Identifying the Risk in Civil Engineering Projects in Karbala Governorate in Iraq and Prioritizing Them by Using AHP Method

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Abstract

The main developments in business environment, such as business globalization and the fast changing process of technology, have increased competitiveness and difficulty in managing the organizations. Effective Risk Management, which is based on a conceptual and valid principal, forms a very significant part of the decision making process. Identifying risky parts and prioritizing the risks before the implementation of the projects help considerably with the reduction of the expenses, the time span of the project, and conflicts between the employer, consultant, and contractor. However, prioritizing risks in projects is influenced by several factors and causes, and there is usually a nonlinear relationship between them. It seems to be a difficult and impossible job but the development of computer science and the emergence of different decision making techniques brought hope to overcome the obstacles. These techniques include Analytic Hierarchy Process (AHP) which is a helpful tool in Multi Criteria Decision Making (MCDM) invented by Thomas L. Saaty. AHP is a method for decision making based on two important factors of knowledge and experience. In the present study, the collected and separate information about different risks existing in construction projects, according to comparative system for each risk, is provided through the questionnaires answered by employers, consultants, and contractors in construction projects in Iraq, and then the data obtained from the questionnaires are analyzed by using Multi Criteria Decision Making (MCDM) tool to prioritize the existing risks.

Keywords: Risk, Analytic Hierarchy Process, Multi Criteria Decision Making, Construction

1- Introduction

The exploitation of scientific methods, modern technology, new and resistant equipment and materials is counted as one of the essential necessities for the improvement of building and housing industry quality in different countries; therefore, the managers, engineers, and architects need to familiarize with the features of these buildings, and create a method for industrial production of buildings in the country due to the increasing demand for housing in society [1].

Undoubtedly, for strengthening the constructions, achieving sustainable development, improving living environment, and ultimately, promoting housing conditions, forgetting about the usual construction methods and considering the utilization of new technology and resistant equipment and materials in construction is inevitable [2]. That is why in 1992, Rio Declaration has been approved with the goal of creating a new, equal, and global collaboration by developing new levels of collaborations between the governments, key sections, societies, and nations for attempting to achieve international agreements which consider interests of all countries and supports the integrity of the global environment and development system. This declaration defined sustainable development in this way:

"Meeting the needs of the present generation and considering not to destroy the abilities of the future generations for meeting their own needs". There are some indicators for sustainable development, but the three main indicators of economic, environmental, and social are the most important ones alongside with dependent sub-indicators [3,4].

The sustainable development indicators demonstrate a range of progress paths in which there is relationship between economical boom, social welfare, and environmental protection in weak or strong forms, and these indicators also show the close and important relationship between these three sections. Moreover, based on the information from CIB[1] in 1998, more than 54 percent of energy has been consumed directly and indirectly for construction activities. It shows the considerable influence of these activities on environmental, economic, and social aspects, and their potential for helping environmental protection and the implementation of sustainable development; therefore, focusing on sustainable development in construction seems to be logic and essential [5,6].

Risk Management has been efficient in the projects which provide an information basis for quantitative data, but it is necessary that the information be available with high quality for determining the method based on useful information.
Generally, the risks should be identified at first, and then their roots have to be detected so that the obstacles causing risks would be found among them. In Table 1, the important and effective risks detected by outstanding contractor engineers can be seen [5,6,7,8].

2- Materials and Methods

In the present study, the collected and separate information about the influence of parameters and factors on making risks in construction projects of Karbala Governorate in Iraq has been provided through the employers, consultants, and contractors' questionnaires in Iraq, and then, by using the Analytic Hierarchy Process (AHP), the data obtained from the questionnaires are analyzed for prioritizing influential factors on existing risks in construction projects of this governorate.

The questionnaires included 37 parameters which have been distributed among the main four sections (owners, contractors, consultants, and unpredictable events) and 32 engineers and owners of 8 construction companies in Karbala Governorate. Each of these four sections of owners, consultants, contractors and unpredictable events had 10, 7, 8, and 12 questions in

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order. At first, each section was studied separately so that the importance of each parameter would be determined in each section. Next, the four sections were compared all together to compare the main factors of risk existence in construction projects of Karbala Governorate. For instance, the consultants' 7 questions were compared separately to analyze the obtained information with the help of AHP method.

