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Empirical Study for Capturing and Allocating Significant Risk Factors in School Construction Projects in Iraq

Hayder Razzaq Abed [1,*], Hatim A. Rashid [2]

Department of Civil Engineering, College of Engineering, Al-Nahrain University, Baghdad, Iraq
alhussaniee@gmail.com[1], hatemakeedy1969@gmail.com[2]

ABSTRACT

In Iraq, more than 1031 school projects have been halted due to disputes and claims resulting from financial, contractual, or other issues. This research aims to identify, prioritize, and allocate the most critical risk factors that threaten these projects' success for the duration (2017-2022). Based on a multi-step methodology developed through systematic literature reviews, realistic case studies, and semi-structured interviews, 47 risk factors were identified. Based on 153 verified responses, the survey reveals that the top-ranked risk factors are corruption and bribery, delaying the payments of the financial dues to the contractors or sub-contractors, absence of risk management strategy, multiple change orders due to changing designs and specifications during construction; inaccuracy in time and budget estimation; construction material price; financial and economic crisis/financial instability; selecting the contractor only based on the lowest bid, regardless of technical competence; instability within the political system of the government/instability of the government as a client; foreign exchange rates fluctuate against the Iraqi dinar. The study also showed that the respondents recommended allocating four risks to the owner, eight risk factors to the contractor, one risk to the consultant, and 32 factors allocated as shared. The study concluded that the results could help identify the most critical risks facing this type of project and the contracting party that can bear the risks and manage them efficiently.

Keywords: School projects; Risk identification; Risk allocation; Iraq; Claim and disputes

*Corresponding author
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دراسة تطبيقية لتحديد وتخصيص عوامل الخطر الهامة في مشاريع بناء المدارس في العراق

حيدر رزاق عبد*[1]، حاتم عبد الكريم رشيد[2]

قسم الهندسة المدنية, كلية الهندسة, جامعة النهرين، بغداد، العراق

الخلاصة

في العراق ، أكثر من 1031 مشروعًا مدرسيًا قد توقفت بسبب النزاعات والمطالبات الناتجة عن قضايا مالية أو تعاقدية أو غيرها. يهدف هذا البحث إلى تحديد عوامل الخطر الأكثر أهمية التي تهدد نجاح هذه المشاريع وترتيب أولوياتها وتخصيصها للفترة من(2017–2022). استنادًا إلى منهجية متعددة الخطوات تم تطويرها من خلال المراجعات المنهجية للأدبيات ودراسات الحالة الواقعية والمقابلات شبه المنظمة، تم تحديد 47 عامل خطر. استناداً إلى 153 استبيانا تم جمعها و التحقق منها ، أن عوامل الخطر الأعلى مرتبة هي: الفساد والرشوة؛ تأخير سداد المستحقات المالية للمقاولين أو المقاولين من الباطن ؛ عدم وجود استراتيجية لإدارة المخاطر ؛ أوامر التغيير المتعددة بسبب تغيير التصميمات والمواصفات أثناء البناء ؛ عدم الدقة في تقدير الوقت والميزانية ؛ سعر مواد البناء الأزمة المالية والاقتصادية / عدم الاستقرار المالي؛ اختيار المقاول فقط على أساس العطاء الأقل ، بغض النظر عن الكفاءة الفنية ؛ عدم الاستقرار داخل النظام السياسي للحكومة / عدم استقرار الحكومة كعميل ؛ تقلب أسعار صرف العملات الأجنبية مقابل الدينار العراقي. كما أظهرت الدراسة أن المستجيبين أوصوا بتخصيص أربعة مخاطر للمالك ، وثمانية عوامل خطر للمقاول ، وعامل خطر واحد للاستشاري ، و 32 عاملاً موزعة على أساس مشترك بين الاطراف التعاقدية. وخلصت الدراسة إلى أن النتائج يمكن أن تساعد في تحديد أهم المخاطر التي تواجه هذا النوع من المشاريع والطرف المتعاقد الذي يمكنه تحمل المخاطر وإدارتها بكفاءة.

الكلمات المفتاحية: المشاريع المدرسية؛ تحديد المخاطر؛ تخصيص الخطر؛ العراق؛ المطالبات والنزاعات.

1. INTRODUCTION

The construction sector is an important sector that significantly contributes to the economic prosperity of developing countries **(Khanh and Kim, 2014)**. This sector adds to several countries' gross domestic product (GDP). Construction generated 2.41 % of Iraq's gross domestic product **(CSO, 2021)**. Educational building projects are among the construction projects most exposed to risks, especially with developing designs and their increasing complexity **(Saleem et al., 2015)**. Educational construction projects are similar to others because they are subject to the same risks as the construction industry sector **(Renault and Agumba, 2016)**. Based on this similarity and the scarcity of studies on this type of project, the most important risks facing construction projects, especially in developing countries, will be highlighted. **(Durdyev et al., 2017)** discussed the major challenge affecting Cambodia's construction industry from the consultant and contractor perspective. They concluded that inadequate project schedules, late material delivery, project complexity, and unsatisfactory site safety are the most significant factors that cause delays in projects. **(Rasul et al., 2019)** advocated that productivity, construction issues, cost overruns, time overruns, resource allocation, and work quality were the most important factors affecting fast-track projects. **(Jaber et al., 2019)** found that inaccurate surveys, the nature of the earth, non-

qualified contractors, and contractors' lack of capital are the leading risk factors in Iraqi construction projects. The inexperience of consultants, design risks, and errors in the bill of quantities are some of the most critical risks affecting projects **(Marwa and Altaie, 2022)**. The discrepancy in costs is also considered one of the problems that Iraqi projects suffer from **(Abbas and Burhan, 2023).**

In a construction contract, allocating risk between the contractual parties is a crucial choice that affects the project's success **(Lam et al., 2007)**. Determining responsibilities towards risks at the beginning of the project would reduce conflicts between these parties **(Peckiene et al., 2013)**.

