Determining the Most Important Hazards in the Cement Industry with a Cost Reduction and Process Optimization Approach

Faezeh Abbasi Balochkhaneh[1], Mohamad Reza Ghotbi Ravandi[2]*, Fatemeh Golkhani[3], Saeed Baesmat[4], Zahra Hasanpour Sodrejani[5]

Abstract

Aim: Occupational health with the goals of providing, maintaining and enhancing the physical, psychological and social health of employees and preventing harmful factors is important.

One of the ways of preventing occupational hazards is to identify them in the workplace. So the purpose of this research is to identify hazards and risk assessment in order to provide the necessary information to help make the decisions required to reduce the occupation-related risks.

Methods: In this study, we used a combination of FMEA and AHP methods to assess the occupational risks of the cement industry.

Findings: In this study, eight hazards were first examined by the FMEA method, which was the highest risk priority number for occupational hazards. Then the hierarchical analysis process technique was used to evaluate and rank the hazards, with the risk of working at an elevated level with a relative weight of 0.2234 in the first place and the dangers of working with machinery with a relative weight of 0.20864.

Conclusion: The manufacturing activities in this industry are required to work in different conditions such as high altitude, work and contact with dangerous rotating and moving equipment, and high-risk manufacturing processes that provide suitable safety controls and structures for the protection of human capital and even upgrading machines. Therefore, the health of the staff and the work environment is necessary.

Keywords: Health promotion, Cement industry, Hazard identification, Risk individuality

1. B.Sc., Department of Occupational Health, School of Public Health, Semnan University of Medical Sciences, Semnan, Iran Email: faezehabasi72@yahoo.com
2. Associate Professor, Department of Occupational Health, Kerman School of Public Health, Kerman University of Medical Sciences, Kerman, Iran Email: ghotbi@kmu.ac.ir
3. B.Sc., Department of Occupational Health, Kerman School of Public Health, Kerman University of Medical Sciences, Kerman, Iran Email: fgolkhani1396@gmail.com
4. B.Sc., Department of Occupational Health, Kerman School of Public Health, Kerman University of Medical Sciences, Kerman, Iran Email: saeedbaesmat@yahoo.com
5. B.Sc., Department of Occupational Health, School of Public Health, Semnan University of Medical Sciences, Semnan, Iran Email: zahra1374715@gmail.com

Introduction

Nowadays, all affairs of the community are dependent on complicated and risky technologies. There is always a fear of work-related accidents. According to the reports from the 1900s, casualties due to work are relatively higher than the casualties of war and other natural disasters [1]. Also the International Labor Organization (ILO) has reported an annual incidence of non-lethal job injuries of 150,000 people and 1,400 deaths in Iran. This means that for each case of death, there are about 130 cases of occupational diseases that may result in absenteeism [2]. Every year, incidents of irreparable damage to personnel and industries occur, most of which are predictable by identifying risks and assessing and controlling the risks [3].

Risk management is a process that is employed by using systems and management principles to identify, assess and control risks [4]. The first step in the risk management process is risk assessment [5]. Risk assessment is an organized methodology that is defined for risk identification, risk estimation and decision making in order to reduce risk and deliver it to an acceptable level [6]. The current risk assessment methods are divided into three major categories. Among them, qualitative analysis has a higher accuracy than the other two methods [7- 9].

In 2010, Kaskotts introduced the risk of falling from heights as the worst risk in his research [10]. In the study of Resvozhany et al., 154 risks were identified in the casting industry using the FMEA method. Of the 154 identified risks, 26% were in an unfavorable situation [11]. Ali Mohammadi and his colleagues used the FMEA technique to identify and control the dangers of two gypsum factories. The results showed that the most important risk is the pouring of refractory bricks inside the furnace [12].

As stated above, there are wide-ranging activities and processes in the industry. Every activity and process has risks that need to be identified and prioritized. In the absence of identifying the risks available, the organization faces many challenges and costs, which can lead to its lack of competition, lack of excellence, the loss of trust of employees, and ultimately, getting away from the main goal of effectiveness. Therefore, the purpose of this study is to assess the risks of activities and processes in a cemetery industry.

Materials and Methods

This descriptive-analytic study was carried out in the cement industry using a combination of FMEA and AHP methods to assess the risks, and to rank the identified risks.

The risk can always exist, but if it is properly controlled, it will be effectively reduced to zero. Identifying all possible hazards in the industry requires a specific methodology, including full knowledge, the power of imagination and the rational framework. In this research, hazard identification was conducted by examining documents, holding storm meetings and using the knowledge and experience of professional health and safety experts.

