RISK ASSESSMENT ON THE REHABILITATION WORK OF THE ARNOIA MANOR

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Abstract

The following dissertation is developed in the ambit of the Safety, Hygiene and Health Protection in the Workplace (SHHPW) in the Civil Engineering sector. Despite its significant slowdown in the recent years due to the poor economic conditions found in Portugal, construction is still the economic activity with the largest incidence of fatal accidents. Therefore, one of the main purposes of this study is to reaffirm the importance of safety, hygiene and health in the construction sites, as well as identify risk situations and establish guidelines for risk assessment.

In this context, this investigation includes a survey of the potential hazards in the construction site of the case-study presented, through the information collection on the tasks/activities, work force, equipment, legislation and standards, as well as on-site observation, and the subsequent risk assessment to quantify the risks, suing the simplified matrix method. Complementarily, a questionnaire was proposed to different personnel involved in the construction process of the case study. The latter aimed at evaluating their behaviour according to the safety and hygiene rules in the work site.

The risk assessment methodology implemented in this study reveals that certain labour conditions need to be improved and it is pivotal to raise awareness amongst the workers regarding the appropriate use of individual protection gear (IPG's).

***Key words**: Safety, Hygiene and Health in the Workplace, Hazard Risk; Civil Engineering, Risk Assessment*

1. THEORETICAL BACKGROUND

1.1. The importance of safety, hygiene and health in the workplace

The work conditions, particularly in respect to Safety, Hygiene and Health in the Workplace, are a fundamental part of the quality of life of the individuals in a society. Considering this premise, the

general improvement of work conditions is a widely discussed topic nowadays. This field of interest has undergone significant development in the last decade, both in terms of new legislation, as well as regarding the creation of service provider companies, further bolstered by new guidelines imposed by the European Community.

From the perspective of the construction companies, there are significant benefits from regarding the SHHPW as an investment with return, rather than an operational cost.

The organizations that are responsible for enforcing the SHHPW rules at a national and international level are the following:

- Portuguese Authority for Labour Conditions (Autoridade para as Condições do Trabalho, ACT), promotes the improvement of labour conditions at a national level;
- The World Health Organization (WHO) has a very specific mission of developing the best health conditions for any human being in any part of the planet;
- The International Labour Organization (ILO) is responsible for setting up mechanisms to stimulate the member countries of the European Union (EU), regarding the establishment of specialized national bureaus or agencies capable of formulating labour related standards and regulations, as well as their review, update and improvement.

1.2. Labour Safety Technician

The Labour Safety Technician (LST) is a professional that organizes, develops, coordinates and oversees (only for superior technicians, LSST), the activities related with the prevention and protection against professional hazards in the ambit of the safety and health services in the workplace (Santo, 2011).

The professional practise requires that strict deontological rules are followed, due to the different specialties involved. Furthermore, it depends on the issuing of a Vocational Training Certificate (VTC). The requirements to obtain the VTC corresponding to the LSST and LST are resumed in the following table, according to the Portuguese Decree-Law 42/2012 from the 38th of August.

LSST (Level 6)	LST (Level 4)
Bachelor degree or equivalent and attendance with approval of a training course on LSST, homologated by the ACT.	High school diploma or equivalent and attendance with approval of a homologated and certified training course on LST,
Bachelor degree or equivalent on Safety and Hygiene in the Workplace recognised by the Education Ministry and homologated by the certifying entity.	3rd cycle school diploma and attendance with approval of a training course on LST, homologated by the certifying entity, included in a system awarding an equivalent degree to the high school diploma.

Table 1 – Requirements to obtain LSST and LST certifications in Portugal

The VTC is valid for a period of 5 years and its renovation depends on the following requirements:

- Professional practice for a minimum period of 2 years;
- Scientific and technical update through the attendance of continuing training for a minimum period of 30 hours;
- Compliance with the deontological principles.