School construction projects are among the most important service projects that receive the attention of the Iraqi government because there is a significant shortage of them, especially with the increase in population growth in the country. In 2022, the Iraqi Ministry of Planning stated that over 1,031 school projects stopped working due to disputes and claims between the contracting parties arising due to contractual, technical, and financial problems, as well as encroachment by certain individuals on some sites **(MOP, 2022)**. Moreover, contractual documents lack a mechanism for risk allocation between these parties. In the same year, the Iraqi government announced the Iraqi-Chinese agreement, during which one of the strategic projects represented in building 1,000 school projects throughout Iraq will be implemented. Despite the seriousness of the agreement, there are fears that these projects will face similar problems, especially with the participation of Iraqi contracting companies as subcontractors. The objectives of this work are:

1. Identification of the main risk factors via a review of previous literature for the period 2017–2022, real-world case studies of stalled school construction projects, and semi-structured interviews with experts in the sector
2. Prioritizing the most important critical risk factors from the point of view of (owner, consultant, contractor, and expert engineers) in the public and private sectors using a structured survey form.
3. Detecting the strength of agreement between the perspectives of the contracting parties about the most influential risk factors by adopting the Kendall correlation test.
4. Allocate the identified risk factors to the appropriate contracting parties to reduce the time required to resolve claims and disputes.
5. Provide actionable recommendations to decision-makers depending on this analysis to reduce or prevent failure risk in Iraq.

2. METHODOLOGY

The authors used a mixed approach, combining qualitative and quantitative techniques, to accomplish the objectives of the article. The questionnaire was utilized in this study to collect data. **(Gillham, 2000)** emphasizes that questionnaire methodologies enhance the reliability of received data. In addition, according to **(Shang and Sui, 2014)**, questionnaires are an efficient, low-cost, and time-efficient approach for selecting possible responders. In the following sections, the authors describe the methods they used in depth. **Fig. 1** explains the methodology of this article.

2.1 Risk Factor Identification

2.1.1 Systematic Literature Review

The authors conducted a comprehensive database search to detect the most important risk-associated factors. The following are the specific processes used in the choosing of relevant studies:

- Database and keyword search engine: Databases in Google Scholar, Science Direct, ASCE, Emerald, Taylor and Francis, and Springer databases and a few conference proceedings were used to collect articles related to the topic. Several keywords were used, such as risk management, Risk factors, Critical failure factors, cost overruns, delay causes, Risk identification, risk assessment, COVID-19 impact, and developing countries.
- Screening and selection criteria: A set of criteria was selected for the screening of literature works, which were: (1) connected to risk management in construction projects and (2) identified risk factors during the period covering from 2017 to 2022.

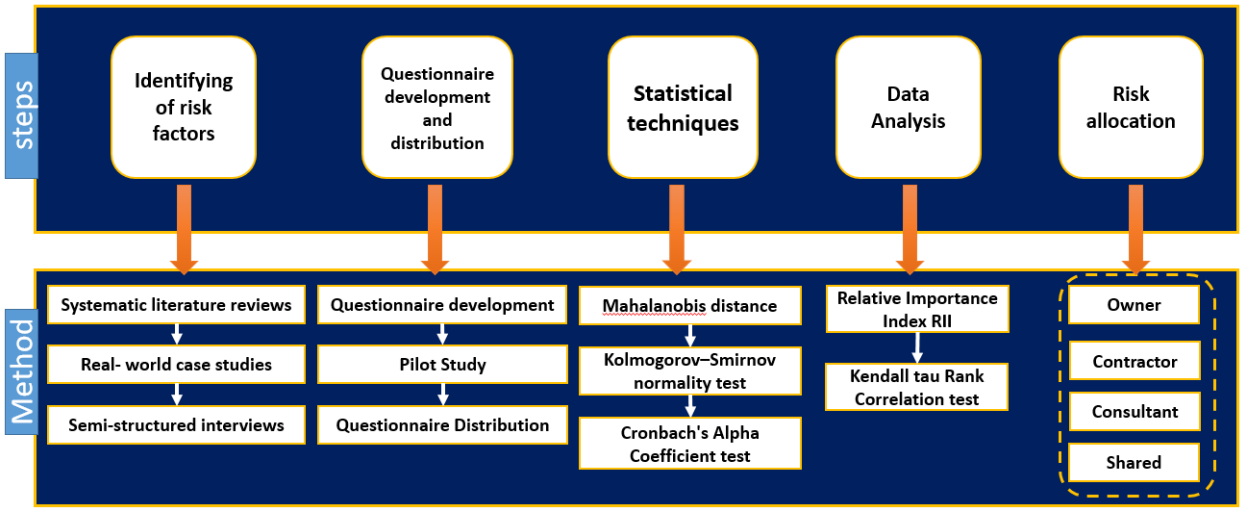

Figure 1. Methodology of the article.

2.1.2 Collecting Data from Real School Projects

Real case studies for 17 projects of the 'Ministry of Education / Directorate of Education of Dhi Qar' (2017-2022) were collected to estimate the risks associated with school construction projects. Some of these projects have been fully implemented, and some are pending or still in progress. These projects were examined and evaluated, in addition to interviews with the supervisors of these projects.

