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Use Risk Score Method to Identify the Qualitative Risk Analysis Criteria in Tendering Phase in Construction Projects

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ABSTRACT

The purpose of this article was to identify and assess the importance of risk factors in the tendering phase of construction projects. The construction project cannot succeed without the identification and categorization of these risk elements. In this article, a questionnaire for likelihood and impact was designed and distributed to a panel of specialists to analyze risk factors. The risk matrix was also used to research, explore, and identify the risks that influence the tendering phase of construction projects. The probability and impact values assigned to risk are used to calculate the risk's score. A risk matrix is created by combining probability and impact criteria. To determine the main risk elements for the tender phase of a construction project, this study constructed the matrix of probability and impact variables and put the periods based on the risk score. Finally, this study identified a fourth main risk group and twenty-two sub-risk factors that are appropriate for the tendering phase of construction projects in Iraq

Keywords: Risk Score Method, Risk Factors**,** Risk Matrix, Qualitative Risk Analysis

استخدام طريقة درجة المخاطر لتحديد معايير التحليل النوعي للمخاطر في مرحلة العطاء في المشاريع الإنشائية

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الخلاصة

كان الغرض من هذه المقالة هو تحديد وتقييم أهمية عوامل الخطر في مرحلة مناقصة المشاريع الإنشائية. لا يمكن أن ينجح المشروع الإنشائي بدون تحديد عناصر المخاطر هذه وتصنيفها. في هذه المقالة ، تم تصميم استبيان حول الاحتمالية والتأثير

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وتوزيعه على لجنة من المتخصصين لتحليل عوامل الخطر. كما تم استخدام مصفوفة المخاطر للبحث والاستكشاف والتعرف على المخاطر التي تؤثر على مرحلة تقديم العطاء في مشاريع الإنشائية. يتم استخدام قيم الاحتمالية والتأثير المخصصة للمخاطر لحساب درجة الخطر. حيث يتم إنشاء مصفوفة المخاطر من خلال الجمع بين معايير الاحتمالية والتأثير. لتحديد عناصر المخاطر الرئيسية لمرحلة العطاء للمشروع الإنشائي، قامت هذه الدراسة ببناء مصفوفة متغيرات الاحتمالية والأثر ووضع الفترات بناءً على درجة المخاطر. وأخيرًا، حددت هذه الدراسة مجموعة من أربع مخاطر رئيسية واثنين وعشرين عامل خطر فرعي مناسب لمرحلة مناقصة المشاريع الإنشائية في العراق.
الكلمات الرئيسية: طريقة درجة المخاطر، عوامل المخاطر، مصفوفة المخاطر، التحليل النوعي للمخاطر

1. INTRODUCTION

The qualitative risk analysis process is the process of integrating and implementing. Further measures on risks had been identified based on their importance by analyzing the likelihood of their occurrence and impact on project objectives **(Duijm, 2015)**. The qualitative assessment of risk focuses on the likelihood of risk and its consequences (financial, reputational, etc.). Risk classification, such as sources of risk, the impact of risk, and extreme vulnerability to the business or stakeholders, are all factors that go into a qualitative assessment **(Radu, 2009)**. Risk probability and impact evaluation, risk urgency evaluation, direct judgment, the matrix of probability and impact, risk data quality evaluation, and comparing choices are some of the qualitative methods of risk analysis used to assess the effectiveness of risk management in construction projects **(Rowe and Wright, 2001)**. The likelihood and impact matrix is the most prevalent method for scoring risks in building projects, with scales ranging from high to low for qualitative risk assessments of known unknowns **(Jardine, 2007)**. This method can be used to establish the level of risk during the risk appraisal process by weighing the chance of risk against the severity of the penalty, which aids in clarification of risk and decision-making **(Ali, C. et al., 2020)**. For the aim of qualitative risk appraisal in the construction sector, two crucial criteria must be defined: likelihood and impact **(Mauksch et al., 2020)**. When dealing with static hazards, such as those with only a negative consequence, the likelihood and impact matrix is frequently utilized. It's comparable to the likelihood and impact matrix that was discussed previously **(Ekung, 2021)**. The decision regarding how to deal with risks is made based on where the risk falls in the matrix. Each project must determine the sort of risk and whether it is acceptable or unacceptable **(Akintoye and MacLeod, 1997)**. The result of qualitative risk analysis is a collection of risks that have been prioritized and may be used as a guide to determine critical risk response techniques and organize all hazards in the project **(Othmaan, 1998)**.

