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A STUDY FOR SIGNIFICANT RISKS AND THEIR EFFECTS ON CONSTRUCTION PROJECTS IN ERBIL CITY

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Abstract: To accomplish a construction project successfully, it is important to manage the risk in terms of cost, time, and quality. Risks always exist in construction projects and often cause schedule delay or cost overrun. Risk management is a process which consists of identification of risks, assessment with qualitatively and quantitatively, response with a suitable method for handling and control risks. The aim of this paper is to identify top major of 50 risks by contractors, owners and engineers. Questionnaire surveys were used to collect data, based on a comprehensive assessment of the likelihood of occurrence and their impacts on the project objectives. Also the impact of risks on cost, time, and quality, on construction project were analyzed. Questionnaire distributed to stakeholders who are working in construction sector in Erbil City during 2014-2015, then analyzed statistically. The results of the questionnaire indicate that the most significant risks are: inability of owner to finance the project, awarding the design to unqualified designers, poor qualifications, skills & experience of contractor and technical staff, design errors or defective design, poor qualifications and supervision of owner's engineer, and long wait for approval of tests and inspection. These significant risks are from four major risk factors: owner, management, contractor, and consultant. Rise in the prices of materials, poor cost control, and design change by owner, are most significant risks that affects cost of projects. Suspension of work, poor planning and scheduling of the project by the contractor, and slow decision making process by owner have the most significant effect on duration of a project. While, compliance of material to specifications, awarding the design to unqualified designers, and poor qualification and supervision of owners engineer are the most significant risks that affect quality.

Keywords: *Construction projects, Risk management, Risk factors, Risk response, Risk identification techniques.*

دراسة اهم المخاطر و اثارها على المشاريع الانشائية في مدينة اربيل

الخلاصة : لانجاز اي مشروع انشائي بنجاح، من المهم ادارة المخاطر من حيث الكلفة والوقت والجودة. ان المخاطر فى مشاريع الانشاء غالبا ما تكون سببا فى تاخر مدة انجاز المشروع او تجاوز كلفته عن المخطط. ادارة المخاطر هي تحديد المخاطر وتقييمها نوعا وكما، و مواجهتها بانسب الطرق لمعالجة تلك المخاطر والسيطرة عليها. ان الهدف من البحث هو تحديد ٥٠ سبب للمخاطر من قبل المقاولين و اصحاب العمل والمهندسين عن طريق الاستبيان و جمع البيانات، استنادا الى تقييم شامل لاحتمالية حدوثها واثارها على اهداف المشروع . كما وقد تم تحليل أثر المخاطر على الكلفة والوقت والجودة بالنسبة للمشاريع الانشائية. وقد وزع الاستبيان على اصحاب العلاقة الذين يعملون فى قطاع الانشاء فى مدينة اربيل خلال العامين ٢٠١٤-٢٠١٥، ثم تم تحليل النتائج احصائيا. و قد بينت نتائج الاستبيان ان اشد المخاطر هى: عجز صاحب العمل في تمويل المشروع ومنح التصميم لمصممين غير اكفاء و ضعف المؤهلات والمهارات و الخبرات لدى الكوادر الفنية للمقاول و وجود اخطاء في التصميم او التصاميم المعيبة و ضعف كفاءة المهندس المشرف لدى صاحب العمل

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الطويل من اجل الحصول على الموافقات و التراخيص بالنسبة للاختبارات والفحوصات. ان هذه المخاطر ناتجة من اربعة عوامل خطر رئيسية هي : صاحب العمل والادارة و المقاول و المهندس الاستشاري. ان ارتفاع اسعار مواد البناء و ضعف السيطرة على الكلف و اجراء التغيير ات في التصاميم من قبل صاحب العمل، هي اهم المخاطر التى تؤثر على كلفة المشاريع. اما ايقاف العمل و سوء التخطيط والجدولة للمشروع و البطء في اتخاذ القرارات من قبل صاحب العمل هي الاكثر تاثيرا على مدة المشروع. فى حين ان عدم مطابقة المواد للمواصفات، ومنح التصاميم لجهات غير كفوءة و ضعف الكادر الاشرافي لمهندس صاحب العمل هي اهم المخاطر التى تؤثر على الجودة.

