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Analysis of Safety Risks of Construction Projects Using Multi-Criteria Decision-Making Models (A Case Study of Residential Towers of Armitage, Tehran)

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Abstract

The ever-increasing increase in population and urbanization and, as a result, the lack of land has caused many cities in the world to increase in height and create high-rise structures instead of increasing the level. The development and construction plans of civil infrastructure projects, such as the construction of urban tunnels, highways, railways, etc., in addition to the construction projects of residential and construction units, even though they are considered to be one of the most important and job-creating industries of the countries, the advantages and have brought benefits for humans, but due to the complexity and diversity in the construction phase, they are the source of many risks, especially for employees. Therefore, it is very important to pay attention to the issues related to the safety and occupational health of employees in the construction phase. The effects and consequences of not complying with safety issues and the occurrence of accidents will be very costly and sometimes irreparable for the interested groups. This, in turn, is a great limitation for decision makers to optimize energy alternatives independently and discretely, especially in the case of rural communities. In addition, the topographical limitations in the case of renewable energy systems, which are mainly distributed in nature, make energy planning more complicated. In such cases, decision-making analysis plays an important role in designing such a system according to different criteria and goals, even at the exclusive levels of electricity.

Keywords: Energy systems, Safety management, Risk classification.

1 | Introduction

Jafarnia et al. [1], in their research, suggested the use of a fuzzy inference system to estimate fuzzy risk priority numbers with the help of experts' opinions. They stated that the advantages of the proposed fuzzy rule base for use in the FMEA method are: 1) it uses the expert's knowledge and experience in the FMEA structure,

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and 2) it can be used in systems where safety data is invalid or unavailable. Zavadskas et al. [2] stated that accidents in the construction sector occur for three root reasons: first, the weakness in identifying unsafe conditions that exist before the start of the activity or spread after the start of the activity. Second, the continuation of work after a worker identifies unsafe conditions, and third, the decision to perform an unsafe act regardless of the initial conditions of the work environment.

Yousefi et al. [3] identified quality, environmental, and safety risks for the management of construction projects by using potential error analysis and its effects. They developed a methodology for contractors of construction projects so that by using it by contractors, risk can be improved with the above method of identification and project implementation using the demonic cycle, and the amount of work accidents can be reduced. Since many years ago, in various countries, the applicable safety rules and regulations have been approved and implemented. In ancient times, Hammurabi's laws mentioned the safety of construction workers. In 1844, the first law that set the number of hours for young women to 12 hours per day was approved in England, which can be considered an initial step in the field of safety regulations. In 1884, Germany formulated the first workers' compensation law, followed by Austria in 1887 and England in 1897 [4].

In her research, Burcar proposed failure prioritization using the intuitionistic fuzzy ranking method. He explains the advantages of using the fuzzy intuitive ranking method as follows. 1) this method reduces the probability of obtaining the same risk priority numbers, and 2) failure information in the FMECA method is described as fuzzy intuitive variables, which causes a more realistic reflection. It becomes more flexible than practical conditions; 3) the results obtained from this method provide more accurate and effective information for the decision-making process; and 4) the mentioned approach can provide the possibility of evaluating redundant items. This action can help the designer make the right decision to make a safer and more reliable product [5].

2 | Risk

Major changes in the business environment, such as the globalization of business and the rapid pace of changes in technology, have increased competition and the difficulty of management in organizations. In these difficult, specific and complex conditions, risk management affecting existing risks constitutes an important part of the decision-making process. In other words, environmental uncertainty and the intensity of competition between organizations and managers have confronted them with numerous challenges. 1 For the effective management of these challenges, new management approaches and specific competencies have been proposed and recommended. Risk identification and management is one of the new approaches used to strengthen and enhance the effectiveness of organizations. In general, risk is understood as the concept of probability, loss or uncertainty, which has different types and diverse classifications. One of these classifications is speculative risk and hazardous risk. All forms of risk include common elements such as content, activity, conditions and consequences. Another classification is strategic risk and operational risk. Risk management refers to the concept of assessing risk and then adopting strategies to manage it. Risk types can be divided according to their probability of occurrence and impact, which results in risk reinforcement and the application of appropriate strategies (transfer, avoid, reduce and accept) [6].

2.1 | Definition of Risk

To understand the nature of risk, we must first start with its definition. Although there are many differences in how risk is defined, the definition that follows briefly shows its nature: risk is the probability of incurring a loss [7]. This definition includes two main aspects of risk.