2. QUALITATIVE RISK ANALYSIS TECHNIQUE

The qualitative risk analysis that is illustrated below can be conducted using a variety of techniques**.**

2.1 Effect Tree Analysis:

It's a graphical model-building method for analyzing the optimal decision based on the information given. Many construction decisions are ambiguous, and using a decision tree analysis to convey these options in an organized fashion might help. As in event tree analysis, the tree structure in this technique is built from left to right. Several event trees can be used to describe a decision tree.

Decision tree branches show prospective events (as squares) as well as decisions (as squares) (as circles). The usage of decision tree diagrams allows decision-makers to see the uncertainty and possible outcomes of potential decisions. Each decision tree outcome should be accompanied by a probability that reflects the likelihood of its occurrence. We're having trouble guessing here **(Town and Middlands, 2016)**. **Fig. 1** shows the effect tree analysis

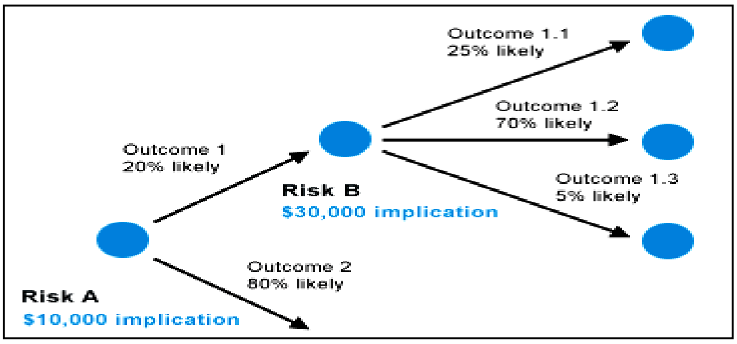

Figure 1. Effect tree analysis technique.

2.2 Impact Charts:

It is a new technique, which is a schematic representation of probability trees that can be used to measure and identify the effects of a chain of worrying events, where project risks and costs are represented by a node in the diagram, and arrows indicate relationships between nodes. Dashed lines in Impact Diagrams separate nodes for discussion purposes. Impact diagrams provide the means to build models related to project issues at risk. On the other hand, they allow the development of very complex risk models that can be used to analyze project cost, time, and economic parameters **(Ghahramanzadeh, 2013)**. **Fig. 2** shows the impact chart analysis.

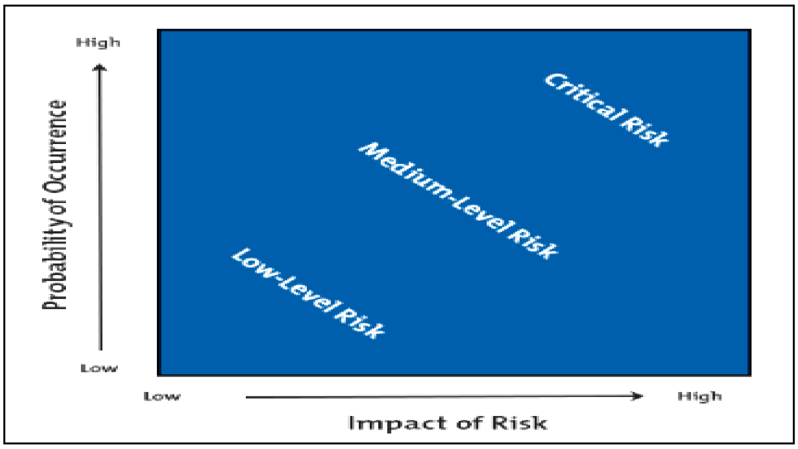

Figure 2. Impact Charts analysis technique.

2.3 Sensitivity analysis:

Sensitivity analysis can be performed by altering one unproven project component, such as design delays or material costs, and analyzing the impact of the change on total project performance. Its significance stems from the fact that a single modification in a single risk factor can make a significant difference in the project's result (**Bakr, 2019)**. On the one hand, changes in the risk variable may have little impact on project performance, while on the other hand, simple adjustments in the risk variable may have a substantial impact. **Fig. 3** shows the sensitivity analysis