1. Introduction

Construction companies and firms, such as the government, consultants and contractors, normally face different kinds of risks during construction. Risk is known as the potential for unexpected consequences of an activity such as a combination of construction hazard and exposure. The probability of something happening that will have an impact on construction project objectives; may have either a positive or negative impact combination of "frequency" of occurrence of a defined threat or opportunity and the "magnitude" of the consequences of the occurrence in the construction project [1]. Risk and uncertainty are two misconstrued concepts but distinct in nature. Whereas risk is upheld as an uncertain discrete event which can be estimated using probabilistic analysis, uncertainty is associated with an uncommon state of nature characterized by the absence of any information related to a desired outcome. It is the gap between the information required to estimate an outcome and the information already posed by the decision maker [2] .Compared to other industries, the construction industry is at or near the top in the annual rate of business failures and resulting liabilities. This is because it is a risky business with too many uncertainties that management has to deal with. These uncertainties stem from a variety of external and internal factors [3]. The PMBOK (project management body of knowledge [4], defines a standard process to identify risks, which is based on an iterative process because new risks may evolve or become known as the project progresses through its life cycle [5]. The identification of risk factors in project life cycle of construction business is not really new previously its roots belong to the advancement of the Program Evaluation and Review Technique (PERT) [6]. In project management terms, the most serious effects of risk can be summarized as follows [7]:-

1. Failure to keep within the cost estimate.
2. Failure to achieve the required completion date.
3. Failure to achieve the required quality and operational requirements.

The track record of construction industry is very poor in terms of managing with risks, resulting in the failure of many projects to meet time schedules, targets of budget and sometimes even the scope of work [8]. As a result, a lot of suffering is inflicted to the clients and contractors of such projects and also to the general public. Some risks in construction processes can be easily predicted or readily identified; still some can be totally unforeseen [8]. Construction industry development is a common and contemporary goal of many urban development policies in various countries. Development of the construction industry also requires knowledge of risk management policies. It is a well establish fact that every stage of the construction process, from initial investment appraisal through to construction and use of the built facility, is

subject to risk for all the parties involved [9]. The risk management technique is used very less because of less knowledge and awareness among the people. The track record is also very poor in terms of coping up with risks in projects, resulting in the affection of project objectives. Risk management is adopted to contain the possible future risks proactively rather than being reactive [10]. Risk management involves the identification of influencing factors which could negatively impact on cost, schedule or quality objective of the project, quantification of the impact of potential risk and implementation of measures to mitigate the potential impact of the risk [11]. PMI [12], proposes an almost similar definition for project management, as to include the process concerned with conducting risk management planning, identification, analysis, responses and monitoring and control on project. All these steps of the risk management process should be included to deal with risk in order to implement the processes of the project management [10].

2. Literature Review

There is always the possibility of encountering risk in every aspect of business endeavors. Whereas some risks are self-inflicted, others are simply unavoidable. Thus, it is always important for stakeholders to assess the risks that are most likely to be encountered in their daily activities. The very first step in risk assessment is the identification and categorization of all possible risk situations. A number of studies have been carried out to determine the factors of risk in construction project. P.J.Edwards [13], conducted a research on risk and risk management in construction. They primarily classify risk into two main categories natural risk and human risk. Natural risk occurs outside human system, while human risks arise within humanly organized system. Shen [14], categorized risks into six groups in accordance with the nature of the risks, i.e. financial, legal, management, market, policy and political, as well as technical risks.. Smith and Kashiwagi [15], concluded that risks are analyzed using a combination of quantitative and qualitative assessment techniques. In quantitative risk assessment, this is carried out in terms of mathematical probability of occurrence and the associated consequence. Chapman [16], translated the risks described within the Central Computer and Telecommunications Agency Publication Management of Project Risk into the design risks which included but were not limited to “difficulty in capturing and specifying the user requirements, difficulty of estimating the time and resources required to complete the design, “difficulty of measuring progress during the development of the design”. Chen and Wang [17], identified fifteen risk factors about project cost and divided them into three groups: resource factors, management factors, and parent factors. Chen found that “price escalation of material” pertaining to resource factors, “inaccurate cost budget” and “supplier or subcontractors’ default” pertaining to management factors, and “excessive interface on project management” pertaining to parent factors are the most significant risks in this particular project. Joshua [18] concluded that risk in construction can be seen as introduction of construction activities to financial loss due to unanticipated events for which doubt was not properly fitted. Grace [19] stated that risk in the construction industry can prevent the meeting of time,

