skills from those excluded communities (Centro

Innovación UTPCH, 2010; J-Pal Latam, 2010 focus groups). In those cases, a few minutes of familiarization and training on computer use was done in order to give a better understanding on computer use and how it worked. Also the program that funded this project included a posterior stage of training on basic computer skills for the housewives.
Based on this diversity is that 4 main users (housewives) and 4 secondary students were selected for each test. In testing multiple groups of disparate users the overlap between observations will ensure a better outcome from testing a smaller number of people in each group, where 3-4 from each category if testing 2 groups of users is the ideal (Nielsen et al., 1993). In this study, the main persona was the housewives group, labelled as “weak” since in Chile this demographic group (over 18 years of age and lower income quintiles) had never used a computer (Mideplan, 2006).

2.2. Procedure

Testing procedure was done according to ISO 25062:2006. The development of the contents and information structure was done based on the results of focus groups done by J-PAL Latam. The main end user identified was the housewife, who carries out most of the high impact tasks for the home, which is providing the main income, seeking for education and healthcare options (Centro Innovación UTPCH, 2010; J-Pal Latam, 2010 focus groups). High school and tertiary students usually used internet to seek information for homework’s, download music and usually helped their mother to find information (Centro Innovación UTPCH, 2009). A Persona was developed for the housewives in order to guide the design team (Preece et al., 2007; Nielsen, 1993).
Based on these findings those tasks were transformed into scenarios with tasks related to finding healthcare, education and work information (ISO 25062:2006; Nielsen, 1994a; Potosnak, 1988; Preece et al., 2007). The tasks can be seen in table 1. Task 4 under “Work” was only performed by housewives. Task 2 is identical but depending on the subject, student or housewife, they were assigned to search for a degree or a childcare center respectively, based on their needs.

Table 1 – Task to be achieved by the subjects on each category

Health	Education	Work
1. Finding information about a specific disease(drugs included)	1. Finding information about tertiary studies admission´s test	1. Finding a job through a job web site
2. Finding out if a specific disease was covered by government funds	2. Finding information about a specific degree or childcare center.	2. Finding out how to make a CV
		3. Advertising a service or product on the web
3. Finding out the working hours of nearest health center	3. Finding help regarding financial aid for studying	4. Finding information on how to start your own business

Subjects had to fulfil the tasks asked from them using the interface. The scenarios were read out loud, after the instruction to proceed, time was measured using a stopwatch, stopped after each task was finished and time noted. The Think Aloud technique was used during the test to get insights on issues (Preece et al 2007). This was complemented by the completion of a user satisfaction questionnaire with a debriefing part were subjects could comment openly on their thoughts about their experience (ISO 25062:2006, Nielsen 1994a, Preece et al, 2007, Shneiderman, 2004).
The scenarios read to the housewives group and to students can be seen in table 2 and table 3 respectively.

Table 2 – Scenarios used with housewives

Health	Education	Work
1. Winter is coming and kids are the most vulnerable, you would like some advice on how to prevent that they get sick	1. You would like to help your son to prepare for the tertiary studies admission´s test	1. Your mom asks you for some help to get a job with a higher pay
2. A member of your family has a chronic disease and you would like to know if it´s covered by the government	2. You just got a job from 9 to 17 and you would like to take your smallest child to a childcare center that´s nearest from your home	2. When you try to apply for a new job you realize that they require a CV and you would like information on how to make one
		3. You have a trade/product that you would like to offer on the web
3. You have to take one of your kids to the nearest health facility and would like to know which one is it and is opening hours	3. One of your kids got into Engineering and you would like to know the options to pay for the studies	4. You would like to know how to start a small business

Table 3 – Scenarios used with students

Health	Education	Work
1. You have a friend that has issues with drugs and you would like some info on how to help him 2. Your mom is sick and you would like to know if that specific illness she has is covered by the government 3. Your mom has to take your little brother or sister to the hospital to get checked, she asks you to find out where is the nearest facility and what are it´s opening hours	1. This year you have to take the PSU test, and you would like some help to prepare for it 2. You would like to get in to Law studies and you would like to know which universities offer the degree and which are the best ones 3. You would like to know how can you pay for your studies once you get in	1. You would like to get a part-time job to help with the expenses at home 2. When you try to apply for a new job you realize that they require a CV and you would like information on how to make one 3. Your mother asks you some help to promote her product or trade on the web

In total three user tests were performed, the first two (T1 and T2) with a paper based low fidelity prototype and the third test (T3) was done with a fully operational functional prototype (Kelley, 2001; Preece et al, 2007). T3 was done with a Lanix Neuronlt netbook device loaded with Windows 7 Starter Eight subjects per testing were used. All three tests were performed at the subjects' houses. Only T1 and T2 were compared fully between them since it would be invalid to compare paper based performance (eg. time) with those of a fully functional prototype. However, some usability issues found using the high fidelity prototype can be compared with the ones on the low fidelity prototype, like not understanding words, abbreviations or similar (Nielsen, 1994 a; 1994b; 1994c).