2.1.3 Semi Structured Interviews

The authors performed semi-structured interviews to confirm the exhaustiveness and applicability of the discovered list. Typically, semi-structured interviews are conducted by drafting open-ended questions in advance. Consequently, the authors prepared the questions based on relevant previous studies. These questions were then pilot-tested by professionals in the construction industry to optimize benefits and prevent inefficiencies. Five experts in the construction industry, having experience more than 13 years participated in the pilot study. They were requested to supply feedback on questions needing modification, clarification, addition, or deletion. The authors handled all the experts'

opinions and suggestions until no additional changes were necessary. After completing open-ended questions, 16 semi-structured interviews were performed with experts for this pilot test for other risks and a to confirm the list of risk factors. The interviewees' profiles are shown in **Table 1**.

Table 1. Illustrate experts' profile.

No. of experts	Role	Experience	Education level		
			Ph.D.	M.Sc.	Bachelor
2	University academics	≥ 15 years	2	0	0
3	Consultants	≥ 20 years	0	2	1
4	Project managers	≥ 15 years	0	3	1
3	Contractors	≥ 10 years	0	0	3
4	Site engineers	≥ 12 years	0	3	1

2.2 Questionnaire Development and Distribution

The subsections below describe the development of the questionnaire, sample size, and distribution mechanism:

2.2.1 Questionnaire Development

The authors developed a questionnaire to identify and prioritize, the significant risk factors associated with school construction projects. The first part of the questionnaire requested participants' general information. In the second part of the questionnaire, participants were asked to identify significant risks occurring in school construction projects, using a (1-5) Likert scale, where (1) indicates very rare and (5) shows always. In addition, by adopting **(Hiyassat et al., 2020)** approach, participants were asked to allocate each risk by picking one of the following options: (I) the owner, (II) the consultant, (III) the contractor, and (IV) shared between two or more parties. Finally, the questionnaire was translated to be in Arabic language.

2.2.2 Pilot study

The authors conducted a second pilot test to improve the questionnaire. The authors thus performed a preliminary test with 10 construction management professors, project managers, and consultants. They had more than 18 years of expertise in the construction sector. Those experts were requested to prepare comments and suggestions to clarify errors in the questionnaire. Finally, the authors reviewed and revised all respondents' feedback and improved the questionnaire appropriately.

2.2.3 Questionnaire distribution

The questionnaire was delivered to construction experts from various sectors in this research. The questionnaire was distributed to (200) construction professionals.

2.2.4 Data outlier

The term "outlier" was likely coined by **(Grubbs, 1969)**, a sample member that seems to differ significantly from the rest of the sample in which it occurs. The issue is that a slight outlier is always sufficient to skew data findings. The Mahalanobis distance is a prominent technique for determining outliers in multivariate statistics **(Majewska, 2015)**. It is the squared distance between the vector of an observed point and the vector of the mean (μ) for the closer points **(Hair et al., 2014)**. If the probability of Mahalanobis distance is less than

(P < 0.001), the response will be omitted. The respondents' responses were screened for outliers.

2.3 Statistical Tests

Several statistical tests, as mentioned below, were conducted using statistical packages.

- Data Normality: 'Kolmogorov–Smirnov normality test (K-S)' was used to determine the data's normality. The k-s evaluate the relationship between the presented data and the normal scores that are ideal **(Gunduz et al., 2020)**. Two hypotheses were formulated for the data distribution: the null hypothesis and the alternative hypothesis ($H_{o(normality)}$: the observed distribution does not differ from the normal distribution; $H_{a(normality)}$: the observed distribution differs from the normal distribution). The (p-values) must be more than 0.05 for the data to be normal.
- The 'Cronbach's Alpha Coefficient (α)' is a non-parametric test calculated to evaluate the questionnaire's consistency and reliability. The measure is deemed credible if the value of ($\alpha \geq 70\%$) **(Cronbach and Shavelson, 2004)**.

2.4 Relative Importance Index (*RII*)

It is often known as the *RII* approach, which is used to ascertain the rankings of items and factors provided by the respondents. Eq. (1) can be used to determine *RII*:

$$RII = \left(\frac{\sum W}{A \times N} \times 100\%\right) \quad (1)$$

where:
W is the weight respondents assign to each factor (ranging from 1 to 5).
A is the most substantial weight (which equals 5).
N is the overall number of respondents to the questionnaire.

2.5 Comparison Between Participant Groups

Kendall Tau's correlation test was utilized to analyze the strength of correlations among the replies of the participating groups. It is a non-parametric test computed for the four groups (owners, contractors, consultants, and expert engineers). The following research hypothesis will be established initially: ($H_{o(correlation)}$: There is no correlation between the groups; $H_{a(correlation)}$: There is a correlation between the groups). The null hypothesis will be accepted if the sig >0.01 and rejected if the sig.≤ 0.01, thus accepting the alternative hypothesis. The correlation coefficient between any two groups is calculated such that:

$$\tau = \left(\frac{n_c - n_d}{n(n-1)/2}\right) \quad (2)$$

where:
τ is Kendall Tau's correlation coefficient.
n_c is the number of concordant pairs.
n_d is the number of discordant pairs.
n is the risks number.