Table 1: The Influence of Some Important and Effective Risk on Contractor

Types of Risks	**Risk Causes**
Technical Risk	Lack of studying and local information from the field conditions of the work place. Difficultly of accessing materials Incompatibility between the design and information for planning and estimating the costs
Working Conditions Risk	Lack of sources such as materials, field, and workers
Construction Risks	Inefficient productivity and exploitation Climate instability and other climate factors Inadequacy of contractor's knowledge Not predicting the schedule delays for providing and accessing resources Industrial issues
Financial Risks	Inflation (short-term)/ Lack of scale for activities costs Incorrect payment schedule Workers' strikes and dissatisfaction Employer's financial problems

In the ranking system for making a binary comparison of the parameters in AHP, the numbers from 1 to 5 were used. This means that if the rank of the first parameter is 3 in comparison to the second parameter, the first parameter makes the construction projects in the specified area 3 times riskier than the second one. And if this is 1, it means they have the same influence on creating risks in the projects.

3- Results and Presentation

At first, each of the main sections (owners, contractors, consultants, and unpredictable events) are compared to each other in binary way. In this way, 6 ways of binary comparison are made, and the respondents should rank them. In Table 2, there is an example of the comparison made by the participant engineers in the present study.

Table 2: Paired Comparisons of Normal Matrix of Rework Factors Caused by Employer

			5	4	3	2	1	2	3	4	5	
1	1	Employer						✓				Consultant
2	1	Employer							✓			Contractor
3	1	Employer								✓		Unpredictable Events
4	2	Consultant							✓			Contractor
5	2	Consultant									✓	Unpredictable Events
6	3	Contractor							✓			Unpredictable Events

The prioritization in Analytic Hierarchy Process is created based on 'The Paired Comparison' (pairwise) of the existing risks in the project. At the first step, a paired comparison matrix can be provided with the help of each questionnaire's information. Then, another paired comparison matrix demonstrating geometric mean of the paired comparisons matrices related to each expert should be made to consider the opinions of all participants. Table 3 shows this matrix. The amount in each cell of this matrix shows the importance of the factor related to the head of the cell in comparison to the factor related to the column of that cell. For instance, the amount in the cell related to the second row and the third column of this matrix is 0.35. This amount shows that the importance of the factor related to the second row is that the consultant is on average 0.35 time more effective than the factor related to the third column, which is the contractor.

Table 3: The Paired Comparisons Matrix of the Effective Factors on the Risk Caused by Four Main Factors

		1	2	3	4
Employer	1	1.00	0.49	0.32	0.26
Consultant	2	2.06	1.00	0.35	0.20
Contractor	3	3.11	2.88	1.00	0.33
Unpredictable Events	4	3.90	4.91	3.07	1.00
		10.07	9.27	4.74	1.79

After this level in Table 4, paired Comparisons of normal matrix of Table 3 is calculated. As it can be seen in Table 4, by dividing the total amounts of each of the items into total amounts of each column in Table 3, a paired comparison of normal matrix is made. According to the calculations made, the unpredictable events with a higher number than the other factors, is in the first priority place. In other words, the unpredictable events in the war ridden country of Iraq is the cause for half of the existing risks in the construction projects. Moreover, the employers with the percentage of 0.09 has the least effect on the existing risks of the project. It should be mentioned that the inconsistency rate for this situation has been calculated as 0.06 which is lower than the critical point of 0.1.

Table 4: The Paired Comparisons Matrix of Effective Factors on the Risk Caused by Four Main Factors

		1	2	3	4	w
Employer	1	0.10	0.05	0.07	0.14	**0.09**
Consultant	2	0.20	0.11	0.07	0.11	**0.12**
Contractor	3	0.31	0.31	0.21	0.18	**0.25**
Unpredictable Events	4	0.39	0.53	0.65	0.56	**0.53**
Inconsistency Rate						0.06

1-3- Related Factors to Employer

Table 5 demonstrates the paired comparison matrix of the risks caused by the employer in sustainable construction projects.