I. The amount of loss must be possible.

II. There must also be uncertainty about that loss.

In most definitions of risk, its two aspects, namely loss and uncertainty, are clearly mentioned. However, its third aspect, namely choice, is usually implicitly mentioned, where choice means how to pay attention to it. These three conditions are the fundamental foundations of risk and the basis for its deeper investigation.

2.2 | Different Types of Risk

We know that the term risk is currently widely used, but different audiences often have relatively different interpretations of it [8]. For example, the way risk is related to opportunity depends on the circumstances in which the risk is perceived. Sometimes, a situation provides both the opportunity for profit and the potential for loss. But in other cases, there is no opportunity for profit, only the potential for loss. Therefore, risk can have two other types of subdivisions:

I. Speculative risk.

II. Hazardous risk.

2.3 | Risk Assessment

Today, the use of risk assessment methods in various industries is expanding. So that there are currently more than 70 different qualitative and quantitative risk assessment methods in the world. These methods are usually used to identify, control and reduce the consequences of risks. The main methods of risk assessment are suitable for assessing risks and their results can be used to manage and make decisions about controlling and reducing its consequences without worry. Each industry can benefit from the aforementioned methods depending on its needs. These methods have different advantages and disadvantages compared to each other. Therefore, one of the tasks of the health and safety systems in each industry (HSE) is to examine all methods of assessing risks and hazards and select the appropriate method to implement in its respective industry and organization. In general, it can be said that the type of method used in risk assessment and the depth of its assessment can, to some extent, determine the ability of the existing safety system and, as a result, the way in which safety is managed in the said industry.

Usually, the acceptable level of risk is different for each organization or individual and depends on financial and economic resources, technological limitations, experienced human factors, discretion and decision-making in managing risks such as hidden risks.

Organizations usually need a system that, in addition to assessing their activities and processes, can guide them on the risk status, determine tolerable risk criteria, and accurately specify the risk of their processes, etc. Depending on the complexity of each industry's activities, the type of system that can help them achieve the aforementioned goal varies. Therefore, organizations should be able to choose one or a combination of several risk assessment methods. In some cases and for some sensitive processes, especially in the chemical industry producing explosive and combustible products, all methods should be analyzed before determining the type of method, and the best method should be selected considering financial resources, the need for qualitative or quantitative information, time constraints, limitations on experienced workforce, type of application, risk identification method, advantages and disadvantages of each of the aforementioned systems. Basically, systems analysis is a highly skilled method and should be carried out by a complete team of experts who have complete knowledge of their organization. Choosing the right risk identification method leads to the efficiency of the selected method and the accurate determination of risks. Also, if the risk of each process is correctly identified, determining acceptable risk and corrective actions to reduce risk are more tangible [9].

2.4 | Risk Management

Project risk is an integral part of every project, so it must be managed. Correct risk management is a prerequisite for facilitating the project's critical conditions, and the need to acquire related sciences and expand these sciences is obvious. Project risk management consists of all processes related to identifying, analyzing, and responding to any uncertainty, which includes maximizing the results of favorable events and minimizing unfavorable results. In fact, it can be said that risk management is a new approach in order to improve the

effectiveness of organizations, which is of undeniable importance due to the uncertain nature of projects and the need to spend project resources [10] optimally. Safety risks are one of the key issues of risk management. Risk factors can exist for long periods without an accident occurring. The general goal of risk management is to increase the opportunities and reduce the risk consequences of each event [11].

3 | System Safety

It is a branch of system engineering that, by applying scientific, engineering, and management principles, in order to achieve appropriate and sufficient safety, identifying risks at the time and initiating preventive measures throughout the life of the system, taking into account efficiency limitations, time, and cost. The system is a set of instructions and equipment to perform a specific task or set of tasks.

4 | Safety Plan Factors

I. Preliminary planning: in this stage, general and partial goals are defined.

II. Design: the program is more detailed in the design, and the map, parameters and features of the design are compiled.

III. Implementation: the programs are implemented considering that it is associated with a lot of costs. This step is very important.

IV. Operation: at this stage, the efforts of the system process will become practical.

5 | Evaluation of Its Systems and Methods

It consists of using available information to identify risks and estimate the risk caused by them for people, population, assets, or the environment, which has three main elements:

I. Identify risks.

II. Risk assessment of identified risks.

III. Provide suggestions for safety measures.

6 | Suggesting Safety Measures

The severity and probability of occurrence provide a suitable index for determining the priorities of the risk. The smaller the probability of occurrence, the more acceptable the risk. No matter how old the system is, it is more expensive to make changes to reduce their risk. A set of actions is important in terms of prioritization.