1.1 Occupational Safety and related risk

Occupational safety addresses labour related accidents with the purpose of eliminating or minimizing potentially unsafe conditions associated with the material components of labour. It further relates to the worker education and training regarding the use of preventive measures. Prevention is certainly the best tool to reduce or ideally eliminate possible safety problems for the workers.

The occupational safety hazards are classified in two groups: mechanical risk and non-mechanical risk.

1.2. Occupational Hygiene and related risk

Occupational hygiene is related to the prevention and protection from professional diseases and other hazards, from a non-medical perspective, through the identification of environmental agents that may affect the labour environment and the worker. It aims to eliminate or at least reduce the professional risk.

The **aggressive environmental agents** that may affect the professionals' health are classified according to their nature in three categories: physical, chemical and biological.

1.3. Risk assessment

Generically, risk assessment consists on a structured analysis of every labour related task from the risk identification standpoint. More specifically, it entails the diagnosis of the risk factors, estimation and valuation of the risks and the information regarding the workers or third-parties that may be exposed to potential hazards. The adequate prevention or protection measures for each case are defined based on the purpose of eliminating the risk or at least reducing its consequences, whenever the first objective is unattainable (Freitas, 2012).

The main goal of risk assessment is the quantification of the impact that a certain hazard has on the health and safety of the workers, thus providing the employer with the necessary data to take informed decisions regarding the preventive measures that must be implemented (Carneiro, 2011).

The delivery of the risk assessment must be composed by three independent stages:

1. Risk identification and its possible consequences;
2. Identification of the exposed personnel;
3. Risk estimate (Risk Level = Probability x Impact).

The risk assessment methodologies may be classified as qualitative, quantitative or semi-quantitative. The present investigation presented in this article may be described as the latter.

2. THE CONSTRUCTION SECTOR AND HEALTH AND SAFETY IN THE WORKPLACE

The construction sector evidences a wide number of specificities that determine a somewhat different approach to the health and safety in the workplace, when compared with the majority of other economic activities. However, in its core, it is still governed by the general principles of prevention, according to Freitas (2012). As a consequence of the previous statement, the main characteristics of the construction sector and the differences regarding the health and safety in the workplace plans are presented in the following sections.

2.1. Overview of the construction sector in Portugal

The construction sector is one of the most relevant drivers of the Portuguese economy. This activity has a very significant impact in employment as it is estimated that each direct job created has the potential to generate three new jobs in the economy as a whole. To further exemplify the importance of the construction sector in Portugal, the following remark is sometimes referred: “In Portugal, when the construction sector sneezes, the economy gets a cold”.

Despite its undeniable bearing, the construction sector has suffered a critical slowdown in the past few years, following the general tendency of the Portuguese economy. It is estimated that about 42100 jobs have been lost in the construction sector.

Regarding the accident ratio, construction is one of the economic sectors in Portugal, which evidences the worst results. Furthermore, it is actually the sector where most fatal accidents occur, as may be confirmed through inspection of Table 2.

The European Union is responsible for a study on labour related accidents, which yielded the following conclusions regarding accidents with casualties (Freitas, 2011).

- 35% are due to conceptual errors (architectural, material, equipment);
- 28% are organizational accidents, due to the execution of incompatible activities
- 37% are related to execution errors in the construction site, due to lack of work organization, lack of information or lack of training, amongst others.

Year	Total	Primary Sector	Secondary sector				Service sector			
			Total	Extractive industries	Manufacturing industries	Construction	Total	Wholesale and retail commerce, automobile and motorcycle repairs	Transports and storage	Hotel and restaurant services
2000	368	33	192	9	78	**102**	115	42	33	9
2001	365	33	215	16	59	**139**	116	32	32	6
2002	357	45	193	5	75	**109**	114	32	38	4
2003	312	25	174	8	52	**113**	108	38	34	4
2004	306	32	180	12	55	**110**	93	27	38	1
2005	300	28	174	6	56	**111**	95	24	32	2
2006	253	38	132	3	43	**83**	82	21	33	5
2007	276	22	157	4	49	**103**	97	36	29	2
2008	231	23	120	12	27	**78**	87	25	30	1
2009	217	19	120	8	29	**76**	77	20	23	1
2010	208	28	102	5	27	**67**	78	22	33	4

