

Accident risk assessment of construction projects by AHP method in Tehran

Pedram Mohammadzadeh

Department of Industrial Engineering, Faculty of Engineering, South Tehran Branch, Islamic Azad University, Tehran, Iran.

Correspondence: Pedram Mohammadzadeh, Department of Industrial Engineering, Faculty of Engineering, South Tehran Branch, Islamic Azad University, Tehran, Iran.

ABSTRACT

The present research aims to assess and prioritize the possible risk concerning construction projects in district 22 of Tehran using the analytic hierarchy process (AHP). A questionnaire containing 37 statements were used to collect data through which criteria as well as sub-criteria regarding potential risks and dangers of running construction projects in district 22 of Tehran were determined. Detected risks were fire and explosion, building collapse, falling from a scaffold, stumbling and colliding with things, electric shock, getting stuck between things, being subject to dangerous materials, and the last but not the least sliding. Data were examined through the TOPSIS method. Results suggest that sliding, getting stuck between things, as well as fire and explosion are referred to as the top three risk factors in terms of importance among existent risks in the construction sites in district 22 of Tehran.

Keywords: Risk, Accidents, Construction projects, Multi-criteria decision.

Introduction

Job accidents annually cause over three hundred thousand mortalities and more than three hundred million injuries worldwide. The high amount of these events cause societies to suffer from diverse serious human and financial damages. Previous studies have demonstrated that labors working in different industries will be widely subject to job accidents. The construction sector is among the most dangerous industries worldwide. Mortalities arising from injuries during work, serious job damages as well as lost time are usual in this industry^[1]. Diverse factors such as continuous changes in the work place, regular changes of the team members due to shift works, inappropriate work conditions, being subject to all weathers, and high number of unskilled and temporary workers will lead

to several events in this sector. Therefore, analyzing safety and job risks in large construction sites is taken into account as a vital step to achieve an appropriate safety level and the basis of security management in the construction industry which forms a part of the safety management system^[2]. The project risk management as one of the nine-fold strategic management elements plays a pivotal role in the project's success. Experience of applying the method in diverse projects has revealed its efficiency. Every project has its own risks which offer some chances and uncertainties for increasing its value, so it may cause many problems when there is not a good balance between chances for increasing value and major risks.

An effective risk management will lead to proper management of the project. Regarding environmental uncertainties as well as distinctive features of projects, risk management is not only unavoidable but also is of great importance^[3]. Construction projects are subject to diverse risks from the beginning. On other hand, such accidents impose direct and indirect expenses on the project which are seen as risk factors that decrease value and quality of construction projects. So, all beneficiaries are seeking to decrease such risks. There is a close relationship between accidents and solution to decrease them and combinational parameters of the risk management^[4]. Risk detection underlies determination and documentation of risk

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factors which will affect the project. Members of the project team, the risk management team, authorities of different parts of the company, clients, final users, other project managers, beneficiaries, and foreign experts are all involved in detecting risks. Risk detection is a repetitious process. So, simple and effective solutions to the risks could be provided and fulfilled once a risk is detected.

Today, there are diverse risk analysis methods which are utilized to evaluate and estimate risks. These methods may be divided into qualitative and quantitative classifications depending on available information or amount of necessary details [5]. Considerations concerning accessibility, time, budget, as well as demanding for qualitative or quantitative reports about risk and its impacts would determine its usage. When quantitative analyzes are repeated, course of results will show the necessity for increasing or decreasing measures for risk management [6]. Salimi et al (2017), carried out a research entitled "a combination of risk management and value engineering in order to decrease the number of accidents taking place in construction sites". First, they studied risk management and its conception in order to find key factors which pose risk and then they built a bridge between management of value engineering and risk management through illustrating characteristics of the value engineering and its advantages. The research results showed that combination of value engineering and risk management will lead to a decrease in the accidents' rate occurring in construction sites [4].

Hang Lee et al (2016), in a study entitled "making the use of technology in order to reduce accidents in the construction industry by means of such technological and state-of-art methods of safety as intelligent care, control and automation of personnel" came up with some effective solutions [7].