Table 5: The Paired Comparisons Matrix of the Effective Factors on the Risk Caused by Contractor

factor		1	2	3	4	5	6	7	8	9	10
Delay in Contractor's payment	1	1.00	4.00	0.49	2.87	0.51	0.20	1.99	0.51	0.49	0.98
Incorrect Division of Amount of Working	2	0.25	1.00	0.25	1.98	0.34	0.25	0.34	0.34	0.33	0.25
Unreasonable Time Schedule	3	2.02	4.06	1.00	2.04	1.90	0.32	3.04	0.50	0.49	0.51
Delay in Delivering Field and Not Dealing with Opponents at Right Time	4	0.35	0.51	0.49	1.00	0.50	0.20	0.50	0.51	0.32	0.33
Delay in Sending Maps	5	1.96	2.97	0.53	2.01	1.00	0.24	0.50	0.34	0.33	0.50
Selecting an Inappropriate Contractor at Time of Tender Offer	6	4.95	4.03	3.17	5.08	4.08	1.00	3.89	1.94	4.04	1.96
Mistakes and Contradictions in Map	7	0.50	2.95	0.33	2.01	2.02	0.26	1.00	0.48	0.99	1.00
Employer's Lack of Technical Experience in Controlling and Analyzing Studies Done by the Consultant	8	1.94	2.97	2.01	1.96	2.94	0.52	2.07	1.00	1.01	1.95
Having Demands Out of Contract Scope from Contractor and Compensating Costs by Contract	9	2.02	2.99	2.02	3.11	3.04	0.25	1.01	0.99	1.00	0.51
Contractual Weakness, and as a Result Failing to Identify Demands Correctly, and Accepting Contractors' Unjust Financial Claims	10	1.02	3.94	1.97	3.02	2.00	0.51	1.00	0.51	1.95	1.00
		16.03	29.43	12.26	25.07	18.32	3.74	15.33	7.13	10.96	8.99

According to previous steps, the paired comparisons matrix of Table 5 should be normalized. In order to normalize the matrix, each cell should be divided into total numbers of the columns related to that cell. These amounts are specified in Table 6 in "Total" row at the end of the matrix.

Table 6: The Paired Comparisons of Normal Matrix of Effective Factors on the Risk Caused by Unpredictable Events

factor		1	2	3	4	5	6	7	8	9	10	w
Delay in Contractor's payment	1	0.06	0.14	0.04	0.11	0.03	0.05	0.13	0.07	0.05	0.11	**0.08**
Incorrect Division of Amount of Working	2	0.02	0.03	0.02	0.08	0.02	0.07	0.02	0.05	0.03	0.03	**0.04**
Unreasonable Time Schedule	3	0.13	0.14	0.08	0.08	0.10	0.08	0.20	0.07	0.05	0.06	**0.10**
Delay in Delivering Field and Not Dealing with Opponents at Right Time	4	0.02	0.02	0.04	0.04	0.03	0.05	0.03	0.07	0.03	0.04	**0.04**
Delay in Sending Maps	5	0.12	0.10	0.04	0.08	0.05	0.07	0.03	0.05	0.03	0.06	**0.06**
Selecting an Inappropriate Contractor at Time of Tender Offer	6	0.31	0.14	0.26	0.20	0.22	0.27	0.25	0.27	0.37	0.22	**0.25**
Mistakes and Contradictions in Map	7	0.03	0.10	0.03	0.08	0.11	0.07	0.07	0.07	0.09	0.11	**0.08**
Employer's Lack of Technical Experience	8	0.12	0.10	0.16	0.08	0.16	0.14	0.14	0.14	0.09	0.22	**0.13**
Having Demands Out of Contract Scope from Contractor	9	0.13	0.10	0.17	0.12	0.17	0.07	0.07	0.14	0.09	0.06	**0.11**
Contractual Weakness	10	0.06	0.13	0.16	0.12	0.11	0.14	0.07	0.07	0.18	0.11	**0.12**
	Inconsistency Rate											0.06

The inconsistency rate was 0.06, which is lower than the critical point of 0.1, therefore, it can the obtained results were reliable. According to Table 6, 'Selecting an Inappropriate Contractor' with the number of 0.25, is the most effective risk caused by the contractor in the construction projects. 'Delaying in Delivering the Field' and 'Incorrect Division of the Amount of Working' have also the least amount of risk with the number 0.04.