7 | Using Safety Equipment in the System

If it is not possible to eliminate the risks or reduce their risk, they should be reduced by using engineering controls and safety tools, and it is better to consider periodic inspection in the operation and maintenance of safety tools. If the controls did not lead to risk reduction, tools should be used to identify dangerous conditions and create appropriate signs to inform employees of the risk [12].

8 | Reducing Safety Risks in Construction Projects

The construction industry is known as one of the most dangerous industries in terms of work-related losses, injury rates, and compensation payments to workers. Fatal injuries, serious occupational injuries, and lost time occur in this industry due to its unique nature. According to the statistics of the Ministry of Labor and Social Affairs in recent years in our country, 44% of all accidents occurred in industries, on average, accidents in construction sites. Therefore, paying attention to safety and reducing safety accidents in this industry seems necessary. The method of potential error analysis and its effects (FMEA) can identify all failure modes, evaluate their effects, and plan for corrective measures. Safety management is a decision-making tool for

improving the continuous performance of a system in which saving human lives is defined as goal setting. In construction projects, the safety department has always had a special place. Still, today, due to the identification and occurrence of all kinds of risks and crises caused by the fact that they were not defined in the safety system before, on the one hand, and from On the other hand, it has been raised that it is not up to the capacity of the organization's safety. In order to deal with these risks, risk management and crisis management methods are used inconsistently at the top levels of the organization. In order to deal with the risks and accidents caused by it in a structured way, it is necessary to use safety, crisis, and risk management together.

Crisis management

Crisis management includes all activities that are carried out to prevent and reduce the effects of a crisis and quickly return to normal conditions. In addition to the official government body, non-governmental Non-Governmental Organizations (NGOs) and social organizations also play a vital role in crisis management.

Crisis management stages

The stages of a crisis vary based on different definitions of organizations, institutions, etc. The most important stages include the following:

Preparedness

Preparedness to deal with a crisis must exist continuously and permanently at the level of organizations and local government departments. Preparedness criteria can be considered as logistical preparedness to deal with crises and can be strengthened and developed through the regulation of mechanisms and guidelines for response, public education, and the design of rapid warning systems.

Response and technician

After a crisis (disaster) occurs, it is necessary to take immediate measures related to response and relief. No delay is acceptable at this stage. Delay occurs if the responsible government agencies do not have the necessary plans in place in a clear manner. Therefore, having strong contingency plans is very important at this stage.

For example, in the event of a disaster such as a major flood in a city, it is necessary that the search and rescue plans are clearly formulated and all the main actors have complete information about their roles and functions. Basic needs such as shelter, water, food, and medical aid are provided, and an implementation plan that clarifies the responsibility of each person for this activity is available. In the response stage, volunteers, local officials, government agencies and private organizations first begin their activities. In addition, if the damage exceeds local or provincial capabilities, national assistance is required.

Reconstruction and recovery

In practice, for many disaster victims, the reconstruction phase is the most difficult time of the incident-related phase. Activities related to job creation, reconstruction of the destroyed site, social reconstruction, and some of the necessary measures are in this phase. The victims cannot be forgotten when the disaster itself ends.

Safety management phases

The most important principle in safety management is to prevent accidents. Therefore, managerial and technical skills in systematic identification and control of hazards constitute a major part of the safety management process. Therefore, risk management, which involves the process of timely identification of hazards, their elimination or control, and is achieved through risk assessment, prioritization, and then necessary decision-making, constitutes the most important part of system safety management.

The planning phase includes estimating the effects and consequences of known hazards. Risk analysis, its leveling, and then the necessary action for each level of risk from the prevention, adjustment, preparedness,

and response stages are carried out in this stage. This process is before any accident occurs and is considered a preventive measure.

The operation stage includes the risks that lead to accidents and requires an operation process in which preventive, adjustment, preparedness, and response measures are necessary in proportion to the accident levels.

Considering the overall process of dealing with risks, the stages covered by each of the management methods were examined. Safety management has a phase of risk recognition and, given its position, especially in the construction sector, it includes both natural hazards and unintentional manufactured hazards. In the planning stage, safety management plans and controls controllable and semi-controllable accidents by recognizing the damage caused, and then in the operation stage, predetermined plans are implemented [13].

Safety management system

The safety management system is responsible for the necessary organization for safety management, including the definition of the necessary building structures and policies. The complexity of the safety management system is proportional to the needs of the organization.