cost and quality targets. KarimiAzari, Mousavi, Farid and Hosseini [20], stated that risk analysis can provide avenue for knowing the origins of project risk and enable management to develop directed corrective action. Studies by Ogunsanmi [21], revealed 37 risk factors that affect the design and project concluding that designers and contractors should watch out for cost overruns and poor quality as major risk categories. Rezakhani [22], classified the risk factors under three heads: External, Legal and internal. External risk was sub divided into two subsets: unpredictable/ uncontrollable, predictable/ uncontrollable and Internal risk was sub divided into two subsets: Non-technical / controllable, Technical / controllable. Chilesh and Yirenkyi-Fianko [23], identified 25 major risk factors associated with construction projects in Ghana and have major impacts on issues related to project performance and delivery in relation to cost, time and quality. Thaheem [24], include probability analysis, brainstorming, interviewing, scenerio analysis, probability distributions and sensitivity analysis. Patel Kinnaresh [25], conducted study on risk assessment and its management in India according to them it is safe to say that the majority of construction projects in India have no systematic procedure to deal with risks from the obtained results. It is also found out that financial, construction, and quality risks were associated with construction projects in India. According to Prof. Shakil S. Malek [26], concluded that risk management ultimately minimizes the project losses & increase the likelihood that the project in completed on schedule & within the budget. Risk management is a proactive management tool used for early visibility of potential problem areas & possible mitigation measures. Goh [27], identified 19 risk factors in the life cycle of the project under four heads such as Planning stage, Design stage, Procurement stage, construction stage, Handling over stage. They discussed the use of work shop with an integrated approach which includes brain storming, checklist, probability impact matrices, subjective judgment, and risk register. Bhandari M.G [28], conducted study on management of risk in construction. Thy classify risk into technical risk, logistical risk, management related risk, Environmental risks, Financial risks, socio-political risks. Jimoh Richard Ajayi & Yahaya Isah [29], studied the impact of the various risk factors on cost of building construction projects, and found that increase of labour cost, improper planning and budgeting, top the list while among the impact of the various risk factors on time duration of building construction projects improper planning and budgeting were giving the overall top ranking. Peter Mwangi Njogu, Alkizim Ahmad, Abednego Gwaya [30] revved the risk management process of contingency estimation holding that the deterministic method of contingency estimation lacks basis and confidence for the management of uncertainties on construction projects. M. A.Raza, S. Kanwal, and A. Hussain [31], identified the major risks associated with the Malaysian construction industry evaluated the practical measures that the various local construction industry players would take to respond to those risks.

3. Methods and Materials

Data collected for risk assessment and analyzed according to the following:-

3.1. Sampling Method

Stratified random sampling was adopted for this study. According to Kothari [32], this method of sampling is used where the population embraces a number of distinct categories, the frame can be organized by these categories into separate "strata." Each stratum is then sampled as an independent sub-population, out of which individual elements are randomly selected. Selection of respondents from each stratum was based on simple random sampling. In assessing construction risk the research targeted owners, engineers, and contractors as the sample units.

Data was collected via questionnaire. It was designed to collect preliminary data about the most important risks that faced building construction sector in Erbil City projects. The questionnaire consisted of two sections. Section 1 solicited general information about the respondents. Section 2 consisted of a total of 50 risks associated with construction projects and asked respondents indicate the likelihood of occurrence of these risks as highly likely, likely or less likely and the level of impact on each project objective that would result in as high, medium or low. These risks were mainly sourced from Chapman [16], Wang and Liu [33], Ahmed [34], Chen [35], and Rahman and Kumaraswamy [36], These risk factors were put into seven categories, with (10) risks related to management, (8) related to owner, (9) related to consultant, (8) related to contractor (5) related to material, (5) related to labour and equipment, and (5) related to external. (25) questionnaire were distributed to owners , (50) to engineers and (75) to contractors . Out of (150) questionnaire (120) questionnaire were returned forming (30) of owners (25%), (48) of engineers (40%) and (42) of contractors (35%) as shown in figure (1). The target groups in this study of a different year experience as shown in figure (2). They are working in different sectors of construction industry as shown in respondents profile, figure (3).