2-3- Related Factors to Unpredictable Events

Table 7 shows paired comparison matrix of effective factors on the risk caused by natural disasters, political events, etc. This table also shows that none of the main involved factors in the project (contractor, consultant, and employer) cause these events to happen in construction projects.

Since Iraq is involved with political conflicts and even civil wars, these parameters have been selected to measure their influence on the existing risks in the project. According to Table 7 results, these parameters have an important influence on creating long-term risks in construction projects. For instance, the number related to the ninth row and the third column shows the importance of 'Civil War' occurrence in comparison to 'Sudden Machine Failure' used in the project. This number in Iraq and based on the analysis of the results is 3.96, which means that the possibility of stopping the project caused by 'Civil War', is 4 times more probable than stopping the project caused by 'Sudden Machine Failure'.

Moreover, two similar parameters to 'Civil War' have been included in the questionnaire. As it can be seen, the two items of 'Inconsistency of Government's Policies', and 'Political Conflicts' have caused in order 3.10 and 4.11 times higher risks than 'Sudden Machine Failure'.

After this step, it is necessary to normalize the paired comparisons matrix of Table 7. Each cell amount should be divided into total amounts of that cell's column for normalization of the matrix. These numbers are specified in Table 8 in "Total" row at the end of the matrix. Therefore, we can calculate the paired comparisons normal matrix according to Table 8.

The amount of inconsistency rate, which has been calculated by the relations of Chapter Three, is 0.09. Since the obtained results are lower than critical point of 0.1, the results are reliable.

According to Table 8, 'Problems with Neighbors and Residents of Area' with the weight of 0.31 is the most effective risk caused by the contractor in construction projects. After that, 'Avoiding to equip the Workshop at Right Time by Contractor' will be the second factor with the weight of 0.17. 'The Contractor's Poor Management' has the least effective risk with the weight of 0.05.

Table 7: The Paired Comparisons Matrix of Effective Factors on the Risk Caused by Unpredictable Events

factor		1	2	3	4	5	6	7	8	9	10	11	12
Low Adjustment Indicators	1	1.00	2.03	0.95	0.20	2.04	0.20	0.32	0.33	0.25	0.49	0.25	1.95
Shortage of Human, Materials, and Equipment Resources	2	0.49	1.00	2.10	2.02	1.02	0.26	1.01	0.99	0.34	2.00	1.02	3.91
Machine Failure	3	1.05	0.48	1.00	0.49	0.25	0.32	0.52	0.98	0.25	0.33	0.24	1.00
Force Majeure Events	4	5.04	0.49	2.04	1.00	0.96	0.24	0.49	1.98	0.26	0.34	0.26	1.97
Bad Weather	5	0.49	0.98	3.95	1.04	1.00	0.50	1.98	4.02	0.98	1.98	1.00	3.87
Inconsistency of Government's Policies	6	5.02	3.92	3.10	4.12	2.00	1.00	2.94	2.99	1.01	1.97	1.01	5.12
Sudden Haste for Opening the Project	7	3.12	0.99	1.92	2.04	0.51	0.34	1.00	1.90	0.49	2.85	0.34	3.89
Government Contractors	8	3.00	1.01	1.02	0.50	0.25	0.33	0.53	1.00	0.24	0.99	0.25	0.50
Civil Wars	9	3.98	2.96	3.96	3.88	1.02	0.99	2.03	4.17	1.00	1.96	1.99	4.88
Structural Changes in Related Organizations	10	2.05	0.50	3.04	2.94	0.50	0.51	0.35	1.01	0.51	1.00	0.50	2.02
Political Conflicts and Imposing Related Sanctions	11	4.05	0.98	4.11	3.82	1.00	0.99	2.98	4.02	0.50	1.99	1.00	3.81
Accidents Happening to Human Forces	12	0.51	0.26	1.00	0.51	0.26	0.20	0.26	2.01	0.20	0.50	0.26	1.00
total		29.81	15.58	28.19	22.57	10.80	5.88	14.41	25.41	6.04	16.40	8.12	33.91