The safety management system implementation plan [14]:

I. Determining the safety policy
II. Safety planning objectives
III. System description
IV. Failure analysis
V. Introducing the components of the safety management system
VI. Roles and responsibilities of the safety system
VII. Safety reporting policy
VIII. Defining the level of workforce involvement
IX. Safety system performance
X. Safety system performance inspection
XI. Safety training

Components of a safety management system

A safety management system should have the following 4 components [15].

I. Safety and health-related policy and objectives
II. Risk management
III. Insurance affairs
IV. Safety promotion

Safety policy and goal setting

Safety policy includes the methods and processes that an organization uses to achieve the expected level of safety. Creating a positive and constructive safety culture begins with a clear and explicit direction for management accountability. In preparing a safety policy, senior management should consult with staff members regarding the critical points of the safety system. Consultation between members strengthens the sense of shared responsibility for the safety culture among all members of the organization.

Policy and goal setting can be divided into 5 parts [15].

I. Management commitment and accountability
II. Managerial accountability
III. Appointment of safety personnel
IV. Emergency response planning
V. Documentation

Appointment of safety personnel

The organizational structure of the safety management system should be developed based on the size, nature and complexity of the organization, and different positions for people in it should be defined.

Safety Manager: Should be appointed by senior management and have the necessary authority when dealing with safety-related matters and should report directly to the responsible manager of the organization. The safety manager should have the following qualifications.

- *Experience in work management and having a suitable executive background to understand the systems used in the organization*
- *Social skills, as well as speaking and communication skills*
- *Analytical and problem-solving skills*
- *Project management skills*

It is worth noting that the responsibility for the management system is the responsibility of the responsible manager, not the safety manager. The safety manager is a central point for the development and sustainability of an effective safety management system.

The safety manager should at least perform the following tasks [16]:

- *Managing the system implementation plan on behalf of the responsible manager*
- *Equipping the risk management process, which should include identifying hazards and mitigating them*
- *Observing and following up on corrective actions to ensure progress*
- *Preparing periodic reports on the safety department's performance*
- *Planning for the training of forces*
- *Continuing the process of documentation in the safety department*
- *Providing independent suggestions on safety matters*
- *Providing suggestions to the senior manager on matters related to the safety department*
- *Collaborating with line managers*
- *Monitoring the process of hazard identification*
- *Involvement in the process of searching and investigating accidents and incidents*

Safety committees

Safety Review Board (SRB): this board is a high-level committee that reviews the activities of the safety department. The responsible manager should chair the board and include senior management and managers from other departments. This committee ensures that resources are deployed in their proper place to achieve appropriate safety performance and provides appropriate direction to the Safety Action Group (SAG).

The committee is responsible for reviewing the following:

I. Safety department performance in accordance with policies and objectives
II. The effectiveness of the safety management system implementation plan
III. The effectiveness of corrective and mitigation actions

Safety action group

The role of this group is to report and provide strategic direction to the SRB. This group includes managers, supervisors and members involved in the organization's operational areas. The safety director is also included in this group. The SAG has the following responsibilities [17]:

I. Monitors process safety.

II. Mitigates identified risks.

III. Evaluates the safety impact of process changes.

IV. Implements action plans for process correction.

V. Evaluates safety improvements

Emergency response planning

This section (ERP) is responsible for planning safety operations in emergencies. This section should function as a sub-section of the safety management system and reflect the size, nature and complexity of the activities carried out in the organization. The ERP functions are as follows:

- *Adequate and useful discipline and preparedness in emergencies*
- *Determining legal authority in relation to emergencies*
- *Determining the responsibility of different departments in emergencies*
- *Coordinating the activities of different departments to restore the emergency situation to normal*

The ERP should consider the following:

- *Adopted policies*
- *Notifications and warnings*
- *Notification tools*
- *Crisis management center*
- *Review of previous similar incidents*
- *Initial response*
- *Formal investigation and investigation.*

Documentation

The documentation section for a safety management system should reflect the nature, size and complexity of the organization and typically includes the following:

I. Regulations

II. System documents and document management center

III. Safety management system manual

The safety management system manual should be the main reference for achieving safety for all members of the organization and should cover all aspects of the safety management system, including the safety department policy, objectives and goals, operational procedures in the organization, responsibilities and expectations.