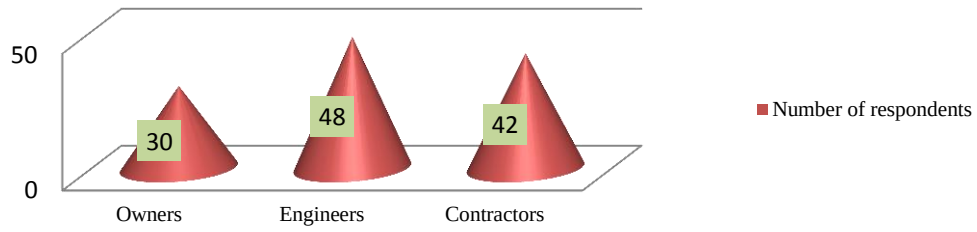

Figure (1): Questionnaire Respondents

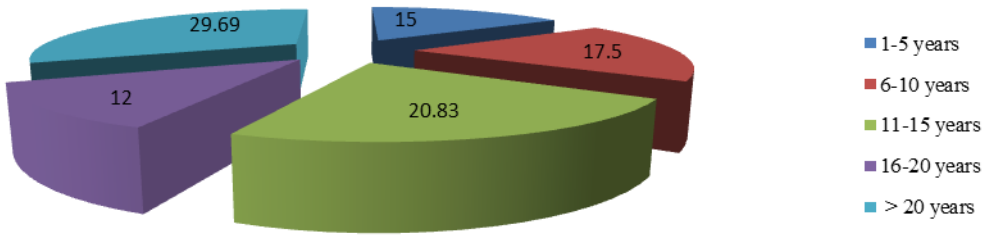

Figure (2): Respondents Experience in Performing Projects in Construction Sectors

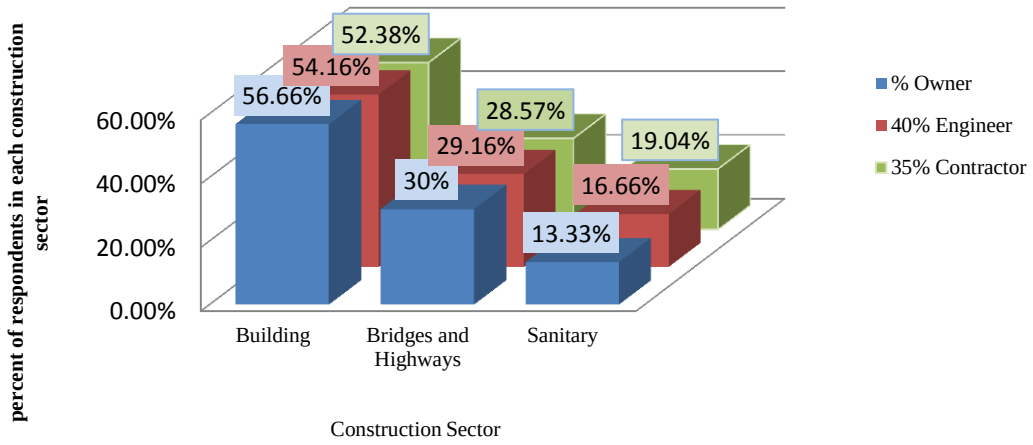

Figure (3): Respondents Profile

A significance score for each risk assessed by each respondent was calculated. Significance index score was then determined for every risk. This is the average score for each risk considering its significance on a project objective. The significant index developed by Shen [14], was used in this research. This can be described as the function of the two attributes, that is, the likelihood of occurrence of risk and its level of impact on project objective.