Table 8: The Paired Comparisons of Normal Matrix of Effective Factors on the Risk Caused by Unpredictable Events

factor	1	2	3	4	5	6	7	8	9	10	11	12	w
Low Adjustment Indicators	0.03	0.13	0.03	0.01	0.19	0.03	0.02	0.01	0.04	0.03	0.03	0.06	0.05
Shortage of Human, Materials, and Equipment Resources	0.02	0.06	0.07	0.09	0.09	0.04	0.07	0.04	0.06	0.12	0.13	0.12	0.08
Machine Failure	0.04	0.03	0.04	0.02	0.02	0.05	0.04	0.04	0.04	0.02	0.03	0.03	0.03
Force Majeur Events	0.17	0.03	0.07	0.04	0.09	0.04	0.03	0.08	0.04	0.02	0.03	0.06	0.06
Bad Weather	0.02	0.06	0.14	0.05	0.09	0.09	0.14	0.16	0.16	0.12	0.12	0.11	0.10
Inconsistency of Government's Policies	0.17	0.25	0.11	0.18	0.18	0.17	0.20	0.12	0.17	0.12	0.12	0.15	0.16
Sudden Haste for Opening the Project	0.10	0.06	0.07	0.09	0.05	0.06	0.07	0.07	0.08	0.17	0.04	0.11	0.08
Government Contractors	0.10	0.06	0.04	0.02	0.02	0.06	0.04	0.04	0.04	0.06	0.03	0.01	0.04
Civil Wars	0.13	0.19	0.14	0.17	0.09	0.17	0.14	0.16	0.17	0.12	0.24	0.14	0.16
Structural Changes in Related Organizations	0.07	0.03	0.11	0.13	0.05	0.09	0.02	0.04	0.08	0.06	0.06	0.06	0.07
Political Conflicts and Imposing Related Sanctions	0.14	0.06	0.15	0.17	0.09	0.17	0.21	0.16	0.08	0.12	0.12	0.11	0.13
Accidents Happening to Human Forces	0.02	0.02	0.04	0.02	0.02	0.03	0.02	0.08	0.03	0.03	0.03	0.03	0.03
Inconsistency Rate													٠,٠٩

3-3- Related Factors to Contractor

Table 9 represents this matrix. The amount in each cell of this matrix demonstrates the importance of the factor related to the head of that cell in comparison to the factor related to the column of that cell. For instance, the amount of the cell related to the third row and the seventh column of this matrix, colored in black on the top of the main matrix, is 0.48. This amount shows that the importance of the factor related to the third row is 'Inability of Paying Off Subcontractor's Debt' is 0.48 time on average more influential than the factor related to the column which is 'Avoiding to Equip the Workshop at Right Time by Contractor'. In other words, the influence of 'Inability to Pay Off Subcontractors' Debt' is 0.48 time more than 'Avoiding to Equip the Workshop at Right Time by Contractor'.

Table 9: The Paired Comparisons Matrix of Effective Factors on the Risk Caused by Contractor

Factor		1	2	3	4	5	6	7	8
Poor Quality of Work Done by Contractors	1	1.000	۰,۵۱	۲,۰۲	۰,۳۲	۰,۳۲	۱,۰۱	۰,۵۰	۰,۹۹
Inappropriate Workshop Conditions	2	۱,۹۸	1.000	۱,۹۳	۰,۲۵	۱,۰۵	۲,۰۶	۰,۵۲	۱,۰۳
Inability of Paying Off Subcontractors' Debt	3	۰,۴۹	۰,۵۲	1.000	۰,۲۵	۰,۵	۱,۹۹	۰,۴۸	۱,۰۰
Problems with Neighbors and Residents of Area	4	۳,۰۸	۴,۰۳	۴,۰۳	1.000	۳,۸۹	۳,۹۶	۲,۹۷	۲,۹۴
High Competitive Pressure to Get a Project with Low Price	5	۳,۱۶	۰,۹۶	۲,۰۰	۰,۲۶	1.000	۳,۰۰	۰,۳۳	۰,۴۸
Contractor's Poor Management	6	۰,۹۹	۰,۴۹	۰,۵۰	۰,۲۵	۰,۳۳	1.000	۰,۳۳	۰,۳۴
Avoiding to Equip Workshop at the Right Time	7	۱,۹۸	۱,۹۴	۲,۰۸	۰,۳۴	۳,۰۳	۳,۰۱	1.000	۲,۰۴
Inadequate and poor Performance of Subcontractors and Suppliers	8	۱,۰۱	۰,۹۸	۱,۰۰	۰,۳۴	۲,۰۷	۲,۹۷	۰,۴۹	1.000
Total		30.39	14.08	2.906	12.52	11.54	9.871	16.32	13.29