3. RESULTS AND ANALYSIS

3.1 Identified Risk Factors

Based on a study of the relevant literature and semi-structured interviews, the authors identified 47 risks. Below is a list of risk factors with supporting resources, as shown in **Table 2.**

Table 2. The identified risk factors

No.	Risk factors	References
R1	Owner intervention, as in the selection of suppliers or subcontractors	**(Dang et al., 2017; Annamalaisami et al., 2019; Sami et al., 2020; Sanni-Anibire et al., 2020)**
R2	Contractor errors, low quality, and non-conformity of his work to design and specifications during construction	**(Rasul et al., 2019; Hadi et al., 2021; Alvand et al., 2021)**
R3	Lack of experience and qualifications for the contractor or sub-contractors	**(Bajjou, and Chafi, 2018; Yeganeh et al., 2021)**
R4	Ineffective communication and coordination among all contracting parties	**(Khlaifat et al., 2017; Egwim et al., 2021; Rasheed et al., 2022; Jahan et al., 2022)**
R5	Delay in approving finished work	**Semi-structured interview (Hiyassat et al., 2020)**
R6	Weakness of supervision engineers due to reliance on non-professional or recent graduate engineers to assume all site responsibilities.	**(San Santoso et al., 2019; Patel et. al., 2019; Yaseen et. al., 2020; Gondia et al., 2020)**
R7	absence of risk management strategy	**(Tembo and Khatleli, 2017; Rachid et al., 2018; Wuni et al., 2020)**
R8	inaccuracy in time and budget estimation	**(Kassem, and Hamzah, 2020; Al-Mhdawi, 2022)**
R8	Weak design and absence of design information	**(El-Sayegh et al., 2018; Hung, 2018; Patel et al., 2019; Hiyassat et al., 2020)**
R10	Delay in reviewing and approving the design documents	**(Chen et al., 2017; Rasul et al., 2019; Jaber et al., 2019; Sami et al., 2020)**
R11	Errors in site surveys and investigations	**(Chatterjee et al., 2018, Tepeli et al., 2019)**
R12	Selecting the contractor only based on the lowest bid, regardless of technical competence.	**(Gondia et al., 2020), Semi-structured interview**
R13	Multiple change orders due to changing designs and specifications during construction	**Real school documents (Kassem and Hamzah, 2020; Yaseen et al., 2020)**
R14	Inconsistency in contract documents/ambiguous contract conditions	**(Che et al., 2017; San Santoso et al., 2019; Gondia et al., 2020; Egwim et al., 2021)**
R15	Corruption and bribes	**(Dang et al., 2017; Hiyassat et al., 2020), Semi-structured interview**
R16	Instability within the government's political system/ The government's instability as a client	**(Kassem, and Hamzah, 2020; Egwim et al., 2021; Rasheed et al., 2022)**

R17	Legal problems with the project's neighbours	**Real school documents (Gondia et al., 2020)**
R18	Use vocabulary with multiple interpretations in contract documents	**Semi-structured interview, Real school documents**
R19	Shortage of periodic review of the contract terms	**Semi-structured interview**
R20	High bureaucratic administration	**(Xu et al., 2018) Semi-structured interview**
R21	Financial and economic crisis/ financial instability	**(Kassem and Hamzah, 2020)**
R22	Foreign exchange rates fluctuate against the Iraqi dinar	**(Jahan et al., 2022), Semi-structured interview**
R23	Construction material price fluctuations/ increase purchase cost	**(Gondia et al., 2020; Jahan et al., 2022) Real school documents**
R24	A monopoly of some suppliers of construction materials	**(Khlaifat et al., 2017; Rasul, et al., 2019) Semi-structured interview**
R25	Delaying the payments of the financial dues to the contractors or sub-contractors	**(Dang et al., 2017; Kassem, and Hamzah, 2020; Jahan et al., 2022), Real school documents**
R26	Economic inflation	**(Alvand et al., 2021; Hadi et al., 2021)**
R27	Unpredicted weather conditions/cold and hot weather that may stop the project	**(Rasul et al., 2019; Hiyassat et al., 2020; Hadi et al., 2021), Real school documents**
R28	Force majeure	**(Santoso et al., 2019; Hiyassat et al., 2020)**
R29	The presence of opponents to hand over the land to the contractor.	**Real school documents**
R30	The impact of wars in the regional environment, causing the interruption of some materials and equipment necessary for work	**Semi-structured interview, Real school documents**
R31	different cultures between foreign and local partners (different languages)	**(Kassem, and Hamzah, 2020)**
R32	Delay in granting approvals for samples of materials used in the project	**(Hiyassat et al., 2020; Sanni-Anibire et al., 2020), Semi-structured interview**
R33	Unavailability of the necessary equipment for work	**(Rachid et al., 2018; Sanni-Anibire et al., 2020; Yaseen et al., 2020)**
R34	Low quality of materials used	**(Tembo et al., 2017; Kassem and Hamzah, 2020)**
R35	Poor storage of materials inside the site	**(Rachid et al., 2018; Sanni-Anibire et al., 2020; Gondia et al., 2020)**
R36	Increase salaries of workers.	**(Santoso et al., 2019)**
R37	Poor productivity of labour and equipment	**(Santoso et al., 2019; Yaseen et al., 2020), Semi-structured interview**
R38	Lack of skilled workers in the region	**(Rachid et al., 2018; Santoso et al., 2019)**
R39	Restrictions on the import and export of some materials	**(Hiyassat et al., 2020)**

R40	Problems and obstacles in transporting materials to the work site	**(Kassem, and Hamzah, 2020)**
R41	Inadequate protection of completed work items from tampering and theft	**Semi-structured interview, Real school documents**
R42	Armed groups threats/vandalism and terrorism	**(Kassem and Hamzah, 2020), Semi-structured interview**
R43	Accidents caused by noncompliance with HSE standards	**(Rachid et al., 2018; Gondia et al., 2020; Egwim et al., 2021; and Al-Mhdawi, 2022)**
R44	material theft /equipment theft	**(Dang et al., 2017;Siraj and Fayek, 2019)**
R45	the threat of revolutions, riots, and criminal acts	**(Siraj and Fayek, 2019), Semi-structured interview, Real school documents**
R46	Epidemic illnesses like COVID-19	**(Al-Mhdawi et al., 2021)**
R47	The occurrence of clan conflicts	**Real school documents**

3.2 Demographic of Questionnaire Respondents

The authors developed a questionnaire in step 3.2 of the methodology to quantify the key risk factors shown in **Table 2.,** that may negatively affect school construction projects. Only 181 out of 200 questionnaires were returned. Although 181 replies were collected, only 162 were considered complete for analysis. Consequently, the survey response rate is 81%, which is regarded as high.