A thoughtful planning for risk management needs to be economical, convenient, realistic, widely accepted from all involved sectors and certifiable by an expert. It is often necessary to provide the best feedback on the risk among diverse choices. Therefore, the present research aimed to assess and prioritize risk as well as potential accidents which are normally occurred in the construction sites in district 22 of Tehran using the multi criteria decision making (MCDM) method.

Methodology

A combination of descriptive, applied, and inductive approaches was used in this study. The initial sample was made up 80 contractors, managers, and consultants. The sample size was reduced to 40 after using the Cochran formula.

In this study, a combination of library and field methods were used to collect data. For this purpose, a five-point Likert scale questionnaire was used. With this scale, respondents were asked to specify their level of agreement to statements typically in five points: 1- very low, 2- low, 3- medium, 4-high, and 5-very high.

A copy of questionnaire used is here with enclosed. Collected data were finally evaluated making the use of SPSS (for obtaining descriptive statistics, validity and stability), as well as TOPSIS (for inferential statistics).

Research variables

Potential risk and dangers occurring in construction sites were applied as research variables. The accidents and number of questionnaire statements were as follow:

1. Fire and explosion (3 statements)
2. Building collapse (9 statements)
3. Falling from a scaffold (5 statements)
4. stumbling or colliding with things (6 statements)
5. Electric shock (5 statements)
6. Getting stuck between things (3 statements)
7. Being subject to dangerous material (3 statements)
8. Sliding (3 statements)

Analyzing the questionnaire

First of all, questionnaires' reliability and validity were studied through Cronbach's alpha test and CVR indexes, respectively, by making the use of SPSS software. Then, data obtained from the questionnaire was evaluated via the TOPSIS method for responding to research questions.

Content validity ratio (CVR)

Regarding the number of experts who had evaluated the questionnaire statements, the minimum admissible CVR needed to be based on the table below. As a result, statements for which the calculated CVR value was less than the given amount concerning the number of experts should be removed, simply because they lack acceptable validity on the basis of the CVR index.

Table 1- The minimum admissible CVR value based on the number of assessors

Number of experts	CVR	Number of experts	CVR	Number of experts	CVR
5	0.99	11	0.59	25	0.37
6	0.99	12	0.56	30	0.33
7	0.99	13	0.54	35	0.31
8	0.75	4	0.51	40	0.29
9	0.78	15	0.49		
10	0.62	20	0.42		

CVR value obtained for this research (0.42) suggests admissible validity of the questionnaire.

Reliability

The questionnaire reliability was determined by means of Coefficient Alpha (Cronbach's). The Coefficient Alpha value higher than 0.7 indicates a very good level of questionnaire's reliability, and values between 0.6-0.7 show an acceptable level.

As in the present research, the Coefficient Alpha were found to be 0.76. so, we deduce that the questionnaire had acceptable reliability.

Multi criteria decision making (MCDM)

A multiple criteria decision making method (MCDM) refers to special preferential decisions such as assessing, prioritizing, and/or choosing from available choices which sometimes needs to be done among some opposed indexes. The MSDM method includes the following steps:

1. Determining the purpose of decision making
2. Making a list of decision criteria
3. Summarizing decision criteria
4. Defining choices/ solutions
5. Developing the matrix of decision making
6. Determining weight of decision criteria
7. Comparing choices with decision criteria
8. assessing and selecting the final choice

The TOPSIS method

The TOPSIS method, in the present research, was used to analyze data obtained from the questionnaire. Steps of the method are as follow:

Zero Step: calculating the decision matrix:

$$D = \begin{matrix} & X_1 & X_2 & \dots & X_j & \dots & X_n \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{matrix} & \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1j} & \dots & X_{1n} \\ X_{21} & X_{22} & \dots & X_{2j} & \dots & X_{2n} \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ X_{i1} & X_{i2} & \dots & X_{ij} & \dots & X_{in} \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ X_{m1} & X_{m2} & \dots & X_{mj} & \dots & X_{mn} \end{bmatrix} \end{matrix} \quad (1)$$

A_i : refers to the i^{th} choice

X_{ij} : refers to the numerical value obtained from the i^{th} choice with j^{th} index

In this matrix, profit and cost are referred to indexes having positive and negative desirability, respectively.