2.3. Outcoming measures

Efficiency, Efficacy and Satisfaction/Ease of use were the main outcomes for every test (ISO 25062:2006). The specific usability metrics used for each criterion can be seen in Table 4.

Table 4 – Usability Metrics

Efficiency	Efficacy	Satisfaction & Ease of use
Task completion mean time (s) Total tasks completion mean time (s)	Task completion rate (in %) with and without assistance	Number of users rating in a 5 point Likert scale the experience regarding satisfaction and ease of use.

The measurements were done only to test the portal, since it acted as a distribution site to many government agencies and private companies, each one with their own interfaces, and since escaping the scope of the tests performed. The task was considered successful once subjects achieved the level under which the information laid.

Efficiency results for T1 and T2 were compared using the geometric mean, showing percentual values of positive or negative performance (Nielsen, 2001).

The procedure implied to obtain the relative percentages for the average time per task during T1 and T2. Then (T1/T2)*100 gives the relative percentage for each task B subtracting the relative percentage from 100 the improvement or deterioration is obtained in %. The formula for the geometric mean is given below in Figure 1:

$$\bar{x} = \sqrt[n]{\prod_{i=1}^{n} x_i} = \sqrt[n]{x_1 \cdot x_2 \cdots x_n}$$

Figure 1- Geometric mean formula

From figure 1 can be seen that the geometric mean is obtained by getting the n- root of n number of relative percentages, thus giving a value where, if any number is higher than 1 implied the difference from 1 implied a percentual improvement in efficiency and vice versa if the value is inferior to 1.

All issues found during the user tests were noted in an Issues List, describing the issue, rating its severity and the heuristic that it violated (Nielsen, 1994 b; 1994c).

3. RESULTS AND DISCUSSION

3.1. Efficiency

After the redesign of T1 paper based prototype overall efficiency results, as it can be seen in table 5 increased by 29 % on the housewife´s group, however decreased 3% in the students' group (See table 6). Note also from table 5 that task 2 under Work (making a CV) improved by a 502% mainly by changing "CV" by "Curriculum Vitae", however task 1 under Work (getting a new job) had a deterioration in both groups (-64% housewives, -53% students) mainly because of a word change of the title that was corrected for T3. There should be a new test with a high fidelity prototype to see the effects.

Table 5 – Housewives efficiency (time in seconds)

Tasks	Average time per task		Relative %	Improvement/ deterioration	Geometric mean	Overall result
Work	**T1**	**T2**				
Task 1	33	89	36	-64	1.29	+29
Task 2	89	15	602	502		
Task 3	34	36	96	-4		
Task 4	47	25	186	86		
Health						
Task 1	71	64	111	11		
Task 2	43	18	234	134		
Task 3	35	16	227	127		
Education						
Task 1	22	51	43	-57		
Task 2	31	40	76	-24		
Task 3	29	18	163	63		

Table 6 – Students efficiency (time in seconds)

Tasks	Average time per task		Relative %	Improvement/ deterioration	Geometric mean	Overall result
Work	**T1**	**T2**				
Task 1	15	32	47	-53	0.97	-3
Task 2	41	32	129	29		
Task 3	86	30	283	183		
Health						
Task 1	17	35	48	-52		
Task 2	49	40	123	23		
Task 3	33	55	59	-41		
Education						
Task 1	28	42	67	-33		
Task 2	26	23	113	13		
Task 3	11	7	167	67		

Housewives had higher total test completion mean time (Test 1 = 432 s; Test 2= 371s) than students (Test 1= 306 s, Test 2= 295 s). The results can be seen in detail in table 7.

Table 7 – T1 housewives group (time in seconds)

Tasks	S1	S2	S3	S4	Xbar	S1	S2	S3	S4	Xbar
Work		**T1**					**T2**			
Task 1	40	20	34	36	33	41	56	230	30	89
Task 2	107	128	100	20	89	24	7	8	20	15
Task 3	16	28	69	23	34	38	48	41	15	36
Task 4	83	18	30	55	47	16	21	45	18	25
Health										
Task 1	63	28	144	50	71	54	47	116	40	64
Task 2	15	35	106	15	43	16	14	25	18	18
Task 3	17	10	58	56	35	31	11	12	8	16
Education										
Task 1	13	20	20	35	22	58	45	48	52	51
Task 2	23	29	48	22	31	22	102	25	11	40
Task 3	17	21	67	9	29	9	35	16	10	18
Total test completion time	394	337	676	321	**432**	309	386	566	222	**371**

Table 8 - T 2 Students group (time in seconds)

Tasks	S1	S2	S3	S4	Xbar	S1	S2	S3	S4	Xbar
Work		**T1**					**T2**			
Task 1	5	18	8	30	15	17	72	20	20	32
Task 2	97	20	39	8	41	75	16	15	21	32
Task 3	126	44	51	122	86	67	19	19	16	30
Health										
Task 1	27	15	20	5	17	5	66	18	50	35
Task 2	95	17	63	22	49	26	24	97	13	40
Task 3	75	7	22	26	33	51	48	69	51	55
Education										
Task 1	33	25	30	23	28	82	26	41	17	42
Task 2	48	19	22	15	26	15	11	19	47	23
Task 3	12	10	15	8	11	4	8	7	8	7
Total test completion time	518	175	270	259	**306**	342	290	305	243	**295**

3.2. Efficacy

Completion rate was kept at a 100% without assistance in the first two tests for the two groups. This is very important since more that time subjects in a non working environment want to achieve goals in a reasonable time (Nielsen, 1994; 2001a; 2001b). Only during the T3 using a netbook is that subjects needed some assistance, however it only implied some clarification on the meaning of words and/or acronyms. Table 9 shows efficacy the results of T3.