The Mahalanobis distance was then applied to detect multivariate outliers using SPSS version 26 software. It was determined that the probability of Mahalanobis distance is much less than ($P < 0.001$) for nine responses; hence, those nine were omitted. Only 153 answers were utilized for further analysis after data screening. **Table 3** shows the background and distribution of the 153 respondents.

As indicated above, the roles include owner, contractor, consultant, and expert engineers (project managers and site engineers). As expected, most respondents have bachelor's degrees (44.4%) and postgraduate degrees (40.5%). The respondents were dispersed among 13 of Iraq's 18 governorates. Roles, educational qualifications, and geographic variety reflect the survey respondents' high reliability.

3.3 Survey Normality and Reliability

- After gathering the responses, the authors carried out the Kolmogorov–Smirnov test (K-S) to determine the normality of collected data. The K-S values for risk factors varied from 0.197 to 0.307. In addition, the K-S test revealed that all significant values were less than 0.05 for each item. The data thus deviated from normality, and the alternative hypothesis was accepted, necessitating the application of nonparametric tests for data analysis.
- A reliability study using Cronbach's alpha coefficient was carried out to measure the degree to which variables and scales were consistent. Alpha Cronbach value for the second section of the questionnaire was (0.894), which is much greater than (0.7). The results ascertain that the questionnaire is reliable and valid.

Table 3. Respondents' profile

Profile	Category	Distribution	
		Number	Percent %
Role	Owner	30	19.6
	Contractor	31	20.3
	Consultant	26	17
	Expert engineers	66	43.1
Experience (year)	< 5	20	13.1
	5-10	32	20.9
	10-20	69	45.1
	>20	32	20.9
Working sector	Public sector	85	55.6
	Private sector	56	36.6
	Public-Private Partnership	12	7.8
Education Qualifications	Ph.D.	10	6.5
	M.Sc.	52	34
	Bachelor's degree	68	44.4
	Diploma	10	6.5
	Others	13	8.5

3.4 Data Analysis

3.4.1 Relative Importance Index

This research used *RII* to reflect the importance of risk factors and to prioritize respondent groups' perceptions of the important risk factors affecting schedule, cost, quality, and safety. According to the survey findings, prioritizing risk factors affecting school construction projects in Iraq from the perspectives of each group and the overall perspective is provided in **Table 4.** According to the overall perspective, the highest risk factor importance was R15, 'Corruption and bribes', while the lowest risk factor importance was R28 ', Force majeure'.

Based on the data shown in the table above, the top 10 risks associated with school construction projects, as determined by the overall *RII*, are as follows: The first and most significant risk is 'corruption and bribery', with (*RII*= 86.01%, SD.= 1.16508). This risk is caused by the corruption of the contractual parties and the suspicious referrals of incompetent contractors, causing delays in implementing these necessary projects. The second most significant risk is 'Delaying the payments of the financial dues to the contractors or sub-contractors', with (*RII*= 85.49%, SD= 0.77997). This risk results from the owners' late payment of the expenses of finished work items to the contractors. This led to delays by the contractors in delivering the financial obligations to subcontractors or suppliers. 'Absence of risk management strategy' is the third most critical risk, with (*RII*=81.57%, SD=0.807).

This risk is represented by the failure of the contracting parties to define a clear risk management plan and allocate risks to the party most suited to handle them. The fourth most significant risk is 'Multiple change orders due to changing designs and specifications during construction' with (*RII*= 81.57%, SD= 0.87757). This risk is often generated by a shortage of experts in certain specialized domains and an inaccurate project scope specification. The fifth most significant risk is 'Inaccuracy in time and budget estimation' with (*RII*=80.78%,

SD=0.9381). This risk is often caused by the inability of local contractors working on school construction projects to estimate time and costs accurately

Table 4. Risks priority from different respondents' perspectives

No.	Risk factors	Owner		Contractor		Consultant		Expert Eng.		Overall	
		RII	Ran	*RII*	Ran	*RII*	Ran	*RII*	Ran	*RII*	Ran
R1	Owner intervention, as in the selection of suppliers or subcontractors	63.3	32	36.7	45	80.7	8	76.9	14	66.8	30
R2	Contractor errors, low quality, and non-conformity of his work to design and specifications during construction	71.33	14	58.71	30	78.46	12	77.88	13	72.81	17
R3	Lack of experience and qualifications for the contractor or sub-contractors	80	4	52.9	37	84.62	4	78.48	10	74.64	14
R4	Ineffective communication and coordination among all contracting parties	68	22	47.1	42	75.38	14	73.03	19	67.19	25
R5	Delay in approving finished work	76	9	69.68	15	75.38	15	78.48	11	75.69	11
R6	Weakness of supervision engineers due to reliance on non-professional or recent graduate engineers to assume all site responsibilities.	68	23	90.32	2	74.62	17	70.91	22	74.9	12
R7	Absence of risk management strategy	78.67	7	70.97	12	88.46	3	85.15	4	81.57	3
R8	Inaccuracy in time and budget estimation	76	10	83.23	6	80.77	9	81.82	8	80.78	5
R9	Weak design and absence of design information	71.33	15	85.16	5	69.23	24	73.94	18	74.9	13
R10	Delay in reviewing and approving the design documents	69.33	18	69.68	16	72.31	20	71.52	21	70.85	20
R11	Errors in site surveys and investigations	68.67	19	76.13	9	67.69	27	67.27	32	69.41	22