After this stage, it is necessary to normalize the paired comparisons Matrix of Table 9. Each cell amount should be divided into total amounts of the related column of that cell. These amounts are specified in "Total" row at the end of the matrix. In this way the paired comparison of normal matrix can be calculated according to Table 10. The relative importance of each factor can be identified with the help of paired comparisons of normal matrix. For this to happen, the average amount of each paired comparisons of normal matrix should be calculated. The average amount represents the relative importance of the factor. This amount can be seen in "Average" column of Table 10.

In the next step, it is necessary to calculate the validity of the obtained results by inconsistency rate indicator. If inconsistency rate is lower than the critical point of 0.1, the received results from the participants will be valid. The amount of this indicator, which has been calculated by the relations in Chapter Three, is 0.05. Since the amount is lower than the critical point of 0.1, the obtained results are reliable. According to Table 10, 'Problems with Neighbors and Residents of Area' is the most important and effective risk, with the weight of 0.31, caused by the contractor in construction projects. After that, 'Avoiding to Equip the Workshop at Right Time by Contractor' is the second factor with the weight of 0.17, and 'Poor Management of Contractor' is the least effective risk factor with the weight of 0.05

Table 10: The Paired Comparisons of Normal Matrix of Effective Factors on the Risk Caused by the Contractor

		1	2	3	4	5	6	7	8	**W**
Poor Quality of Work Done by Contractors	1	0.07	0.05	0.13	0.11	0.03	0.05	0.08	0.10	**0.08**
Inappropriate Workshop Conditions	2	0.15	0.09	0.13	0.08	0.08	0.10	0.07	0.10	**0.10**
Inability of Paying Off Subcontractors' Debt	3	0.04	0.05	0.07	0.08	0.04	0.10	0.07	0.10	**0.07**
Problems with Neighbors and Residents of Area	4	0.22	0.38	0.28	0.33	0.33	0.21	0.45	0.30	**0.31**
High Competitive Pressure to Get a Project with Low Price	5	0.23	0.09	0.13	0.08	0.08	0.16	0.05	0.05	**0.11**
Contractor's Poor Management	6	0.08	0.05	0.04	0.08	0.03	0.05	0.05	0.03	**0.05**
Avoiding to Equip Workshop at the Right Time	7	0.15	0.19	0.15	0.11	0.25	0.16	0.15	0.21	**0.17**
Inadequate and poor Performance of Subcontractors and Suppliers	8	0.07	0.10	0.07	0.11	0.16	0.16	0.07	0.10	**0.11**
Inconsistency Rate										0.05

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3-4- Related Factors to the Contractor

Table 10 represents The Paired Comparison Matrix of Effective Factors on the Risk Caused by Consultant in Construction Projects'. For instance, the amount related to the first row and the seventh column demonstrates the importance of 'Designing the Details with Vague Features and Shortcomings in Maps' in comparison to the 'Inappropriate Time Prediction for Implementation of Project'. Moreover, the inverse number of 1.96 in the first column and the seventh row is 0.51. This number is specified with black color under the main matrix.