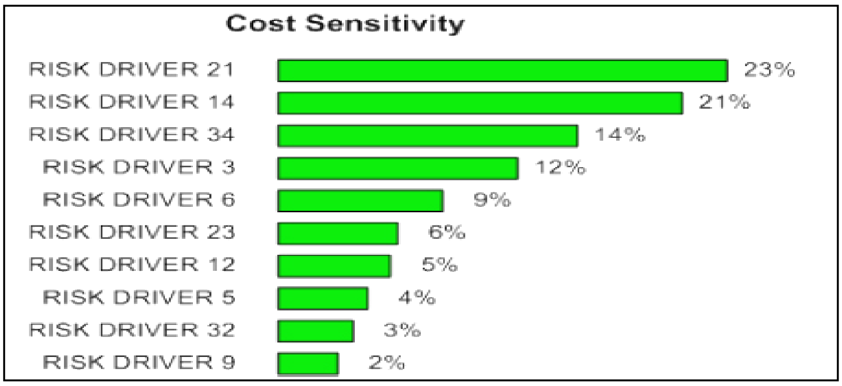

Figure 3. Sensitivity analysis technique.

2.4 Simulation:

In the quantitative assessment of risk, simulation is considered to be the best of the different likelihood analysis techniques. The input variables, output variables, and the project representation model, which highlights the interactions between project parts, are the three main components of the simulation technique **(Baloi and Price, 2003)**. The length or cost of each project activity is represented by the variables entered using probability distributions, while the duration or overall cost of the project is represented by the output variables. The random computation of values that are within the defined probability distribution described by three estimations, namely minimal or optimistic, moderated or more frequent, and maximum or pessimistic, is the basis for this method. The aggregate of the values specified for each of these hazards determines the project's overall outcome **(Zou and Wang, 2007)**. **Fig. 3** shows the simulation analysis.

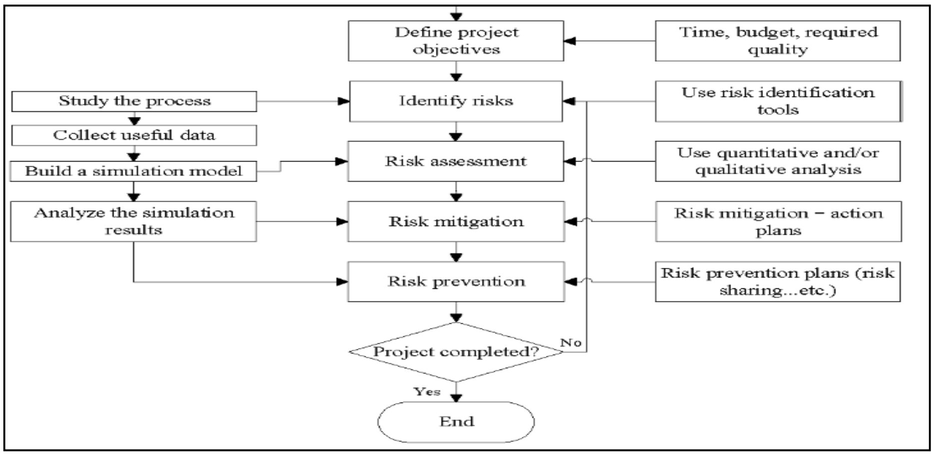

Figure 4. Simulation analysis technique.

3. RISK SCORE METHOD

The probability and impact values assigned to risk are used to calculate the risk's score. A risk matrix is created by combining probability and impact thresholds to show the range of possible ratings for a risk **(Elhag and Ballal, 2005)**.

A likelihood threshold, cost impact threshold, schedule impact threshold, and an optional user impact threshold are all included in each risk matrix **(Dikmen and Han, 2005).** The risk score can be used to perform a qualitative study of the risk variables that cause project delays in the construction industry **(TAH and Carr, 2001)**. Eq. (1) and Eq. (2) can be used to compute the risk score **(Roger, 2004),(Wang and Aguila, 2004).**

Risk Score = Probability * Impact (1) for determining the level of risk score influence by computing intervals using the equation

$L=R*N$(2)

Where:

L: Period length,

R: The length of the range between the largest and the smallest value,

N: Number of periods.

The intervals are depicted in **Table1,** where the first interval represents (very low-risk occurrence and very low impact) for reasons with a degree of occurrence and importance less than (1.8), and so on for each period by adding the length of the period **(Ghosh and Jintanapakanont, 2004)**. The intervals level for probability and impact that follow it are shown in **Table 1**.

Table 1. The intervals level for probability and impact.

Intervals	Period Limits	Probability (P)	Impact (I)
[1+0.8] = 1.8	1 < 1.8	Very Low	Very Low
[1.8+0.8] = 2.6	1.8 < 2.6	Low	Low
[2.6+0.8] = 3.4	2.6 < 3.4	Medium	Medium
[3.4+0.8] = 4.2	3.4 < 4.2	High	High
[4.2+0.8] = 5.0	4.2 < 5.0	Very High	Very High

By multiplying the intervals for each level according to the risk index equation, the study arranged the matrix of probability and impact and set the periods based on the risk score Eq. (1) as shown in **Table 2 (Enshassi and Hadi, 2013)**.