R12	Selecting the contractor only based on the lowest bid, regardless of technical competence.	81.33	1	53.55	35	89.23	1	86.36	3	79.22	8
R13	Multiple change orders due to changing designs and specifications during construction	80.67	2	90.97	1	79.23	11	78.48	12	81.57	4
R14	Inconsistency in contract documents/ambiguous contract conditions	64	31	70.97	14	66.15	29	69.7	27	68.24	23
R15	Corruption and bribes	80.67	3	87.1	4	88.46	2	86.97	1	86.01	1
R16	Instability within the government's political system/ The government's instability as a client	80	6	63.87	24	84.62	5	83.03	6	78.82	9
R17	Legal problems with the project's neighbours	65.33	27	65.16	23	67.69	26	68.18	31	66.93	27
R18	Use vocabulary with multiple interpretations in contract documents.	64.67	28	69.03	18	70	22	64.85	33	66.54	31
R19	Shortage of periodic review of the contract terms	66.6	25	52.9	36	66.1	30	70	23	65.2	33
R20	High bureaucratic administration	72.67	13	72.26	11	74.62	18	75.15	17	73.99	15
R21	Financial and economic crisis/ financial instability	78	8	69.03	17	82.31	7	84.24	5	79.61	7
R22	Foreign exchange rates fluctuate against the Iraqi dinar.	73.33	12	70.97	12	80	10	81.21	9	77.39	10
R23	Construction material price fluctuations/increased purchase cost	70.67	16	82.58	7	80	10	82.42	7	79.74	6
R24	A monopoly of some suppliers of construction materials	61.33	36	65.16	22	66.92	28	70	26	66.8	29
R25	Delaying the payments of the financial dues to the contractors or sub-contractors	80	5	90.32	3	83.85	6	86.36	2	85.49	2

R26	Economic inflation	62.67	33	67.1	21	75.38	13	76.67	15	71.76	18
R27	Weather conditions/cold and hot weather that may stop the project	60.67	38	48.39	40	54.62	37	59.39	42	56.6	43
R28	Force majeure	46.6	46	43.2	44	35.3	42	43.0	47	42.4	47
R29	The presence of opponents to hand over the land to the contractor.	67.33	24	65.16	23	66.92	28	70	24	67.97	24
R30	The impact of wars in the regional environment, causing the interruption of some materials and equipment necessary for work	56.67	42	49.68	38	57.69	35	60	40	56.86	42
R31	Different cultures between foreign and local partners (different languages)	54.67	44	49.03	39	50	41	54.24	43	52.55	45
R32	Delay in granting approvals for samples of materials used in the project	62	34	60	28	62.3	32	64.5	36	62.7	37
R33	Unavailability of the necessary equipment for work	62	35	63.23	25	64.62	31	64.85	34	63.92	36
R34	Low quality of materials used	70	17	56.13	32	73.08	19	76.36	16	70.46	21
R35	Poor storage of materials inside the site	64	30	54.19	33	68.46	25	72.42	20	66.41	32
R36	Increase salaries of workers	60.67	37	70.97	13	58.46	34	50.91	46	58.17	40
R37	Poor productivity of labour and equipment	74	11	79.35	8	75.38	14	70	25	73.59	16
R38	Lack of skilled workers in the region	68.67	20	53.55	34	75.38	14	69.7	28	67.19	26
R39	Restrictions on the import and export of some materials	59.33	39	56.77	31	53.85	39	62.42	38	59.22	39
R40	Problems and obstacles in transporting materials to the work site	59.33	40	61.29	27	56.92	36	61.82	39	60.39	38

R41	Inadequate protection of completed work items from tampering and theft	64	30	67.74	20	62.31	33	64.85	35	64.84	35
R42	Armed groups threats/vandalism and terrorism	66	26	74.84	10	75.38	16	69.7	29	70.98	19
R43	Accidents caused by noncompliance with HSE standards	68.67	21	59.35	29	69.23	23	68.79	30	66.93	28
R44	Material theft /equipment theft	57.33	41	47.74	41	54.62	38	59.7	41	55.95	44
R45	Threat of revolutions, riots, and criminal acts	50	45	44.5	43	51.5	40	53.9	44	50.8	46
R46	Epidemic illnesses like COVID-19	56.67	43	68.39	19	54.62	38	52.73	45	56.99	41
R47	The occurrence of clan conflicts	64.67	29	62.58	26	70.77	21	64.24	37	65.1	34

The sixth most significant risk is 'Construction material price fluctuations/ increase purchase cost' with (*RII*=79.74%, SD=0.91037). The frequent and sudden change in the prices of building materials is common in Iraq, as the cost of necessary building materials fluctuates whenever the government changes the price of petroleum products. The seventh most significant risk is 'Financial and economic crisis/ financial instability', with (*RII*=79.61, SD=0.75629). This risk is represented by the exposure of the owner or contractor to financial problems during the execution of the project, which creates delays in the project's timely completion. The eighth most common risk is 'Selecting the contractor only based on the lowest bid, regardless of technical competence' (*RII*=79.22%, SD=0.98597). The reason for this risk is frequently the poor experience of the price analysis committees in this field, which leads to the selection of the lowest submitted bids to avoid legal issues from regulatory authorities if they select a higher offer, resulting in the failure of projects and the postponement of their implementation. The ninth most significant risk is 'Instability within the political system of the government/instability of the government as a client' (*RII*=78.82%, SD=0.90492). This risk is expected in the present period, causing sober organizations to avoid work out of fear of this change, enabling incompetent bidders to obtain the contracts and thus delaying or stopping these projects in the future. The tenth most significant risk is 'Foreign exchange rates fluctuate against the Iraqi dinar' (*RII*=77.39%, SD=0.87127). This risk has increased significantly over the last two years, forcing many projects to halt owing to changes in the pricing of construction materials and an increase in the workforce's salaries, posing a significant challenge to the timely completion of these projects.