1. Quantifying and unscaling the decision matrix (N): A norm unscaling method was used in this research. The step aimed to unscale available scales in the decision matrix. In the same way, obtained values were divided into the vector length of the same index. So, the equation below is used to obtain entry of every matrix (r_{ij}):

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^m X_{ij}^2}} \quad (2)$$

2. Calculating a measured unscaled matrix (V):

A decision matrix is a parametric factor which is needed to be quantified. Therefore, the decision maker introduces a weight for every index. The sum of weights (W) is multiplied in a normalized matrix (R).

$$W = (w_1, w_2, \dots, w_j, \dots, w_n) \quad (3)$$

$$\sum_{j=1}^n w_j = 1 \quad (4)$$

$$V = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1j} & \dots & v_{1n} \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ v_{i1} & v_{i2} & \dots & v_{ij} & \dots & v_{in} \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ v_{m1} & v_{m2} & \dots & v_{mj} & \dots & v_{mn} \end{bmatrix} = \quad (5)$$

$$\begin{bmatrix} w_1 v_{11} & w_2 v_{12} & \dots & w_j v_{1j} & \dots & w_n v_{1n} \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ w_1 v_{i1} & w_2 v_{i2} & \dots & w_j v_{ij} & \dots & w_n v_{in} \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ w_1 v_{m1} & w_2 v_{m2} & \dots & w_j v_{mj} & \dots & w_n v_{mn} \end{bmatrix} \quad (6)$$

3. Determining a positive and negative ideal solution: the step is defined as follow:

$$\begin{cases} (V_j +): A \text{ positive ideal solution} = \\ \text{[is defined as the vector of good values for every index of matrix V]} \\ (V_j -): A \text{ negative ideal solution} = \\ \text{[is defined as the vector of poor values for every index of matrix V]} \end{cases} \quad (7)$$

$$\begin{matrix} \text{Positive} \\ \text{ideal option} \end{matrix} \quad A^+ = \left\{ \left(\max_{i,j} v_{ij} \mid j \in J \right) \left(\min_{i,j} v_{ij} \mid j \in J' \right) \mid i = 1, 2, \dots, m \right\} = \{ v_1^*, v_2^*, \dots, v_j^*, \dots, v_n^* \}$$

$$\begin{matrix} \text{Negative} \\ \text{ideal option} \end{matrix} \quad A^- = \left\{ \left(\min_{i,j} v_{ij} \mid j \in J \right) \left(\max_{i,j} v_{ij} \mid j \in J' \right) \mid i = 1, 2, \dots, m \right\} = \{ v_1^-, v_2^-, \dots, v_j^-, \dots, v_n^- \}$$

(8)

The best value for positive indexes is referred as the maximum value introduced to that criteria for diverse choices in a measured unscaled matrix. While, for negative criteria, it would be the minimum value. Therefore, the equation needs to be reversed for determining a negative ideal solution.

4. Calculating distance from every choice to negative and positive ideals

A Euclidean or orthogonal distance was used for calculating the distance. The Euclidean distance between every choice and a positive ideal, as well as the orthogonal distance between every choice and a negative ideal were determined via equations below.

$$d_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2}, \quad i = 1, 2, \dots, m \quad (9)$$

$$d_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2}, \quad i = 1, 2, \dots, m \quad (10)$$

5. Determining the proximity coefficient (CL) of a choice to an ideal solution:

$$CL_i^* = \frac{d_i^-}{d_i^- + d_i^+} \quad 0 < C_{i^*} < 1 \quad (11)$$

Clearly, the less distant a choice is from an ideal solution, the proximity coefficient would be more close to 1.

6. Ranking choices

The more CL is, the choice would be better. For this purpose, the relative distance to every choice should be calculated and organized from high to low. So, the choice that has the maximum relative distance compared with others would obtain the highest rank.

Findings

Ranking criteria making the use of the TOPSIS method

The respondents were asked to choose a number from 1-5 in order to answer statements. Table 2 illustrates the average matrix for ranking criteria.

