Development of an Occupational Risk Assessment Method; A Case Study of a Research Center in Morocco

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Abstract: ***To reduce occupational accidents and diseases, as well as physical and financial losses associated to them, regulations in several countries require risk assessment. However, the difficulty of carrying out the risk assessment was reported by several companies. The present work proposes a method of risk assessment inspired by methods from the literature, and introduces staff competence as a parameter of risk assessment. It also presents the results from a case study of a scientific research center in Morocco. The chemical synthesis laboratory is identified as the laboratory with the highest risk score. Risks related to the handling of chemicals, fire risk and risks related to pressure equipment and fluids are successively risks whose scores are the highest in the whole center and are present in the chemical synthesis lab.***

Keywords: Risk assessment, hazard identification, risk prioritization

1. Introduction

According to the International Labor Office (ILO) in 2011, Occupational Accidents (OA) and Occupational Diseases (OD) are increasing internationally, an average of 2.3 million people die each year worldwide [1]. In Morocco, the rate of fatal work injuries is estimated at 47.8 for 11000000 economically active population [2]

On the other hand, the impact on the economy is also mentioned in 2009 during the global health and safety at work day by the International Labor Organization that estimates that about 4% of annual global Gross National Product (GDP), 1250 billion dollars, are absorbed by direct or indirect costs of OA and OD [3]

Consequently to the economic impact of OA and OD on one side and their impact on the human factor on the other, a relevant strategy must be implemented by companies wishing to reduce their accuracy and severity rates.

For this purpose, the occupational risk assessment has become a regulatory requirement in many countries such as France [4] England [5] and Japan [6]. In Morocco, the regulation requires the identification of risks and the staff who is being exposed in a regulatory document [7]. On the other hand, the international OHSAS 18001 standard on health and safety at work, which is a reference in the field, contains an entire chapter requiring the implementation of risk assessment [8].

That said, an investigation by the Japanese government in 2005, noted that only 20.4 % of companies surveyed had carried out risk assessments. Two reasons have been identified to explain this rate; lack of staff or insufficient knowledge of the implementation process of risk assessment [9].

This paper describes a method of risk assessment and results from a case study in Morocco. It reports fieldwork, in a research center taking into account the following laboratories:

- Vegetal Biotechnology Laboratory
- Medical Biotechnology Laboratory
- Microelectronic Laboratory
- Chemical Synthesis Laboratory

For conducting a risk assessment, some organizations use the traditional method based on two aspects: the frequency and severity. Yet this matrix has been criticized because of its subjectivity [11]. Other methods have been developed to improve the assessment of risks including a US study that has established a matrix of factors for determining the level of risk, such as age and sex [12], an Iranian study that proposes a new method based on five main variables: difference, frequency, severity, occurrence and cost [13] or another study that proposes a method based on the parameters: frequency, causes, equipment concerned and consequences of incidents [14].

In our study, the developed method uses parameters of occupational risks in the literature, including the probability of occurrence, severity, accidents historic, index of current risk control, and also introducing the factor of staff competence as relevant for the purpose of the method. These parameters are selected in order to simplify the risk assessment based on descriptive tables and a scoring system to avoid subjectivity. Also, staff is highly involved since it is, according to ISO, a major point in the as yet unpublished Occupational Health and Safety standard ISO 45001 [15].

That said, as there is no regulatory requirement method on risk assessment, interested organizations can begin by adopting the traditional method and adapt it to the needs of the organization.

2. Methods

Although several countries impose the realization of risk assessment, none of them preconizes a specific method for application. A logical route is recommended, though, by The french National Institute for Research and Safety (INRS), addressing four main steps [10]:

Preparing the assessment, identifying hazards, prioritizing risks and finally, risk control.

The present study follows the steps recommended of hazards identification and risk assessment:

2.1. Launching the assessment

In this step, interviews are held with the heads of teams. Occupational accident statistics are also consulted. This has allowed taking a first look on the existing dangers.

The scopes of intervention are the laboratories of the research center, whose activities will be cut and evaluated by laboratory.

2.2. Hazard identification

For each laboratory, field observation and consultation of the staff on site are carried out. For each activity, Hazard Areas, description of hazards and related damages are listed, using a list of danger areas and their descriptions and a list damage of the INRS.

2.3. Risk prioritizing

For the purposes of risk prioritizing, a number of parameters is used based on literature existing methods, and adapted to the needs of the study. Staff Competences Index is added to the chosen parameters.

2.3.1. Measuring Inherent Risk Level (IRL) :
To calculate the Inherent Risk Level, which does not take into account the level of risk control, the following formula is used:

IRL = Severity S x Occurrence Probability OP

Based on our investigation on different levels, we suggest that occurrence probability must be measured as following:

And: *OP = Exposure Index + Competences Index + Historic Index of Accidents*

A meeting with Health and Safety Comity, including occupational physician is useful to determine the scores scale of each parameter. Companies can adapt to their work environment specifications, and same for the scoring of each risk, provided careful not to underestimate them.