The significance score for each risk assessed by each respondent can be calculated through Equation (1).

$$r_{ij}^{k} = \propto_{ij} \beta_{ij}^{k} \qquad (1)$$

Where

i= ordinal number of risk, = (1, 50)

k = ordinal number of project objective, = (1, 7)

j = ordinal number of valid response = (1, n)

r_{ij}^{k} = significance score assessed by respondent j for the impact of risk i on project objective k

n = total number of valid response to risk i

$\propto_{ij}$= likelihood occurrence of risk i , assessed by respondent j .

β_{ij}^{k}= level of impact of risk i on project objective k, assessed by respondent j.

The average score for each risk considering its significance on a project objective can be calculated through Equation (2). This average score is called the risk significance index score and will be used to rank among all risks on a particular project objective.

$$R_i^k = \frac{\sum_{j=1}^{n} r_{ij}^{k}}{n} = \frac{1}{n}\sum_{j=1}^{n} \propto_{ij} \beta_{ij}^{k} \qquad (2)$$

where

R_i^k = significance index score for risk *i* on project objective *k*.

The three-point scales for *a* (highly likely, likely and less likely) and *b* (high level of impact, medium level of impact and low level of impact) need to be converted into numerical scales. According to Shen [14], Wang and Liu [33], and Zou [37], index was expressed verbally as 'low, medium and high'. Each of Low level of risk and low problem frequency take the value 0.1, 'medium' level of risk and 'medium problem frequency' take the value 0.5, and 'high' level of risk and 'high problem frequency' take the value 1.0. The matrix presented in Table (1) shows the calculation of the risk significance index.

Table (1): Matrix for the calculation of the risk significance index

a / b	High level of impact (1.0)	Medium level of impact (0.5)	Low level of impact (0.1)
Highly likely (1.0)	1.00	0.50	0.10
Likely (0.5)	0.50	0.25	0.05
Less likely (0.1)	0.10	0.05	0.01

The respondents also were requested to answer the effect of the (50) causes of risk on cost, time and quality. Each Low level effect take the value 0.1, 'medium' level of effect take the value 0.5, and 'high' level of effect take the value 1.0. According to El-Sayegh [38], the Relative Importance Index (RII) was calculated using Eq. (3). The higher value of RII presents a higher overall risk significance effect on the cause.

$$\text{RII}=\frac{\sum_{i=1}^{s} s_i x_1}{\sum_i^s x_i} \qquad (3)$$

where
Si = significant index assigned to ith response; Si = 0.1, 0.5, and 1 for i = 1, 2, and 3, respectively
Xi = frequency of the ith response
i = response category index = 1, 2, and 3 for low, medium, and high respectively.

3.2. Reliability of factor analyses

According McNeil, [39]. reliability means that if anyone else were to use the same method or techniques to collect data at a different time under similar conditions, they would get the same results. In this research, In order to check the reliability of the factors, Cronbach's alpha (Cα) test using SPSS was performed on each factor group to

see if they were standardized. The value of Cα should be between 0 and 1 where lower values demonstrate lower internal consistency and higher values illustrate greater internal consistency. In fact, there is no set standard or pre-defined acceptable limit of Cα value. Nevertheless, the following criteria explained by Nunally [40], for the interpretation of Cronbach's alpha values was carefully undertaken as a rule of thumb: Cα > 0.8 'Excellent'; 0.8 > Cα > 0.7 'Good'; 0.7 > Cα > 0.5 'Satisfactory'; and Cα < 0.5 'Poor'.

3.3 Validity test

Validity refers to 'the problem of whether the data collected is a true picture of what is being studied' McNeil, [39]. In more specific definitions, qualitative validity means 'the researcher checks for the accuracy of the findings by employing certain procedures', and quantitative validity refers to 'whether one can draw meaningful and useful inferences from scores on a particular instrument Creswell [41], In order to check the Construct validity. KMO test was performed on each factor group. For construct validity, Nunnally [40], has suggested the unifactorial determination method. Unifactoriality is achieved when a single factor is extracted for each test and shown to be valid as a construct. The values for the average variance extracted should exceed the 0.5 threshold, which is accepted as an indication of the validity of a construct's measure [42].