Table 2: Average matrix for ranking criteria

Average matrix	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8
Choice 1	2.9	2.9	3	3	3	3	3	3
Choice 2	2	2.1	2.1	2	2	2	2	2
Choice 3	4	3.8	3.8	4	4	4	4	4
Choice 4	4	3.9	3.9	4	4	4	4	4
Choice 5	4	4.1	3.8	3.8	4	4	4	4
Choice 6	4	4	4	3.9	3.8	4	4	4
Choice 7	4	4	3.9	4.1	4	4	4	4
Choice 8	3	3	2.9	2.9	3.1	3	3	3
Choice 9	2	2.2	2.2	2.2	2.2	2	2	2
Choice 10	4	4.1	4	4.1	4	4	3.8	4
Choice 11	2.6	2.4	2.6	2.9	2.5	2.1	2	2
Choice 12	2.8	2.9	2.9	2.6	2.5	2.6	2.4	2
Choice 13	5	4.9	4.8	5	5	5	5	5
Choice 14	4	4	3.9	4	4	4	4	4
Choice 15	4	4	3.9	4	4	4	4	4
Choice 16	4	4	3.8	4	4	4	4	4
Choice 17	3	3	2.9	3	3	3	3	3
Choice 18	3	3	3.1	3	3.1	3.1	3	3
Choice 19	3	3	3	3	3	3	3.1	3
Choice 20	3	3	3	3	3.1	3.1	3	3
Choice 21	4	4	3.9	4	3.9	3.9	4	4
Choice 22	4	4	3.9	4	4.1	4.1	4	4
Choice 23	2	2	2.1	2.3	2.3	2	2.3	2
Choice 24	4	4	4	4	4	4	3.9	4
Choice 25	2	2	2.2	2	2.2	2	2.2	2
Choice 26	2	2	2.2	2	2.2	2	2.2	2
Choice 27	3	3	3.1	3	3.1	3	3.1	3
Choice 28	2	2	2.2	2	2.2	2	2.2	2
Choice 29	3	3	3.1	3	3.1	3	3.1	3
Choice 30	3	3	3.1	3	3.1	3	3.1	3
Choice 31	2	2	2.2	2	2	2	2.2	2
Choice 32	3	3	3.1	3	3	3	3.1	3
Choice 33	2	2	2.2	2	2	2	2.2	2
Choice 34	3	3	3.1	3	3	3	3	3
Choice 35	5	5	5	5	5	5	4.8	5
Choice 36	5	4.9	4.9	4.9	5	4.9	4.8	4.9
Choice 37	5	4.8	4.7	4.8	4.8	5	5	5

Measured matrix

As can be seen from the table (3), the weighted matrix was calculated given measures of indexes.