Table 2 – Accidents with casualties by economic activity in Portugal in the last decade (PORDATA, 2013)

2.2. Construction site directive

The Decree-Law nº 273/2003 establishes generic rules for the design, organization and coordination of the construction site, with the purpose of promoting safety, hygiene and health. It is applied to every work of construction or engineering in general. This diploma further establishes the duties of the different parties involved in the construction site: the client, the design author, the safety coordinators, the company in charge of the works, the employers and the independent employees (Pinto, 2012).

This legislation requires the issuing of three critical documents regarding the prevention of professional hazard:

- Prior notification (PN)
- Health and Safety Plan (HSP)
- Technical compilation

Furthermore, this document has created two new professional roles in the construction site:

- Design for Safety Coordinator
- Construction Safety Coordinator

3. CASE STUDY

The subject of the present paper is the rehabilitation work of a manor in the village of Arnoia (*Solar de Arnoia*), located in the commune of Celorico de Basto,in the Braga county. The service contract for the construction works was awarded to the company Júlio Lemos Ferreira, Unipessoal Lda.

The data collection involved two independent observation techniques in this particular study: the first one may be considered direct, as it was simply based on observation of the construction site to determine the procedures and practices adopted, while the second one, indirect, consisted of a survey in order to collect implicit knowledge from the workers involved.

✓ **Direct observation methodology**

As the main objective of this study was the risk assessment in construction, the case study was subject of a direct observation for risk identification. In particular, the examination addressed the following activities involved in this rehabilitation project:

- Demolition work on a building adjacent to the main building;
- Roof dismantling;
- Execution of the superior slab in the garage;
- Hydraulic lime mortar in the manor façade;
- Execution of the property walls

✓ **Indirect survey methodology**

In the ambit of the indirect survey, close-ended questionnaires were conducted with the purpose of pinpointing what is the perception of the construction company workers regarding the safety, hygiene and health issues, as well as their behaviour. The enquiry also addressed the standpoint of the company regarding the same topic. Twenty-five individuals participated in this enquiry anonymously, and the answers were filled in by the workers themselves.

- **Analysis of the information gathered**

Firstly, it is worth noting that all the population of the survey is composed by males. The reason for this is related with the significant physical demand required in the construction sector, thus explaining the absence of females in the population who answered the questionnaire.

Regarding the risk identification, the answers were almost unanimous considering heat/cold as the factor to which they are most significantly exposed. Fall from a height, noise and vibrations were the following concerns expressed in the answers. It should be highlighted that 36% of the enquired individuals consider that they are exposed to a high level of noise and vibrations.

Concerning the protection gear (collective and individual), 96% of the workers expressed using it consistently. However, it is worth noting that 72% of the workers admitted that they only used the protective gear due to internal company normative, i.e. they were compelled by the safety and hygiene at work professionals in the construction site. From a different perspective, the author of this study was able to gather further information through anonymous conversations, where the workers conceded that they would rarely or not at all use the individual protection gear, such as the helmets and protection masks, if their use was not compulsory. However, a unanimous positive answer was given when the workers were asked, in the questionnaire, if they felt more protected while wearing the safety gear.

Finally, the enquiry also revealed that 88% of the individuals consider that their employer is concerned with the safety, hygiene and health in the workplace, while 80% considered that their productivity was affected by this concern.

4. RISK ASSESSMENT

In this specific work, the formulation adopted for the risk assessment was the simplified matrix methodology, described as follows.

- The process begins with the detection of possible flaws or deficiencies in the object of study;
- Following, the probability of an accident occurring is estimated considering the expected magnitude of its consequences, thus evaluating the risk associated with each of the deficiencies detected.

The method is then based on the basic concepts of risk:

- The probability associated with the risk is classified according to three categories: unlikely, probable and frequent
- The risk impact is classified according to three categories, as well: light, moderate and heavy.