4. Results and Discussion

4.1 Reliability and Validity Test Results

Internal consistency analysis Table (2) shows that the value of Cronbach's alpha (Cα) for all attributes are computed as (0.916), which is considered to be excellent. Table (2) shows the values for the final seven factors ranged from (0.691 to 0.846). These values were at an acceptable level, making all factors reliable.

The percentage of variance explained by each factor in the present study is shown in table (2). The average variance extracted for each factor ranged from (50.850 to 68.815), for the seven factors. Therefore, seven factors were demonstrated to be unifactorial, and this suggests that only a relatively small amount of total variance for each group of variables is associated with causes other than the factor itself. Moreover, the KMO test assessed the suitability of the sample for each unifactorial determination and indicated that all factors were acceptable within the range from (0.691 to 0.799).

Table (2): Internal Consistency Analysis, KMO and Variance Explained of Critical Risk Factors in Unifactorial Test

No.	Factor	Cronbach's alpha (reliability)		Variance explained (%) (unifactorial)	KMO (unifactorial)
1	Management related	0.846	Excellent	68.815	0.720
2	Owner related	0.720	Good	50.850	0.709
3	Consultant related	0.832	Excellent	58.99	0.799

4	Contractor related	0.775	Good	59.46	0.690
5	Material related	0.704	Good	64.253	0.776
6	Labour and equipment related	0.695	Satisfactory	63.674	0.716
7	External related	0.691	Satisfactory	65.210	0.691
	All	0.916	Excellent		

4.2. Top Significant Risks Management Related

Table (3) shows that long wait for approval of tests and inspection ranked as the most significant risk, and the most frequent with rank (1), but for the level of impact ranked as (2). Inaccurate project program ranked as (2), for significance, (3) for frequency and (1) for impact. Absence of accurate feasibility studies for project ranked as (3) for significance, (2) for frequency and (5) for impact. Delayed disputes resolutions, ranked as (4) for significance frequency and impact, while, suspension of work, ranked as (5) for significance, (6) for frequency and (3) of impact, respectively. A careful choice of specialized and qualified management team would eliminate such risks.

Table (3): Top Significant Risks Management Related

	Rusk Factor	likelihood	Rank	Impact	Rank	significance index score	Rank
	Management related						
1	Lack of coordination between project parties	0.501	5	0.613	7	0.307	6
2	Changes in management ways	0.384	10	0.525	9	0.202	9
3	Information unavailability (include uncertainty)	0.444	8	0.605	8	0.268	8
4	Long wait for approval of tests and inspection	0.640	1	0.701	2	0.449	1
5	Delayed disputes resolutions	0.549	4	0.662	4	0.363	4
6	Inaccurate project program	0.561	3	0.759	1	0.425	2
7	Suspension of work	0.493	6	0.688	3	0.339	5
8	Poor cost control	0.469	7	0.647	6	0.303	7
9	Absence of accurate feasibility studies for project	0.5915	2	0.655	5	0.388	3
10	Poor documentations	0.386	9	0.355	10	0.137	10

4.3. Top Significant Risks Owner Related

As for the owner related risks, table (4) shows that the most significant risks are, inability of owner to finance the project, rank (1) for significance, frequency and impact. Such risk increase due to a wrong cost estimation or mistake in assessment of circumstances of construction project. Poor qualifications and supervision of owner's engineer, ranked (2) for significance and impact, while ranked as (3) for frequency. Delay in the approval of contractor submittals to the owner, rank (3), for frequency rank

(2), and for level of impact, rank (5). Delay in progress payments by the owner, ranked as (4), for frequency, ranked (5), while for level of impact, ranked (3). As for design changes by the owner ranked (5) for significance and (4), for frequency, while ranked as (6) for the level of impact. To Control such risks, owner should employ qualified managing, accounting, and technical staff for performance of projects and before that to ensure his financial ability.