The following matrices are used to determine:

Severity (Table 1): The scores scale is determined in a progressive way, starting from the risks with a low severity. The interval should be equal between each two levels.

Table 1: Severity matrix

Notation	*3*	*6*	*9*
Severity	No injuries or Minor injuries	Accident with work stopping less than 10 days	• Deadly accident • Occupational disease • Accident With work stopping for 10 days or higher

Exposure index (Table 2): The scoring is determined in a progressive way also, maintaining the same interval. Notation should respect the coefficients according to the IRL formula.

Table 2: Exposure index matrix

Notation	*1*	*2*	*3*
Exposure	Maximum 1 time per month	Minimum 1 time per week	Minimum 1 time per day or more

Competence Index (Table 3): Two parameters are taking into account, technical knowledge and experience of the staff. These two are combined in a manner that a high score is allocated to staff with low experience and low technical knowledge. The interval should be equal between each two levels of competences. Notation should respect the coefficients according to the IRL formula.

Table 3: Staff competences matrix

Notation		*1*	*2*	*3*
Competences		*Good*	*Average*	*Low*
Staff competences matrix		*Technical knowledge*		
		Advanced competences	*Intermediate competences*	*No knowledge in the field*
Experience	*More than 2 years*	1	1	2
	Between 1 and 2 years	1	2	3
	Less than one year	2	3	3

Historic index of accidents (Table 4): The scoring is done progressively starting from the lowest score attributed to "lack of accidents" generated by a danger to the highest score related to the occurrence of several accidents. Notation should respect the coefficients according to the IRL formula.

Table 4: Historic index of accidents

Notation	*1*	*2*	*3*
Historic	Lack of recurring accidents in the past	Historic proving the occurrence of accident (s)	Historic proving the occurrence of multiple accidents

Therefore, we can calculate the Inherent Level of Risk for each hazard incurred when performing each activity.

2.3.2. Calculating Residual Risk Level (RRL)
Following the calculation of the Inherent Risk Level (IRL), the Residual Risk Level (RRL) is calculated, taking into account the Current Risk Control Index (Table 5)

RRL = IRL / Risk Control Index

Table 5: Current risk control matrix

Notation	*1*	*2*	*3*
Risk operational control	No operational control implementation	Partial control implementation	Total control implementation

2.3.3. Acceptability thresholds and risk prioritizing

At the end of calculating the residual risk level, risk ranking is established based on the notation approved by the health and safety committee (Table 6).

Table 1: Level of risk acceptability matrix

Acceptability level	*RRL*	*Risk control decision*
Very high Risk	RRL ≥25	There should be immediate actions
High Risk	20 ≤ RRL < 25	There should be short-term actions.
Moderate Risk	15≤ RRL < 20	There should be the medium to long term actions.
Low Risk	RRL < 15	No additional control is needed Possible improvement

2.4. Risk control

For each determined risk, actions are recorded in a health and safety program.

The action plan includes actions, actions priorities, the responsible of the action, budget, estimated period and progress.

3. Results

This risk assessment has allowed risk prioritizing according to their level of risk. This enables implementation of adequate and effective means of control by following the logic of risk control from the highest risk levels to the less ones.

3.1. Risk classification according to their levels

As a result of the risk assessment, risk classification is done according to their levels: Very high, high, moderate and low.

Synthesis laboratory is the laboratory in which the percentage of very high risks is the greatest. Conversely, the microelectronic laboratory has the highest percentage of low risks (Fig. 1.).

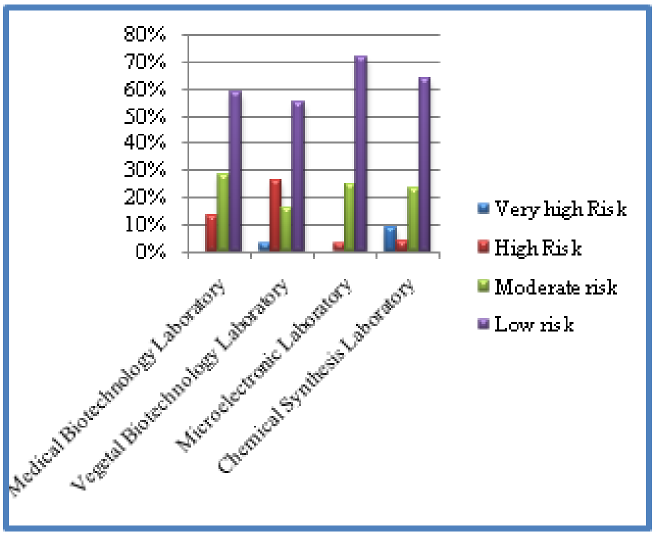

Figure 1: Risk classification according to their level per laboratory

3.2. Nature and score of very high and high risks in laboratories:

The highest risk score is relative to the risks related to the handling of chemicals in chemical synthesis laboratory with a score of 36, followed by the risk related to equipment and fluids under pressure 23, and fire risk 23, in the same laboratory.