Table 9- Task efficacy (U: completed unassisted, Assist: completed with assistance)

Tasks	Housewives				Students			
Work	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
Task 1	U	U	U	U	U	U	U	U
Task 2	U	U	U	U	U	U	U	U
Task 3	U	U	U	U	U	U	U	U
Task 4	U	U	U	U	--	--	--	--
Health								
Task 1	U	Assist	U	U	U	U	U	U
Task 2	U	Assist	U	U	U	U	Assist	Assist
Task 3	U	U	U	U	Assist	U	U	U
Education								
Task 1	U	Assist	U	U	U	U	U	U
Task 2	U	U	U	U	U	U	U	U
Task 3	U	U	U	U	U	U	U	U
Completion rate	100%	70%	100%	100%	90%	100%	90%	90%

Notice that only one subject (S2) from the housewives group had an unassisted completion rate lower than 100%. In the students group 3 out of 4 had an unassisted completion rate of 90%. Notice than in both groups task 2 under health category was the one with more assists, this was due mainly because subjects did not know what AUGE was, which is the government funding program for certain illnesses to be cost free of treatment for any chilean citizen.

3.3. Satisfaction and ease of use

Results from the questionnaires and debriefing showed that users were at least satisfied and found at least easy to interact with the paper based prototype. With the fully functional netbook prototype all subjects referred to be at least satisfied with it but regarding ease of use 4 out of 8 subjects found it not too easy and not too difficult to use, while the other 4 found it at least easy. This reduction in the perception of users might be due the fact that during T3 3 out of 4 subjects had never used a computer before and also the negative contribution to usability caused by reduced screen devices and discomfort is well known (Sommerich et al.2002, Ziefle 2010)

3.4. Issues List

After the second iteration many of the issues found on the first test disappeared, however at the moment of doing the third test with a high fidelity prototype (netbook) an old issue reappeared related specifically with information visibility and a too small font size, and a new one related to the use of mouse pad. The issues list can be seen on table 10.

Table 10- Issues list

Issues	T1								T2								T3							
	Students				Housewive				Students				Housewives				Students				Housewives			
	S 1	S 2	S 3	S 4	S 1	S 2	S 3	S 4	S 1	S 2	S 3	S 4	S 1	S 2	S 3	S 4	S 1	S 2	S 3	S 4	S 1	S 2	S 3	S 4
Confuses category because margins not well defined	x																							
Doesn´t understand the acronym CV	x	x	x		x																			
Thinks that fonts are hard to see (too small)					x												x	x				x	x	x
Doesn´t know what Auge is (government health fund)				x															x		x	x		
Does not understand the term business incubator							x	x																
Selects non clickable headers														x		x								
The mouse pad is hard to use																								x

Notice from the issues list than the most common issues were related to size of the fonts. This issue was resolved after T1, however reappeared with a higher frequency during T3. Students (2 out of 4) and mainly housewives (3 out of the 4) thought the fonts were small using the netbook device. This issue is not by chance, since it is well known that netbook and other small screen devices have usability problems that range from postural discomfort to a higher incidence of mistakes, mainly due to the reduced size of the screen and keyboard (Sommerich et al.2002, Ziefle 2010). Small screens have the mayor issue of making the content to be seen splitted and having a small font size (Ziefle 2010).

The second most common issue had to with subjects not knowing what Auge was, but notice how during T3 using the netbook device is that the frequency increased. This can be mainly attributed to the intense splitting of the screen, making people scroll down, thus making it more difficult to easily see the information at the bottom of the screen which was the case here. Studies indicate that users allocate their attention to the top part by 80% and only 20 % to the bottom part (Nielsen 2010), this gets more relevance if relevant information is placed at the bottom and not be seen.

Another common issue during T1 but resolved afterwards was that people did not understand the acronym "CV", thus from T2 onwards it was broken down into Curriculum Vitae, doing that the issue no longer appeared. Ideally another test with a high fidelity prototype should be done with the interface corrected from the issues that appeared during T3, however it was not possible due time constraints.

4. CONCLUSIONS

Application of usability principles mixed with user testing and even more, user centred design can enhance performance and achieve optimum levels of user satisfaction and ease of use. Good presentation for some users may not be ideal for others. Netbook personal computers may not be an optimum hardware to present information, especially for low literacy users who take longer to read and are not familiarized with computer use (Nielsen 2005). Another test should be performed with a high fidelity prototype in order to compare the performance regarding T3.

Further studies of this portal should be done in order to see the interaction until the very end (government or private sites) in order to get a grasp of other issues that may stop socially vulnerable users of getting the information that they require.

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