Table 10: The Paired Comparison Matrix of the Effective Factors on the Risk Caused by Contractor

		1	2	3	4	5	6	7
Designing Details with Vague Features and Shortcomings in Maps	1	1.00	0.33	2.91	0.52	1.97	2.07	1.96
Lack of Interaction with Implementation Method and Designers' Lack of Executive and Workshop View	2	3.04	1.00	4.01	3.07	2.04	5.03	2.93
Fundamental Changes in Executive Maps or Technical Features	3	0.34	0.25	1.00	0.25	0.49	0.99	0.49
Consultant's Lack of Complete Understanding of Conditions, Contract Terms, and Technical Issues	4	1.91	0.33	4.07	1.00	1.99	2.96	1.99
Failing to Conduct the Experiments On Time and Announcing Results by Consultant	5	0.51	0.49	2.06	0.50	1.00	4.88	0.49
Lack of Consulting Engineer During the Process of Project Implementation in Workshop	6	0.48	0.20	1.01	0.34	0.20	1.00	0.25
Inappropriate Time Prediction for Implementation of the Project	7	0.51	0.34	2.02	0.50	2.03	4.02	1.00
		7.80	2.93	17.08	6.18	9.72	20.95	9.12

According to the previous stage, it is necessary to normalize the pair comparisons matrix of Table 10. Each cell should be divided into amounts related to the column of that cell. These amounts are specified in Table 11 in "Total" row at the end of the matrix.

As it can be seen from the table above, the validity of the received results of inconsistency rate is 0.05. Since this number is lower than the critical point of 0.05, the received results is reliable. According to Table 11 'Lack of Interaction with Implementation Method and Designers' Lack of Executive and Workshop View' is the most important and effective risk, with the weight of 0.32, caused by the consultants in construction projects. After that, 'Consultant's Lack of Complete Understanding of Conditions, Contract Terms, and Technical Issues' is the second factor with the weight of 0.19, and 'Lack of Consulting Engineer During Process of Project Implementation in Workshop' has the least effective risk with the weight of 0.05.

Table 11: The Paired Comparison of Normal Matrix of Effective Factors on the Risk Caused by the Consultant

		1	2	3	4	5	6	7	W
Designing Details with Vague Features and Shortcomings in Maps	1	0.13	0.11	0.17	0.08	0.20	0.10	0.21	**0.14**
Lack of Interaction with Implementation Method and Designers' Lack of Executive and Workshop View	2	0.39	0.34	0.23	0.50	0.21	0.24	0.32	**0.32**
Fundamental Changes in Executive Maps or Technical Features	3	0.04	0.08	0.06	0.04	0.05	0.05	0.05	**0.05**
Consultant's Lack of Complete Understanding of Conditions, Contract Terms, and Technical Issues	4	0.25	0.11	0.24	0.16	0.21	0.14	0.22	**0.19**
Failing to Conduct Experiments On Time and Announcing Results by Consultant	5	0.07	0.17	0.12	0.08	0.10	0.23	0.05	**0.12**
Lack of Consulting Engineer During the Process of Project Implementation in Workshop	6	0.06	0.07	0.06	0.05	0.02	0.05	0.03	**0.05**
Inappropriate Time Prediction for Implementation of Project	7	0.07	0.12	0.12	0.08	0.21	0.19	0.11	**0.13**
Inconsistency Rate									0.05

4- Summary of Results

To gain the whole weight of each effective item on the risks in construction projects, the weight of each subgroup factor is multiplied by the total weight of the group. For instance, 'Selecting an Inappropriate Contractor" in the group related to contractor is 0.25. When this percentage is multiplied by the weight of the contractor group, which is 0.09 according to Table 2, it becomes 0.0225. Then, by dividing the total weight of each item into the total weight, the normal weight of each item is obtained.

Table 12: The Results Summary of the Study in Ranking of the Risk Factors

Criterion	Weight	Normal Weight	Rank
Factors Related to Contractor (0.25)			
Poor Quality of Work Done by Contractor	۰,۰۸	۰,۰۲	۱۹
Inappropriate Workshop Conditions	۰,۱۰	۰,۰۲۵	۱۵
Inability to Pay off Subcontractors' Debt	۰,۰۷	۰,۰۱۷۵	۲۱
Problems with Neighbors and Residents of Area	۰,۳۲	۰,۰۸	۳