Table (4): Top Significant Risks Owner Related

	Owner related	likelihood	Rank	Impact	Rank	significance index score	Rank
11	Lack of coordination with contractors	0.516	6	0.605	7	0.312	7
12	Delay in the approval of contractor submittals to the owner	0.596	2	0.645	5	0.385	3
13	Changes in the scope of the project by owner	0.494	8	0.661	4	0.327	6
14	Inability of owner to finance the project	0.645	1	0.837	1	0.540	1
15	Poor qualifications and supervision of owner's engineer	0.581	3	0.781	2	0.454	2
16	Slow decision-making process of the owner	0.501	7	0.594	8	0.298	8
17	Design changes by the owner	0.557	4	0.616	6	0.344	5
18	Delay in progress payments by the owner	0.518	5	0.737	3	0.382	4

4.4. Top Significant Risks Consultant Related

Table (5) shows that the most significant risks related to consultant are, awarding design to unqualified designers, rank (1) for significance, frequency and level of impact. As for design errors or defective design, rank (2), for significance, (4) for frequency, and (3) for impact respectively. Rank (3) is for poor qualifications of supervisory staff of the consultant engineer, with rank (5) frequency and rank (2) of level of impact. Actual quantities differ from the contract quantities, rank (4) for significance, (2) for frequency, and (6) for impact respectively. Inaccurate cost estimation rank (5) of significance, (3) of frequency and (4) of level of impact. To eliminate such risks consultant professionality should be carefully checked before awarding the design.

Table (5): Top Significant Risks Consultant Related

	Consultant related	likelihood	Rank	Impact	Rank	significance index score	Rank
19	Design errors or defective design	0.566	4	0.708	3	0.455	2
20	Actual quantities differ from the contract quantities	0.588	2	0.667	6	0.392	4

21	Rush design	0.481	6	0.616	7	0.296	7
22	Awarding the design to unqualified Designers	0.655	1	0.811	1	0.532	1
23	Not coordinated design (structural, mechanical, electrical, etc.)	0.459	7	0.676	5	0.310	6
24	Poor qualifications of supervisory staff of the consultant engineer	0.550	5	0.722	2	0.397	3
25	Design changes by consultant	0.422	8	0.589	8	0.248	8
26	Complexity of project design	0.383	9	0.564	9	0.216	9
27	inaccurate Cost estimation	0.567	3	0.677	4	0.384	5

4.5. Top Significant Risks Contractor Related

The most significant risks related to contractor shows in table (6). Poor qualifications, skills & experience of contractor and technical staff, rank (1) for significance, and rank (2) for frequency and level of impact. Poor planning and scheduling of the project by the contractor, rank (2), while for frequency ranked as (1), and impact rank (7). As for financial failure of the contractor, rank (3) for significance, rank (4) for frequency and rank (1) for impact level. Poor site supervision by contractor, ranked (4) for significance, and rank (3) for frequency and impact. Gaps between the implementation and the specifications due to misunderstanding of drawings and specifications, ranked as (5) for significance and frequency, and rank (4) for impact. To minimize contractor related risks the choice of contractor should not be based on lower price bid only, the efficiency of the contractor should be checked according to his working history in construction sector, particularly for projects of special type.

Table (6): Top Significant Risks Contractor Related

	Contractor related	likelihood	Rank	Impact	Rank	significance index score	Rank
28	Poor site supervision by contractor	0.583	3	0.708	3	0.413	4
29	Poor communication by contractor with parties involved in project	0.472	6	0.681	6	0.322	6
30	Poor qualifications, skills & experience of contractor and technical staff	0.606	2	0.772	2	0.468	1
31	Poor planning and scheduling of the project by the contractor	0.645	1	0.677	7	0.437	2
32	Gaps between the Implementation and the specifications due to misunderstanding of drawings and specifications	0.518	5	0.705	4	0.365	5
33	Financial failure of the contractor	0.544	4	0.784	1	0.426	3
34	Frequent change of subcontractors because of their inefficient work	0.627	8	0.627	8	0.251	8
35	Rework due to errors during construction	0.461	7	0.688	5	0.317	7

4.6. Top Significant Risks Material Related

Table (7) shows that, compliance of material to specifications, ranked as the most significant and frequent risk with a highest level of impact rank (1). Rise in the prices of materials, ranked (2) for significance and frequency, while ranked (3) for level of impact. As for availability of construction materials in market, rank (3), with a frequency of rank (4), and impact level rank (2). Change in material types and specifications during construction, rank (4), with frequency rank (3), and impact rank (5). Finally, delay in materials supply ranked (5) for significance and frequency, and rank (4) for impact. A good planning is needed for material procurement from the beginning of the project and a study for the availability of them starting from the design stage.