The manual includes the following:

- *Scope and scope of the safety management system*
- *Policy and objectives*
- *Expectations and responsibilities*

- *Document control process*
- *Risk management and hazard identification process*
- *Safety performance review process*
- *Introduction of key safety personnel*
- *Safety promotion process*
- *Contract activities*
- *ERP*

Hazard identification process

A hazard is any condition or situation that has the potential to cause a harmful outcome. The hazard identification process includes the process of collecting, recording, analyzing, acting on, and providing feedback on hazards that affect the safety of the organization's process activities. In a strong safety management system, hazard identification is an ongoing process.

The steps in the hazard identification and analysis process are as follows:

- *Hazard identification: identifying hazards to personnel and equipment*
- *Hazard assessment (risk severity if it occurs): calculating the severity of the hazard*
- *Hazard assessment (probability of occurrence): how likely is the hazard to occur?*
- *Hazard assessment (acceptability): the final assessment of the acceptability of the hazard to the organization if it occurs*

If the risk is acceptable to the organization, it means that no safety measures need to be taken in relation to this. If it is not acceptable, it is necessary to take the necessary measures to reduce the risk to an acceptable level.

Risk identification

Risk identification is the process of assessing the feasibility and severity of the consequences and damages resulting from an identified hazard. Mathematical models are usually valid results, but qualitative logical analyses usually supplement these analyses. The use of a risk matrix can be useful for identifying the risk of an identified hazard.

Classification of risk by severity of consequences

- *Catastrophic: high mortality rate - Loss of equipment (value = 5).*
- *Hazardous: death and serious injury and damage to major equipment (value = 4).*
- *Large-scale: significant reduction in the organization's ability to work in working conditions caused by work overload and serious injuries to personnel and equipment (value = 3).*
- *Small-scale: minor injuries, use of emergency procedures, practical limitations (value = 2).*
- *Negligible: minor and negligible damage (value = 1).*

Classification by likelihood of occurrence

- *Frequent: likely, the number of occurrences is high (value = 5).*
- *Occasional: likely, sometimes occurs (value = 4).*
- *Unlikely, minor: unlikely, but may occur (value = 3).*
- *Unlikely: very unlikely to occur (value = 2).*
- *Very unlikely: almost impossible to occur (value = 1).*

Risk classification

Acceptable: the following harm is likely or not of such a magnitude as to cause concern. The risk is tolerable. However, special considerations must be taken to minimize the extent of the harm caused by the risk.

Analyzable: there is a basis for concern. Measurements and analyses are made to reduce the extent of the risk as far as is reasonably practicable. Once a risk is under investigation, the investigation should continue until the risk is fully understood and acceptable.

Unacceptable: the consequences of the risk and its severity cannot be ignored. Risk reduction and correction measures are essential to reduce the likelihood and severity of an incident associated with the hazard [14].

Risk mitigation

Risk should be managed to the lowest level practicable and optimized in terms of time and cost.

The level of risk can be reduced by reducing the severity of potential consequences and reducing the likelihood of occurrence. Corrective action removes obstacles to reducing the level of risk. The scope and scale of any safety investigation should be appropriate to measure and validate the risks involved.

Safety investigation methods

Investigations follow a step-by-step process that may require iterating and repeating steps to obtain new results. Information sources should include [17]:

I. Documentation
II. Observation of operational statistics and data
III. Visits and interviews
IV. Simulations
V. Safety databases

Safety assurance

Safety assurance includes the following components:

- *Monitoring, measuring and reviewing safety performance*
- *Change management*
- *Progressive improvement of safety responsibility*

Monitoring and measuring safety performance

The matters that should be considered during this process include.

I. Safety reporting
II. Safety studies
III. Safety inspection
IV. Evaluation

Safety inspection is to ensure the structure of the safety management system in relation to the following:

I. Competence of members employed at each level
II. Compliance of work processes with predetermined procedures and instructions
III. Inspection of equipment and facilities used in the system and ensuring the appropriate quality level of their performance

The following are usually used in safety assessments.

I. Checklists

II. Questionnaires

III. Formal interviews

Progressive improvement

The process of progressive improvement of the safety system should.

I. Consider the results of performance below the safety standard in the organization and follow its reasons.

II. Act to compensate for and improve the conditions involved in performance below the safety standard.

Progressive improvement can only be achieved by the following measures:

I. Assessing the facilities, equipment, documents and methods used through formal inspections and evaluations.

II. Evaluation to confirm the effectiveness of the safety management system used to control and mitigate risks, for example, by reviewing statistics on accidents and incidents.