3.4.2 Comparison Between Participant Groups

To examine the strength of agreement among the perspectives of owners, consultants, contractors, and expert engineers, a Kendall rank correlation test was performed to determine the degree of consensus in pairs among those four groups by adopting the relative importance of risk factors for each group in the SPSS environment. Based on the results shown in **Table 6**, which refer to Kendall rank correlation tests, it is evident that there is a correlation range (0.308 to 0.788) at the level of statistical significance (0.01). These results demonstrate no statistically significant differences in risk ranking among the four groups, but the contractor appears to have a low correlation with other groups.

Table 6. Kendall rank correlation for respondents' groups

		Owner	Contractor	Consultant	Expert Eng.
Owner	Correlation Coefficient	1	0.386**	0.756**	0.734**
	Sig. (2-tailed)	-	0.000	0.000	0.000
Contractor	Correlation Coefficient	0.386**	1	0.308**	0.310**
	Sig. (2-tailed)	0.000	-	0.003	0.002
Consultant	Correlation Coefficient	0.756**	0.308**	1	0.788**
	Sig. (2-tailed)	0.000	0.003	-	0.000
Expert Eng.	Correlation Coefficient	0.734**	0.310**	0.788**	1
	Sig. (2-tailed)	0.000	0.002	0.000	-

**Correlation is significant at the 0.01 level (2-tailed).

3.5 Allocating Risk Factors

Risk allocation, which means assigning risks to appropriate contractual parties, is an essential aspect of risk management. Inappropriate risk distribution will likely result in disputes, cost increases, and project delays. This study adhered to **(Hiyassat et al., 2020)** approach to allocating every risk to the group that obtains greater than 50 % of the respondents' choices. The classification for risks with a threshold of less than 50 % is 'Not decided'. The recommended allocation for each risk factor is given in **Table 7**. Only two risk factors were not allocated, namely (R2) 'Contractor errors, low quality, and non-conformity of his work to design and specifications during construction'; (R8) 'Inaccuracy in time and budget estimation'. The risk factors (R12, R16, R25, and R29) were allocated to the owner. While, the risk factors (R33, R34, R35, R36, R37, R38, R41, and R44) were allocated to contractor. One risk factor was preferably allocated to the consultant: ' Weak design and absence of design information'. Other risk factors were allocated to be shared among parties of the contract. It can be observed that (27) risk factors have been allocated at less than 60%, indicating that many respondents have conflicting perspectives about allocating risks. This uncertainty and discrepancy in risk allocation may contribute to claims and disputes in this project.

Table 7. Allocation of risk factor

No.	Risk factors	Owner %	Contractor %	Consultant %	Shared%	Allocation
R1	Owner intervention, as in the selection of suppliers or subcontractors	25.5	12.42	7.83	54.25	Shared
R2	Contractor errors, low quality, and non-conformity of his work to design and specifications during construction	25.5	31.4	9.8	33.3	Not decided
R3	Lack of experience and qualifications for the contractor or sub-contractors	20.9	9.8	9.2	60.1	Shared
R4	Ineffective communication and coordination among all contracting parties	28.7	8.5	11.8	51	Shared
R5	Delay in approving finished work	23.5	14.4	9.8	52.3	Shared
R6	Weakness of supervision engineers due to reliance on non-professional or recent graduate engineers to assume all site responsibilities.	8.5	26.14	15.03	50.33	Shared
R7	Absence of risk management strategy	14.4	19	16.3	50.3	Shared
R8	inaccuracy in time and budget estimation	32.7	19.6	17	30.7	Not decided
R9	Weak design and absence of design information	17.6	5.9	53.6	22.9	Consult ant
R10	Delay in reviewing and approving the design documents	17.64	7.83	23.53	51	Shared
R11	Errors in site surveys and investigations	17	16.34	15.03	51.63	Shared
R12	Selecting the contractor only based on the lowest bid, regardless of technical competence.	66.7	3.9	7.8	21.6	Owner
R13	Multiple change orders due to changing designs and specifications during construction	20.9	9.8	15.7	53.6	Shared

R14	Inconsistency in contract documents / ambiguous contract conditions	30.72	5.23	12.42	51.63	Shared
R15	Corruption and bribes	31.3	7.2	2	59.5	Shared
R16	Instability within the government's political system/ The government's instability as a client	55.6	6.5	2.6	35.3	Owner
R17	Legal problems with the project's neighbours	32	11.8	2.6	53.6	Shared
R18	Use vocabulary with multiple interpretations in contract documents	28.7	10.5	9.2	51.6	Shared
R19	Shortage of periodic review of the contract terms	21.5	9.2	8.5	60.8	Shared
R20	High bureaucratic administration	33.33	5.9	7.842	52.94	Shared
R21	Financial and economic crisis/ financial instability	27.4	10.5	2.6	59.5	Shared
R22	Foreign exchange rates fluctuate against the Iraqi dinar	23.5	11.1	3.3	62.1	Shared
R23	Construction material price fluctuations/increased purchase cost	17	24.8	3.3	54.9	Shared
R24	A monopoly of some suppliers of construction materials	9.8	36.6	1.3	52.3	Shared
R25	Delaying the payments of the financial dues to the contractors or sub-contractors	64.71	9.16	3.26	22.87	Owner
R26	Economic inflation	28.8	5.2	4.6	61.4	Shared.
R27	Unpredicted weather conditions/cold and hot weather that may stop the project	7.2	20.9	2.6	69.3	Shared
R28	Force majeure	15.03	13.73	1.3	69.94	Shared
R29	The presence of opponents to hand over the land to the contractor.	59.5	5.2	0.7	34.6	Owner