Table 2. Probability and Impact Matrix.

Impact → / Probability ↓	Very low (1-1.8)	Low (1.8-2.6)	Medium (2.6-3.4)	High (3.4-4.2)	Very High (4.2-5.0)
Very low (1-1.8)	(1-3.24)	(1.8-4.68)	(2.6-6.12)	(3.4-7.56)	(4.2-9.0)
Low (1.8-2.6)	(1.8-4.68)	(3.24-6.76)	(4.68-8.84)	(6.12-10.92)	(7.56-13.0)
Medium	(2.6-6.12)	(4.68-8.84)	(6.76-11.56)	(8.84-14.28)	(10.92-17.0)

(2.6-3.4)					
High (3.4-4.2)	(3.4-7.56)	(6.12-10.92)	(8.84-14.28)	(11.56-17.64)	(14.28-21.0)
Very High (4.2-5.0)	(4.2-9.0)	(7.56-13.0)	(10.92-17.0)	(14.28-21.0)	(17.64-25.0)

The intervals showing the amount of risk importance for the paragraphs in **Table 3.** have been organized according to **Table 1 (Enshassi and Hadi, 2013)**.

Table 3. Relative Importance Level for Risk Score.

Intervals	Relative importance
(1.0 - 3.24)	Very Low
(3.24 - 6.76)	Low
(6.76 - 11.56)	Medium
(11.56 - 17.64)	High
(17.64 - 25.0)	Very High

4. IDENTIFIEDED RISK FACTORS IN TENDERING PHASE IN CONSTRUCTION PROJECTS

Because different risk variables apply to distinct and diverse places nearby, different academics utilized different risk criteria when it came to the tendering phase in construction projects. For the tendering phase of construction projects, there are several essential risk elements, which are divided into four groups: technical, contractual, management, and finally, political risk factors.

Table 4. Important risk factors for tendering phase from the previous study.

Main Risk Group	Sub-Risk Factors	Authors
Technical Group	Designer persistent of own idea	**(Issa and Ahmed, 2015)(Samson and Wiecek, 2009)**
	Loss of preliminary designs	
	Applying innovative methods or new ways of working in the implementation	
	Omissions and errors in the bills of quantities	
	Lack of experience of technical consultants	
	Developing cost analysis methods	
	The novelty of design and technology	
Contractual Group	Poor contract documentation	**(Smith and Jobling, 2006) (Cooper and Phil, 2005) (Suherman, 2010)**
	Alternative construction materials	
	Tender selection method (open, negotiation, selected	
	Inadequate Tender Documentation	

	Long-period between design and bidding	
	Better procurement procedure	
	Tender period	
	Procurement form (traditional, design and build, project management	
Management Group	Modification or loss of project files by the team	**(GP, 2013)**
	Wrong actions due to the incorrect communication or lack of information	
	Weakness in the work of periodic meetings with heads of departments	
	Luck of knowledge in Project Management techniques	
	Development of better organization for mint the project	
Political Group	Failure to obtain approvals or permission to do some necessary work promptly	**(Augustine and Edwin, 2012)**
	Lackofawarenessbypoliticalauthoritiesoftheimportanceanddangerofsomeofthemeasuresrequiredquickly	

5. PREPARE QUESTIONNAIREFORMSTOFINDSRISK SCORE FOR TENDERING PHASE

The researcher made a questionnaire form to find the probability and impact of each risk factor during the tendering phase of the construction project. The researcher conducted a detailed interview with (10) experts who are workers, experienced, and specialized in tendering phase in construction projects to evaluate the probability and impact of each risk by using the risk score matrix.

6. DISITRBUTIONS QUESTIONNAIRE FOR PROBABILITY AND IMPACT

The questionnaires were distributed among the experts who know tendering phase in construction projects. And each expert can give his opinion on every risk factor for probability and impacts. The questionnaire forms were primarily focusing on giving the expert's opinion on different risk factors, asking them to rate each factor from probability and impact. The researcher distributed the questionnaire forms to (10) experts to evaluate probability and impact of each risk factor. **Table5.** show the data of experts.

Table 5. Data of participants in questionnaire forms.