III. Monitoring organizational changes to determine the effectiveness of these changes.

Safety promotion

Training: all members should receive safety training sufficient for their safety responsibilities. In particular, all members involved in the process, managers, supervisors, senior managers and responsible managers should be trained.

Members involved in the process: Active members should have a good understanding of the organization's safety policy and know the basic principles of the safety management system.

Managers and supervisors: managers and supervisors should understand the safety process, hazard identification, risk management and change management.

Senior managers: senior managers should know the organizational safety standards, regulations and safety guarantees required for the organization.

Responsible manager: the responsible manager should have adequate knowledge of the roles and responsibilities of the safety management system, safety policy, safety standards and guarantees [18].

Safety department communication

Safety communication is an essential part of developing and maintaining an effective safety culture. Various aspects of this communication can include the following:

- *Newsletters*
- *Safety announcements and announcements*
- *Introductions and demonstrations*
- *Informal meetings and workshops between members and senior managers or the responsible manager*

Safety department communication should.

I. Ensure that all members of the organization are adequately aware of the safety management system and safety culture.

II. Communicate critical safety department information.

III. Explain the reasons for safety actions taken.

IV. Explain the reasons for adopting new safety procedures and changes to previous methods.

V. Ensure the effects of safety communication on the safety level of the organization.

VI. Help to increase the safety culture in the organization [18].

The importance of work-related accidents

Risks indicate conditions that are beyond the control of the project control team and, if not managed properly, have irreparable effects on the project. One of these effects is work-related accidents. The International Labor Organization defines a work-related accident as follows:

An accident is an unforeseen and unexpected event that causes injury and damage.

Work-related accidents, on the one hand, cause physical and mental injuries and, as a result, cause discomfort to the worker or his family members. On the other hand, they cause capital loss and economic loss, so they are important from various aspects.

Causes of work-related accidents

Studies and investigations conducted indicate that, in general, work-related accidents do not have a single cause and are the result of technical and human factors. These causes depend on the type of work, the environment, the working conditions, and the tools used, and they can be divided into two categories: direct and indirect causes:

Direct causes: direct causes are those causes that have a major contribution to the occurrence of the accident, such as improper work, excessive speed, defective equipment, negligence and failure, such as management failure to create a safe environment, negligence in informing and installing warning signs, and failure to use protective equipment.

Sub-direct causes: some cases are not the cause of accidents, but they increase their number. These causes can include personal factors, such as lack of knowledge and skills, lack of motivation or physical and mental disabilities or be caused by other factors, such as management, inappropriate design, inappropriate work environment or unsafe methods (Collection of accidents caused by work, Archives of the general directorate of state inspection).

Causes of accidents in projects

- *Behavioral causes: related to the person and his/her negligence*
- *Environmental causes: related to the factors involved (due to the injured person)*
- *Physical causes: such as poor eyesight, distraction, etc*
- *Psychological causes: such as psychological stress, job dissatisfaction, etc*
- *Economic causes: such as avoiding investment in safety matters for economic reasons, not paying attention to technical defects of devices*
- *Cultural and social causes: such as weak safety culture, cultural and social habits, fatalism*

When an accident occurs, a series of obvious and hidden costs are imposed on the system as follows:

I. Waste of time The injured person's usefulness during treatment

II. Stopping or delaying the team in which the injured member was active

III. The amount of time the rescuer spends helping and caring for the injured

IV. Costs and time required for investigations and preparing an accident report

V. Other hidden costs

In the first step to establishing a safety system in a workshop, an appropriate safety program should be designed for the workshop. All committed personnel must accept the safety program. It is even recommended that the contractor consider a series of rewards and prizes to encourage and motivate regular compliance with safety measures. All personnel must be adequately trained in the field of familiarization with the hazards and

compliance with safety tips, and protective and emergency equipment must be provided in the nearest easily accessible place.

It should be noted that the characteristics that are proposed for safety must be common among people and be relatively stable. The meaning of commonality is the existence of a core of key attitudes and values regarding safety that most people adhere to. Relatively stable means that changes in safety must be gradual, and any sudden changes are doomed to failure.

9 | Conclusion

As mentioned in the introduction of this chapter, the use of the output of two fuzzy methods, despite the difference in some results, provides possibilities. Fuzzy logic makes mathematical tools more effective in facing the truth. In this research, in addition to benefiting from effective results, we now have two decision tools to reduce the safety risk of construction projects. In cases where two methods predict the same ranks, we can make an opinion with more confidence (as well as if we reached a certain rank from one ranking method while being firm in the numerical superiority of the weight of the option; this level of confidence would not exist).

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