Table 3: Weighted matrix was calculated given measures of indexes

Measured matrix	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8
Choice 1	0.0184	0.0175	0.0148	0.0176	0.0166	0.0197	0.017	0.021
Choice 2	0.0127	0.0127	0.0104	0.0117	0.0111	0.0131	0.0113	0.014
Choice 3	0.0254	0.023	0.0187	0.0235	0.0222	0.0263	0.0227	0.028
Choice 4	0.0254	0.0236	0.0192	0.0235	0.0222	0.0263	0.0227	0.028
Choice 5	0.0254	0.0248	0.0187	0.0223	0.0222	0.0263	0.0227	0.028
Choice 6	0.0254	0.0242	0.0197	0.0229	0.0211	0.0263	0.0227	0.028
Choice 7	0.0254	0.0242	0.0192	0.0241	0.0222	0.0263	0.0227	0.028
Choice 8	0.019	0.0181	0.0143	0.017	0.0172	0.0197	0.017	0.021
Choice 9	0.0127	0.0133	0.0108	0.0129	0.0122	0.0131	0.0113	0.014
Choice 10	0.0254	0.0248	0.0197	0.0241	0.0222	0.0263	0.0216	0.028
Choice 11	0.0165	0.0145	0.0128	0.017	0.0139	0.0138	0.0113	0.014
Choice 12	0.0177	0.0175	0.0143	0.0153	0.0139	0.0171	0.0136	0.014
Choice 13	0.0317	0.0296	0.0237	0.0294	0.0277	0.0328	0.0284	0.035
Choice 14	0.0254	0.0242	0.0192	0.0235	0.0222	0.0263	0.0227	0.028
Choice 15	0.0254	0.0242	0.0192	0.0235	0.0222	0.0263	0.0227	0.028
Choice 16	0.0254	0.0242	0.0187	0.0235	0.0222	0.0263	0.0227	0.028
Choice 17	0.019	0.0181	0.0143	0.0176	0.0166	0.0197	0.017	0.021
Choice 18	0.019	0.0181	0.0153	0.0176	0.0172	0.0204	0.017	0.021
Choice 19	0.019	0.0181	0.0148	0.0176	0.0166	0.0197	0.0176	0.021
Choice 20	0.019	0.0181	0.0148	0.0176	0.0172	0.0204	0.017	0.021
Choice 21	0.0254	0.0242	0.0192	0.0235	0.0216	0.0256	0.0227	0.028
Choice 22	0.0254	0.0242	0.0192	0.0235	0.0227	0.0269	0.0227	0.028
Choice 23	0.0127	0.0121	0.0104	0.0135	0.0128	0.0131	0.013	0.014
Choice 24	0.0254	0.0242	0.0197	0.0235	0.0222	0.0263	0.0221	0.028
Choice 25	0.0127	0.0121	0.0108	0.0117	0.0122	0.0131	0.0125	0.014
Choice 26	0.0127	0.0121	0.0108	0.0117	0.0122	0.0131	0.0125	0.014
Choice 27	0.019	0.0181	0.0153	0.0176	0.0172	0.0197	0.0176	0.021
Choice 28	0.0127	0.0121	0.0108	0.0117	0.0122	0.0131	0.0125	0.014
Choice 29	0.019	0.0181	0.0153	0.0176	0.0172	0.0197	0.0176	0.021
Choice 30	0.019	0.0181	0.0153	0.0176	0.0172	0.0197	0.0176	0.021
Choice 31	0.0127	0.0121	0.0108	0.0117	0.0111	0.0131	0.0125	0.014
Choice 32	0.019	0.0181	0.0153	0.0176	0.0166	0.0197	0.0176	0.021
Choice 33	0.0127	0.0121	0.0108	0.0117	0.0111	0.0131	0.0125	0.014
Choice 34	0.019	0.0181	0.0153	0.0176	0.0166	0.0197	0.017	0.021
Choice 35	0.0317	0.0302	0.0247	0.0294	0.0277	0.0328	0.0272	0.035
Choice 36	0.0317	0.0296	0.0242	0.0288	0.0277	0.0322	0.0272	0.0343
Choice 37	0.0317	0.029	0.0232	0.0282	0.0266	0.0328	0.0284	0.035

Optimal matrix

As can be seen from the table 4, data illustrates matrix of optimal solution.

Table 4: Data illustrates matrix of optimal solution.

Optimal solution	Criteria 1	Criteria 2	Criteria 3	criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8
Positive	0.0317	0.0302	0.0247	0.0294	0.0277	0.0328	0.0284	0.035
Negative	0.0127	0.0121	0.0104	0.0117	0.0111	0.0131	0.0113	0.014

Finally, all 37 sub-criteria were ranked making the use of the TOPSIS method. For this purpose, first, positive and negative ideal solutions were calculated and then ,as can be seen from table 5, the final rank was obtained through measuring the relative proximity of every choice proportion to the ideal.

Furthermore, preliminary criteria and risks concerning construction accidents, were weighted and ranked. Table 5 shows major risks or criteria.

Table 5- Ranking risks and accidents occurring in the construction sites in district 22 of Tehran

Criteria	Fire and explosion	Building collapse	Falling from a scaffold	stumbling or colliding with things	Electric shock	Being stuck between things	Being subject to dangerous things	Sliding
standard weight	0.1325	0.1257	0.1024	0.1226	0.1164	0.1369	0.1183	0.1452
rank	3	4	8	5	7	2	6	1

It can be seen from data in the Table 5 that, sliding, getting stuck between things, as well as fire and explosion, are top three risk factors in terms of importance among risks and accidents happening in construction projects in district 22 of Tehran. By

contrast, such risks as electric shock and falling from the scaffold showed the least importance.