The risk related to the handling of chemicals also reaches a score of 23 in both vegetal and medical biotechnology laboratories (Fig. 2.)

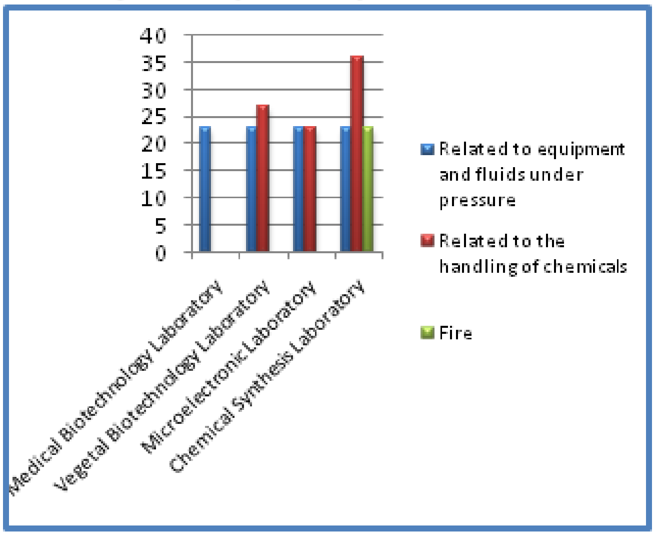

Figure 2: Very high and high risks scores and their nature per laboratory

4. Discussion and Conclusion

In this paper, the case study is an example of organizations that presents a variety of risks, because of the diversification of activities carried out in it. Low risk scores are explained by the introduction by the research center of effective means of control to reduce the inherent risks in its activities.

This study found no biological risk, even within the two biotechnology laboratories, and this can be explained by the absence of agents capable of causing disease in humans [16].

On the other hand, it reports that chemical synthesis laboratory is the laboratory where risks are at highest scores, due to the presence of chemical hazards that was also raised by this study.

This finding is in line with a Swedish study, in which, a risk of 1.7 to undergo a spontaneous abortion is observed, for women working in chemistry laboratories compared to women working in other laboratories [17]. An earlier study on a population of 3637 members of the American Chemical Society, demonstrated a higher mortality from cancer among these chemists than the general population of comparable socio-professional level [18].

Also, it was noted that the risks associated with the handling of chemicals, fire risk and those related to pressure equipment and fluids are successively risks whose scores are highest. A French study supports this finding about the high score of chemical risk, in which one of the major risks facing the researchers is handling toxic chemicals with a prevalence of 90% [19].

Risk assessment and prioritization for efficient control, can reduce occupational accidents and diseases. An Australian study found that non mastery of the risk assessment and lack of control of these, explains a high rate of accidents [20]. Hazard identification and risk assessment is a key step in the implementation of the OHSAS 18001: 2007 [8].

In order to reduce accidents and diseases at work, Morocco may encourage companies to undertake a certification process according to OHSAS 18001. In fact, a study of eight large chemical plants south of the India confirms that employees of the organizations of the certified management systems of health and safety, safe behaviors and have a better perception of their health than employees in non-certified organizations [21]. Although, on the other hand, an Iranian study [22] on three companies certified OHSAS 18001 and three non-certified companies, indicates that accidents do not decrease with OHSAS 18001, and also certification does not guarantee an improvement health and safety.

Among the risks identified by the risk assessment, an element is detected relatively to staff mental health, these are psychosocial risks. And if we take into account the finding of a study le Haut Commissariat aux Plans (HCP) in 2012 [23] according to whom an active out of two is not satisfied with his work in Morocco, the imminence of investigations and studies addressing this issue in Morocco is recommended.

Even though, occupational risk assessment is imposed by several countries, such as France [4], England [5], Japan [6] and Morocco through mandatory danger identification [7], it is still considered complicated by several companies, such as the Japanese exemple [9].

Small organizations concerned with the assessment of risks associated with their activities, should find in this work, a simple, flexible and user-friendly method with a gain in autonomy. Indeed the process and the steps are clear. The adaptation of this tool to the types of activities of the organisation should offer better results. The final aim of our paper is to contribute to improvement of risk prevention and reduction of occupational accidents and diseases, which is one of the main objectives of an efficient quality, health and safety management system.

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