The analysis of the magnitude of professional risk is done in function of the probability of the said risk and the extent of the potential injuries, expressed by the impact. According to this, the global risk

magnitude is given by the following expression, where **NR** stands for the risk magnitude, **NP** is the risk probability and **NG** is the extent of the consequences of said risk.

$$NR = NP \times NG \quad [1]$$

The results obtained through the application of the previous equation are further explained in the following table.

RISK LEVEL		**RISK IMPACT**		
		Light (1)	**Moderate (2)**	**Heavy (3)**
PROBABILITY	**Unlikely (1)**	Acceptable (1)	Low (2)	Average (3)
	Probable (2)	Low (2)	Average (4)	High (6)
	Frequent (3)	Average (3)	High (6)	Extreme (9)

Table 3 – Risk level classification

The priority levels expressed in Table 3 have associated intervention times, which are expressed in Table 4.

Risk Level		**Priority Level**
9	Extreme	**Immediate Intervention** (within 24 hours)
6	High	**Urgent** (2 to 3 days maximum)
3 a 4	Average	**Short term** (15 days maximum)
2	Low	**Medium term** (1 month maximum)
1	Acceptable	**No priority**

Table 4 – Priority levels associated with the risk levels

In the following table, the risk values associated with each task, as well as their level are described. These are then used to establish the priority levels for intervention, regarding the control measures for the evaluated hazards.

Table 5 –Risk assessment table

Operation	Threats	Risk	Risk Level	Execution Deadline
Demolition of the adjacent building	Operation of the drag shovel	Exposure to non-ionising conditions Exposure to extreme temperatures	2	1 Month
		Exposure to noise	4	15 days
		Exposure to vibrations	6	2 or 3 days
		Dust Exposure/Inhalation	2	1 Month
		Exposure to noxious or toxic substances	2	1 Month
		Running over	6	2 or 3 days
		Equipment roll-over	6	2 or 3 days
Dismantlement/Building of roof	Operation of cutting equipment (fettling machine)	Exposure to non-ionising conditions Exposure to extreme temperatures	3	15 days
		Exposure to noise	6	2 or 3 days
		Exposure to vibrations	6	2 or 3 days
		Dust Exposure/Inhalation	6	2 or 3 days
	Removal and laying of roofing ceramic tiles	Personnel fall from a different level	6	2 or 3 days
		Object fall due to slumping Object fall during operation	6	2 or 3 days
		Body strain or inadequate posture	6	2 or 3 days
	Operation with cutting machine (chainsaw)	Exposure to non-ionising conditions Exposure to extreme temperatures	3	15 days
		Exposure to noise	6	2 or 3 days
		Exposure to vibrations	6	2 or 3 days
		Dust Exposure/Inhalation	4	15 days
		Personnel fall from a different level	6	2 or 3 days
	Removal and laying of wooden elements	Object fall during operation	6	2 or 3 days
		Electrical contacts	3	15 days
		Particle shooting	4	15 days
		Body strain or inadequate posture	6	2 or 3 days
		Fire and explosions	3	15 days
	Crane operation for removal/laying of roof elements	Exposure to non-ionising conditions Exposure to extreme temperatures	2	1 Month
		Object fall during operation	6	2 or 3 days
		Entrapment	4	15 days
		Crane collapse	3	15 days
Application of	Operation with	Exposure to non-ionising conditions	3	15 days