R30	The impact of wars in the regional environment, causing the interruption of some materials and equipment necessary for work	30.7	7.2	3.9	58.2	Shared
R31	Different cultures between foreign and local partners (different languages)	15.7	9.8	7.8	66.7	Shared
R32	Delay in granting approvals for samples of materials used in the project	19	10.4	19.6	51	Shared
R33	Unavailability of the necessary equipment for work	6.5	61.4	3.3	28.8	Contractor
R34	Low quality of materials used	5.2	60.8	11.8	22.2	Contractor.
R35	Poor storage of materials inside the site	2.6	73.9	4.5	19	Contractor
R36	Increase salaries of workers	10.5	61.4	1.3	26.8	Contractor
R37	Poor productivity of labour and equipment	2.6	69.9	2	25.5	Contractor
R38	Lack of skilled workers in the region	7.84	62.74	4.6	24.82	Contractor
R39	Restrictions on the import and export of some materials	23.53	16.34	3.92	56.21	Shared.
R40	Problems and obstacles in transporting materials to the work site	7.8	37.9	2.6	51.6	Shared
R41	Inadequate protection of completed work items from tampering and theft	20.9	50.3	2.6	26.1	Contractor
R42	Armed groups threats/vandalism and terrorism	24.2	9.1	0.7	66	Shared
R43	Accidents caused by noncompliance with HSE standards	5.9	31.4	3.9	58.8	Shared.
R44	material theft/equipment theft	13.1	53.6	2.6	30.7	Contractor
R45	the threat of revolutions, riots, and criminal acts	26.8	7.8	3.3	62.1	Shared
R46	Epidemic illness like COVID-19	17.6	7.2	2.61	72.55	Shared

R47	The occurrence of clan conflicts	28.7	9.2	1.3	60.8	Shared

4. STUDY CONTRIBUTIONS AND LIMITATIONS

This study enhances knowledge by presenting an exhaustive list of risk factors that might influence school construction projects. The authors of this research confirmed the exhaustiveness and appropriateness of the discovered list by helping industry experts in Iraq. In addition, the authors estimated the relative importance of these factors from the perspective of contract parties and in general. Using the Kendall correlation coefficient, this research also identified the degree of correlation between contractual parties in identifying critical risk factors in school construction projects. Where the results indicated a high degree of agreement between these parties. This study also helps allocate risk factors that influence school construction projects to the appropriate contractual parties, hence reducing the number of claims and disputes between these parties.
The limitations of this study are represented in reviewing the risk factors related to school building projects and for the period (2017-2022). Concerning realistic study cases, it was limited to school building projects available in the Dhi_Qar Governorate.

5. CONCLUSIONS AND RECOMMENDATIONS

This research aims to identify, prioritize, and allocate the key risk factors influencing school construction projects in Iraq. The methodology was based on a systematic literature review, investigating risk factors in realistic case studies, and conducting semi-structured interviews with 16 experts to construct a final and confirmed list of these factors. 153 verified responses from various contractual parties in the Iraqi construction sector were surveyed. After analyzing the opinions of experts and the data from the questionnaire, the study reached the following results:

- 47 risk factors were discovered in this study.
- The top-ranked risk factors are corruption and bribery; delaying the payments of the financial dues to the contractors or sub-contractors; absence of risk management strategy; multiple change orders due to changing designs and specifications during construction; inaccuracy in time and budget estimation; construction material price; financial and economic crisis/financial instability; selecting the contractor only based on the lowest bid, regardless of technical competence; instability within the political system of the government/instability of the government as a client; foreign exchange rates fluctuate against the Iraqi dinar.
- The overall values (*RII*) for the top ten risk factors were between (77.39 - 86.01) based on participants' replies.
- The respondents allocated risk factors to contracting parties. 27 risk factors have been allocated at a percentage less than 60%, indicating that a significant proportion of respondents have conflicting perspectives about allocating risks. This uncertainty and discrepancy in risk allocation may contribute to claims and disputes in this project.

According to the research findings, the authors summarize the following recommendations as part of response strategies to identified risks:

- The government must strengthen and improve the efficiency of the supervisory authorities in implementing anti-corruption measures.

- Developing a solid economic policy and providing financial support.
- The necessity of defining the project's scope and adopting modern methods and tools in preparing designs and site management plans to reduce the risks related to change orders and errors in estimating time and costs.
- This study recommended that the competent departments in preparing tender documents appropriately allocate risks between the parties to the contract to avoid or reduce cases of claims and disputes.

NOMENCLATURE

Symbol	Description	Symbol	Description
A	Most substantial weight (which equals to 5).	RII	Relative importance index
N	Overall number of respondents to the questionnaire	W	Weight respondents assign to each factor (ranging from 1 to 5).
n	Risks number	$\boldsymbol{\alpha}$	Cronbach's Alpha coefficient
n_c	Number of concordant pairs.	$\boldsymbol{\mu}$	Sample mean
n_d	Number of discordan pairs.	$\boldsymbol{\tau}$	Kendall Tau's correlation coefficient

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