High Competitive Pressure to get Projects with Low Price	۰,۱۱	۰,۰۲۷۵	۱۳
Contractor's Poor Management	۰,۰٥	۰,۰۱۲۵	۲۵
Avoiding to Equip Workshop at Right Time by Contractor	۰,۱۷	۰,۰۴۲۵	۶
Inadequate and Poor Performance of Subcontractors and Suppliers	۰,۱۱	۰,۰۲۷۵	۱۲
Factors Related to Consultant (0.12)			
Designing Details with Vague Features and Shortcomings in Map	۰,۱٥	۰,۰۱۸	۲۰
Lack of Interaction with Implementation Method and Designers' Lack of Executive and Workshop View	۰,۳۲	۰,۰۳۸۴	۹
Fundamental Changes in Executive Maps or Technical Features	۰,۰٥.	۰,۰۰۶	۳۳
Consultant's Lack of Complete Understanding of Conditions, Contract Terms, and Technical Issues	۰,۱۹	۰,۰۲۲۸	۱۶
Failing to Conduct Experiments On Time and Announcing the Results by Consultant	۰,۱۲	۰,۰۱۴۴	۲۵
Lack of Consulting Engineer During the Process of Project Implementation in Workshop	۰,۰٥	۰,۰۰۶	۳۴
Inappropriate Time Prediction for Implementation of Project	۰,۱۳	۰,۰۱۵۶	۲۴
Related Factors to Unpredictable Events (0.52)			
Low Adjustment Indicators	۰,۰٥	۰,۰۲۶	۱۴
Shortage of Human, Materials, and Equipment Resources	۰,۰۸	۰,۰۴۱۶	۷
Machine Failure	۰,۰۳	۰,۰۱۵۶	۲۳
Force Majeure Events	۰,۰٦	۰,۰۳۱۲	۱۱
Bad Weather	۰,۱۰	۰,۰۵۲	۵
Inconsistency of Government's Policies	۰,۱٦	۰,۰۸۳۲	۲
Sudden Haste for Opening the Project	۰,۰۸	۰,۰۴۱۶	۸
Government Contractors	۰,۰٤	۰,۰۲۰۸	۱۸
Civil Wars	۰,۱٦	۰,۰۸۳۲	۱
Structural Changes in Related Organizations	۰,۰۷	۰,۰۳۶۴	۱۰
Political Conflicts and Imposing Related Sanctions	۰,۱۳	۰,۰۶۷۶	۴
Accidents Happening for Human Forces	۰,۰۳	۰,۰۱۵۶	۲۲
Related Factors to Employer (0.09)			
Delay in Contractor's Payment	۰,۰۸	۰,۰۰۷۲	۳۱
Incorrect Division of Amount of Working	۰,۰۴	۰,۰۰۳۲	۳۶
Unreasonable Time Schedule	۰,۱۰	۰,۰۰۹	۳۰
Delay in Delivering Field and Not Dealing with Opponents at Right Time	۰,۰٤	۰,۰۰۳۶	۳۷
Delay in Sending Maps	۰,۰۶	۰,۰۰۵۴	۳۵
Selecting an Inappropriate Contractor at Time of Tender Offer	۰,۲٥	۰,۰۲۲۵	۱۷
Mistakes and Contradictions in Map	۰,۰۸	۰,۰۰۷۲	۳۲
Employer's Lack of Technical Experience	۰,۱٤	۰,۰۱۲۶	۲۶
Having Demands Out of Contract Scope from tContractor	۰,۱۱	۰,۰۰۹۹	۲۸
Contractual Weakness	۰,۱۱	۰,۰۰۹۹	۲۹

4- Summary of Results

The results show that, generally, six factors in the risks related to contractor, employer, consultant, and unpredictable events have the highest priorities. These factors are as follows:

1- Civil Wars
2- Inconsistency in Government's Policies
3- Problems with Neighbors and Residents of Area Adjacent to the Project
4- Political Conflicts and Imposing Related Sanctions
5- Bad Weather
6- Avoiding to Equip Workshop at the Right Time

Moreover, the results show that from the 10 most important factors, 7 factors are related to unpredictable events indicator, 1 factor is related to consultant, and two factors are related to contractor. On the other hand, the very hot weather conditions in Iraq have caused high risks in the projects of Karbala Governorate.

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