FMEA Method

The method used to analyze the failure factors is the most authoritative risk analysis technique [13]. This technique was first used by the US military in 1949 [16]. Later it was used in the 1960s in the American air and space industry, and then by the atomic institutes in the 1970s and 1980s [14].

FMEA is an engineering technique that defines the purpose of identifying and eliminating errors, problems and potential errors in the system, the production process, and the provision of services before the final product or service reaches the customer. This is a prerequisite for predicting errors and how to prevent mistakes [15].

The purpose of this method is to increase the reliability of the process by preventing detected system defects and reducing the resulting inadequate outcomes. FMEA is a relatively time consuming method, and requires detailed and accurate information about the system under investigation.

In the FMEA method, after risk assessment, the risk estimation is performed by calculating the RPN risk priority number for each potential error condition and its effect. This variable is calculated by multiplying the three factors of the intensity of the effect (S), the probability of occurrence (O), and the ability to detect the error (D) as follows:

$RPN = S \times O \times D$

These three factors are graded from scales one to ten. The risk priority number is the basis for prioritizing the failure scenarios. Given that the above three factors can hold numbers between 1 and 10, the RPN will have a digit between 1 and 1000.

AHP method

One of the most efficient decision-making techniques is the Analytical Hierarchy Process (AHP) process, which was first introduced by Thomas El in 1980. It is based on paired comparisons and allows managers to review different scenarios. This technique examines complex issues based on their interactions and turns them into a simple way to solve them. A hierarchical analysis process can be used when decision-making practice with multiple competing choices and decision criteria can be applied. The proposed criteria can be quantitative and qualitative. The basis of this method lies in the decision of the paired comparison. The decision maker begins with the process of bringing the hierarchical tree to the decision. The tree of the decision hierarchy, the factors being compared, and the competing choices are evaluated in the decision. Then a series of paired comparisons are performed. The four frequency criteria, the imposed cost, the severity of the outcome, and the possibility of eliminating it in pairs are compared and weighted. These comparisons represent the weight of each of the factors in line with the competing choices being evaluated in the decision. Finally, the logic of the hierarchical analysis process combines the matrices derived from the paired comparison to make the optimal decision. To rank the dangers by the hierarchical analysis process, the following steps should be taken:

1- Selecting criteria
2- Determining the weight of the criteria
3- Comparison of paired options based on the criteria
4- Computing paired comparison
5- Calculating the priorities

Weight of the criterion × Option weight relative to that criterion =∑ (the final weight of each option for each criterion

Findings

In this research, using the use of documentation and records, holding of intellectual storm meetings, and the use of knowledge and experience of occupational health and safety experts, a list of eight of the most important risks in the cement industry was assessed and evaluated.

First, eight hazards were investigated by the FMEA method, as shown in Table 1. Next, a hierarchical analysis process technique was used to evaluate and rank the hazards table 2. At first, four criteria were selected. The weight of each criterion was then determined as shown in Table 3. In the next step, a comparison of the hazards was performed based on the criteria. In the final stage, prioritization of the hazards took place. The results showed that, from the identified hazards, the risk of working at an elevated level with a relative weight of 0.2234 ranked first and the risk of work with dust with a relative weight of 0.20684-0.1757 was ranked Second (Table4).

Table 1: Evaluation of the hazards of the cement industry by the FMEA method

Hazards	Severity	Probability of occurrence	Chance of discovery	RPN	Control measures
Slipping-sweat	**5**	**7**	**4**	**140**	Clean and keep work place Use proper shoes
Carbamazers	**8**	**6**	**6**	**288**	Device protection Use face shields and gloves Existing staff training Use of hazard warning signs at work
Work at heights	**8**	**7**	**6**	**336**	Use seatbelts Staff training
Burns	**6**	**6**	**5**	**180**	Use proper wrist strap Use of resistant clothing against burn Use a bridal dress to prevent hot spraying on someone
Contact with dust	**8**	**7**	**5**	**280**	Use of ventilation in the work area Use proper masks
Call with	**7**	**6**	**4**	**168**	Use of voice protector Visit and track the course of the workplace sound
Call with you	**6**	**6**	**5**	**180**	Visit her legs from the sound of the workplace Use proper gloves
Contact hazardous substances	**7**	**7**	**6**	**294**	Use proper mask Use of substances with lower risk