Job Title	Experience	Specialization	Qualification
Assistant chief engineer	18	Civil engineering	BSc
Chief Engineer	20	Civil engineering	BSc
Chief Engineer	17	Civil engineering	BSc
Senior Chief Engineer	35	Civil engineering	BSc
Senior Engineer	25	Mechanical	MSc
Chief Engineer	16	Architect	MSc
Assistant Chief Engineer	15	Civil engineering	BSc
Chief Engineer	19	Mechanical	BSc
Senior Engineer	22	Civil engineering	BSc
Senior Engineer	19	Civil engineering	MSc

7. RESULT ANALYSIS OF QQUESTIONNAIREFORMS

The qualitative evaluation for the risk score of all risk factors is conducted and ranked according to the influence level intervals that were described previously, as shown in **Table 6.**

Table 6. Qualitative evaluation for the risk score.

Main Risk Group	Sub-Risk Factors	P	I	Risk Score (P*I)	Effective Level
Technical Group	Designer persistent in own idea	4.5	4.2	18.90	V. High
	Loss of preliminary designs	3.68	2.84	10.45	Medium
	Applying innovative methods or new ways of working in the implementation	3.02	3.22	9.72	Medium
	Omissions and errors in the bills of quantities	4.6	3.8	17.48	High
	Lack of experience of technical consultants	4.16	4.4	19.30	V. High
	Developing cost analysis methods	3.3	2.74	9.04	Medium
	The novelty of design and technology	4.16	3.5	14.56	High
Contractual Group	Poor contract documentation	3.58	3.76	13.46	High
	Alternative construction materials	2.5	3.44	8.6	Medium
	Tender selection method (open, negotiation, selected	3.42	2.58	8.82	Medium
	Inadequate tender documentation	3.04	4.6	13.98	High
	Long-period between design and bidding	3.34	4	13.36	High
	Better procurement procedure	2.92	2.9	8.47	Medium
	Tender period	2.9	2.72	7.89	Medium
	Procurement form (traditional, design and	2.58	3.08	7.95	Medium

	build, project management				
Management Group	Modification or loss of project files by the team	2.64	2.96	7.81	Medium
	Wrong actions due to the incorrect communication or lack of information	3.48	3.38	11.76	High
	Weakness in the work of periodic meetings with heads of departments	4	4.2	16.8	High
	Luck of knowledge in Project Management techniques	2.2	2.76	6.07	Low
	Development of better organization for mint the project	1.5	1.4	2.1	V. Low
Political Group	Failure to obtain approvals or permission to do some necessary work promptly	3.3	2.74	9.04	Medium
	Lackofawarenessbythepoliticalauthoritiesofthe importanceanddangerofsomeofthemeasuresreq uiredquickly	1.5	1.4	2.1	V. Low

8. RESULTS AND DISCUSSION

In this study, the important risk factors in tendering phase rely on many factors like, the technical group and contractual group and management group, and political group. and each main group has sub-risk factors. The fourth main group and twenty-two were found in this study, compared with many studies conducted in the same environment, and found the risk score factors were very minimum. This study used the questionnaire forms and distributions the questionnaire to a group of experts who know tendering phase in construction projects. And each expert can give his opinion on every risk factor for probability and impacts to take their opinion about the evaluation of risk score for risk factors in tendering phase in construction projects after conducting the qualitative evaluation of the identified risk score factors, it was noted that the most significant risk score factors affecting the time of the project and shown in **Table 6.** which have priority in the ranking of risk score factors due to their high-risk score, where the risk score of the Lack of experience of technical consultants appeared the first rank according to influence the level of the risk indicator was (19.30), which belongs to the category of risks of technical origin, while the risk score of designer persistent of own idea appeared in the second rank with a risk index of (18.90), and in the third rank the risk of omissions and errors in the bills of quantities high-risk index of (17.48) while the weakness in the work of periodic meetings with heads of departments in the fourth rank with a high-risk index of (16.13) for the management group, followed by the risk score of the novelty of design and technology at the fifth rank with a score risk(14.56) as shown in

Table 6.

9. CONCLUSIONS

This research presents a set of risk factors group and in tendering phase in the construction project, drawn from previous studies and field works. The goal of the present study is to identify and find the risk score for every risk factor. In this study, the qualitative evaluation for the risk score of all risk factors is conducted and ranked according to the Influence level intervals as well as using the questionnaire forms to evaluate the risk factors from a group of experts. Experts were contacted to evaluate the risk factors and requested to verify the validity of the items of the factor by applying the risk score matrix and arranging the risk factors according to the relative importance level for the risk score

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