The table 6 illustrates weights of sub-criteria concerning risks and accidents happening in construction sites.

Table 6- Weights of sub-criteria concerning construction risks and accidents

Choice No.	35	13	36	37	22	7	10	14
Results	0.9781	0.9776	0.9653	0.9518	0.6712	0.6668	0.6659	0.6629
Choice No.	15	24	16	4	5	6	21	3
Results	0.6629	0.662	0.66	0.6587	0.6558	0.6544	0.6543	0.6514
Choice No.	18	27	30	29	20	32	19	34
Results	0.3429	0.3416	0.3416	0.3416	0.3403	0.338	0.3354	0.3342
Choice No.	17	8	1	12	11	23	9	28
Results	0.329	0.3288	0.3229	0.2011	0.1484	0.0566	0.0401	0.0321
Choice No.	25	26	31	33	2			
Results	0.0321	0.0321	0.0239	0.0239	0.0118			

As can be seen from the table above, statements 35, 13, and 36 are top three risk factors in terms of importance. Therefore, sliding and falling from the scaffold due to weather condition have the most importance among other sub-criteria for construction accidents.

Conclusion

By the term "risk" is meant any condition which has potential to harm personnel, equipment, buildings, material or to decrease efficiency in administration of a pre-set thing. Risk proves to be a potential source or condition which could harm people or cause damage to properties. Detecting and evaluating safety as well as job risks are taken into account as a required step toward achieving comparative safety in projects; moreover, analyzing job safety is regarded as a scientific method to detect, evaluate, and control risks in industrial procedures.

Previous studies have demonstrated that physical and health risks are normally occurred in the construction sites. Physical risks are related to weather condition, as well as equipment used in construction projects. The present research aimed to evaluate and prioritize potential risks and dangers occurring in district 22 of Tehran by means of a multi criteria decision making (MCDM) method. A questionnaire was designed to collect data. 37 items on the questionnaire measured the criteria and sub-criteria of potential risks and accidents occurring in the construction sites in district 22 of Tehran. In this study, the most important risk factors concerning construction accidents were classified through

studying literatures related to the issue, as well as interviewing with reporters. They are:

1. fire and explosion
2. building collapse
3. falling from scaffold
4. stumbling or colliding with things
5. electric shock
6. getting stuck between things
7. being subject to dangerous material
8. sliding

Results of ranking risks and accidents happening in construction projects in district 22 of Tehran showed that sliding, getting stuck between things, as well as fire and explosion were top three risk factors in terms of importance. Results concerning questionnaire's statements or sub-criteria of major risks illustrate that the rate of worker's sliding as well as falling from the scaffold due to bad weather conditions were of the significant importance among other criteria. Findings showed that it is necessary to provide a systematic risk assessment method for safety experts. Previous methods for evaluating job risks in the construction industry were mainly qualitative or statistical, because construction experts are tend to find a numerical, clear value to assess the risk.

Research results would assist safety attendants of construction sites in not only detecting risk factors and causes but also to provide efficient solutions to control and mitigate risks. Given sliding was observed as the most common risk factor in construction projects, it is recommended that widespread

measures are needed to be run in order to reduce the number of accidents due to sliding, especially in the rainy weather.

Moreover, since getting stuck between things achieved the second rank in terms of importance among accidents occurring in district 22 of Tehran, all engineers and contractors are recommended to train workers in using equipment and material, as well as measures to improve health and safety of employees. Meanwhile, fire and explosion were also ranked as important risk factors in construction projects. Despite there has not been any accident due to fire or explosion in district 22 of Tehran, however it is thoroughly recommended by safety experts. Because, if it happens, a large number of people would be seriously injured or died.

To put it simply, unlike other risks, the latter would affect lots of people. There is abundant room for further progress in determining other risk factors concerning construction projects, except from accidents, like material price, decrease in house prices, increase in workers' wages, and prolonging duration of construction project etc. In future investigations, it might be possible to study different issues like ecology, age of workers, as well as experience. It is also recommended to examine and compare construction risks in other cities or districts of Tehran with those in district 22 of Tehran.

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