Table 2: Risk priority numbers considered

Risk classification	Risk level	Percentage achieved in this research
0-150	Acceptable	%12/5
150-290	Unacceptable	%62/5
290>x	Unbearable	%25

Table 3: Calculating the weight of the criteria

Metrics	Weight of the criteria
Frequency	0/1429
Imposed fee	0/1766
Severity of outcome	0/3476
Possibility of disposal	0/3328

Table 4: Assessment and prioritization of the risks of the cement industry by AHP

Hazards	Relative weight	Prioritize
Slipping-sweat	0/0615	5
Carbamazers	0/20864	2
Work at heights	0/2234	1
Burns	0/0576	6
Contact with dust	0/1757	3
Call with	0/5607	7
Call with you	0/0559	8
Contact hazardous substances	0/1551	4

Discussion

It was observed that the cement industry personnel faced with 8 overall hazards (slipping-leakage, work equipment, work-wear, burns, dust, call, call handling, and exposure to hazardous materials). The results also revealed that there is 12.5% of acceptable risk, 62.5% of unacceptable risk, and 25% of unbearable risk in this industry. Among the existing risks, labor at a higher risk level has been allocated. As stated above, the hazards of work at altitude, contact with dust, contact with hazardous materials, working with machinery, in the cement industry were identified by three methods of FMEA, and AHP. Due to the many activities of the cement industry in altitude, lack of proper training, lack of safety equipment and unavailability of safety equipment, the personnel of this industry are at high risk. Work-related control operations at altitude have a significant role in reducing the incidence of accidents by increasing the awareness of hazards and ensuring the use of correct methods. Mandatory use of safety equipment, providing training classes, obtaining mission permits and regular monitoring of the activity area are the most important safety measures possible. Most of the materials used in the industry are allergenic. In the cement industry, chromate compounds in the cement are due to their toxicity and carcinogens. Crystalline silica is another material that puts laborers at risk for pulmonary diseases caused by inhaling silica. Silica can be present in some of the raw materials used in the cement production process. Increasing the employees' awareness and the use of personal protective equipment should also be put on the agenda. Cement manufacturing industries essentially produce a huge amount of dust, which can lead to respiratory illnesses for labor force without proper control. In recent years, considerable attention has been paid to the removal and control of dust sources through the use of removal and control systems such as filters. The use of modern protective equipment, as well as the use of vacuum systems to clean the working environment can reduce damage and loss of the labor force.

Ardeshir and colleagues used the FMEA and AHP methodologies in mass production projects to assess safety risks. In both projects, the fall was considered to be the highest risk. The main cause of this risk was lack of proper training, poor safety performance, lack of safety equipment, and unavailability of safety equipment. This finding is consistent with the current study. A study, called the Risk Assessment for Occupational Hazards in the Construction Industry, revealed that the highest frequency of risks was associated with falling from the height, similar to our study [16]. Another study in the construction industry showed that high-altitude work was one of the most dangerous safety-related activities. The reasons were inadequate training and non-use of conventional collision protection approaches; this result is consistent with the current study. Asadi's study under the title of "Investigation of the dangers of an accident in one of the oil refining companies by the failure factor analysis method", showed that the highest incidence rate related to the fall was from relative heights (10%) [17]. In the study of Nasseri, using the method of occupational safety analysis, work with machinery was considered as one of the reasons for the dangers of the basis in the workplace [18]. In their study of work-related accidents, Majorrup and colleagues referred to blasts and falls as one of the main causes of occupational accidents. They suggested paying more attention to training workers, observing safety tips and using appropriate personal protective equipment, especially in high risk industries, in line with the present study. [19]. In the study of Asadi et al., 4250 hazards of oil refining were identified; the highest frequency was related to the hazards (12%) [20]. The study conducted in Colombia showed that the greatest mechanisms of the occurrence of accidents were related to the work of the machine tools and the fall [21].

Conclusion

As stated, the cement industry is considered to be a tough working environment. The manufacturing activities in this industry are required to work in different conditions such as high altitude, work and communication with dangerous rotating and moving equipment, and high-risk manufacturing processes. It also requires proper controls and structures to protect human capital and machinery and to avoid financial and financial losses. In today's highly competitive world, enhancing safety in the cement industry is one of the most important factors in achieving the organization's top goals and coverage of legal requirements. Achieving this is due to the creation of management systems that will lead to the identification, prioritization and control of the risks in the activities.

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