concrete on the garage slab	automatic pump	Exposure to extreme temperatures		
		Exposure to noise	3	15 days
		Exposure to noxious or toxic substances	6	2 or 3 days
		Personnel fall from a different level	6	2 or 3 days
		Body strain or inadequate posture	4	15 days
	Operation with concrete vibrator	Exposure to non-ionising conditions Exposure to extreme temperatures	3	15 days
		Exposure to vibrations	6	2 or 3 days
		Exposure to noxious or toxic substances	6	2 or 3 days
		Personnel fall from a different level	6	2 or 3 days
		Electrical contacts	3	15 days
		Body strain or inadequate posture	4	15 days
	Lorry circulation	Entrainment Running over	6	2 or 3 days
Application of hydraulic lime mortar in the manor façade	Scaffolding	Exposure to non-ionising conditions Exposure to extreme temperatures	3	15 days
		Exposure to noxious or toxic substances	2	1 Month
		Personnel fall from a different level	6	2 or 3 days
		Object fall due to slumping Object fall during operation	6	2 or 3 days
		Body strain or inadequate posture	4	15 days
		Scaffolding collapse	6	2 or 3 days
Execution of the property walls	Manual Handling of Rocks	Exposure to non-ionising conditions Exposure to extreme temperatures	3	15 days
		Exposure to noxious or toxic substances	2	1 Month
		Body strain or inadequate posture	4	15 days

5. CONCLUSIONS

The importance of Safety, Hygiene and Health in the Workplace has been stressed in many scientific publications as reviewed in this work. Moreover, a very important conclusion from these studies is that the construction companies that regard this topic as investment rather than an operating cost are rewarded with significant benefits to their operation.

It is possible to conclude from the present work that Risk Assessment is essential in the process of eliminating the risk, or at the very least mitigating their inherent consequences. Despite the fact that Risk Assessment is considered as a legal obligation, there is lack of consistent guidelines to carry out this analysis. The Risk Assessment on the case study presented in this paper – the rehabilitation of

the Arnoia manor – showed that 49% of the risks are classified as having a high risk level (Table 4), thus requiring urgent intervention, within 2 to 3 days. This is directly related to the fact that a wide number of the construction operations are carried out at a height. However, it should be highlighted that the construction company did not present any extreme risk level, mostly due to the fact that several measures have already been implemented, such as the adoption of guardrails or the guideline for compulsory use of individual protection gear.

All things considered, the proposed methodology for risk assessment reveals that the generic work conditions need to be improved in certain cases. The key aspect lies in the construction company itself, which should raise awareness amongst the workers and urge them to consistently use the individual protection gear whenever carrying out any task involving potential risk.

6. REFERENCES

ALVES, Luís Manuel Dias; *Documento de Apoio às aulas da disciplina de Qualidade, Segurança e Ambiente na Construção*, IST; Lisboa,2009.

ARAGÃO, João; *Coordenação de Segurança em Projecto- Uma Metodologia*, Dissertação de Mestrado; Faculdade de Engenharia do Porto, Universidade do Porto; Porto, 2007

BAGANHA, Maria; *O Sector da Construção Civil e Obras Públicas em Portugal 1990-2000.*

CARVALHO, Filipa; *Avaliação de Risco- Estudo Comparativo entre Diferentes Métodos de Avaliação de Risco, em Situação Real de Trabalho*, Dissertação de Mestrado; Faculdade de Motricidade Humana, Universidade Técnica de Lisboa; Lisboa, 2007.

ESPIRALSOFT; *Manual do Módulo de Avaliação de Riscos Profissionais*; Curso de Técnico Superior de Segurança e Higiene do Trabalho; Lisboa, 2012.

ESPIRALSOFT; *Manual do módulo de Controlo de Riscos Profissionais*; Curso de Técnico Superior de Segurança e Higiene do Trabalho; Lisboa, 2013.

ESPIRALSOFT; *Manual do Módulo de Segurança do Trabalho*; Curso de Técnico Superior de Segurança e Higiene do Trabalho; Lisboa, 2012.

FREITAS, Luís; *Manual de Segurança e Saúde do Trabalho*; Edições Sílabo; Lisboa, 2011.

INCI; *Relatório de Analise Económico-Financeira*; 2010

PINTO, Abel; *Manual de Segurança: Construção, Conservação e Restauro de Edifícios*; Edições Sílabo; Lisboa 2012.

ROXO, Manuel; *Segurança e Saúde do Trabalho: Avaliação e controlo de riscos*; Edições Almedina; Coimbra, 2003.