Table (7): Top Significant Risks Material Related

	Material related	**likelihood**	**Rank**	**Impact**	**Rank**	**significance index score**	**Rank**
36	Availability of construction materials in market	0.425	4	0.654	2	0.278	3
37	Change in material types and specifications during construction	0.462	3	0.566	5	0.261	4
38	Delay in materials supply	0.418	5	0.579	4	0.242	5
39	Rise in the prices of materials	0.476	2	0.642	3	0.305	2
40	Compliance of material to specifications	0.5	1	0.667	1	0.333	1

4.7. Top Significant Risks Labour and Equipment Related

The most significant risks related to labour and equipment shows in table (8) are, shortage of skillful workers, also it is the most frequent and of a highest level of impact, rank (1).. Varied labor and equipment productivity take the second place in significance, frequency and impact, as rank (2). Equipment availability ranked (3), for significance and for frequency, while (4), for level of impact. Law efficiency of equipment, ranked as (4) for significance, for frequency rank (5), and rank (3), for impact. Finally rank (5), for labour and management relations, for frequency ranked as (4), and rank (5), for impact level. Workers should have training courses which needs specific skills before starting a project, also making extensive study about the available equipment in the market and to import the modern technology of a high productivity from abroad.

Table (8): Top Significant Risks Labour and Equipment Related

	Labour and equipment related	likelihood	Rank	Impact	Rank	significance index score	Rank
41	Varied labor and equipment productivity	0.455	2	0.611	2	0.278	2
42	Equipment availability	0.452	3	0.571	4	0.258	3
43	Law efficiency of equipment	0.427	5	0.593	3	0.253	4

44	Labour and management relations	0.428	4	0.533	5	0.228	5
45	Shortage of skillful workers	0.561	1	0.638	1	0.358	1

4.8. Top Significant Risks External Related

Table (9) shows that the most significant risks related to external causes are, Occurrence of accidents because of poor safety procedure, for significance and frequency, rank (1), and for the level of impact rank (2). Unforeseen site ground condition, ranked (2) for significance, with rank (4) for frequency, and rank (1) for impact level. Adverse weather conditions, rank (3), with a frequency rank (2) and level of impact rank (4). As for difficulty to access the site (very far, settlements), the significance rank (4), with a frequency rank (5), and impact level rank (3). Finally, changes in laws or regulations by Government rank (5) for significance and impact, while, rank (3) for frequency. Suitable safety precautions should be taken in consideration to minimize the main risk of accident occurrence, which is easy to control.

Table (9): Top Significant Risks External Related

	External related	likelihood	Rank	Impact	Rank	significance index score	Rank
46	Changes in Laws or regulations by Government	0.316	3	0.398	5	0.126	5
47	Adverse weather conditions	0.349	2	0.447	4	0.156	3
48	Unforeseen site ground condition	0.315	4	0.561	1	0.176	2
49	Occurrence of accidents because of poor safety procedure	0.361	1	0.544	2	0.196	1
50	Difficulty to access the site (very far, settlements)	0.310	5	0.501	3	0.155	4

4.9. Top Significant Risks and Factors Related

Table (10) shows (25) most significant risk causes in construction projects in Erbil City. Inability of owner to finance the project, ranked as (1) which is related to owner factor. Awarding the design to unqualified designers rank (2) related to consultant factor. Poor qualifications, skills & experience of contractor and technical staff, rank (3) related to contractor factor. Design errors or defective design, rank (4), consultant related factor. Poor qualifications and supervision of owner's engineer, rank (5), owner related factor. Long wait for approval of tests and inspection, rank (6), management factor. Rank (7), is poor planning and scheduling of the project by the contractor, contractor related factor. Financial failure of the contractor rank (8), contractor related factor. As for inaccurate project program, rank (9), management related factor. Poor site supervision by contractor, rank (10), contractor related factor. The study revealed that the most significant risk factors are related to owner, management, contractor, and consultant respectively. While the external, material, and labour and equipment factors are the least significant factors of risk in construction projects in Erbil City.

Table (10): Top Significant Risks and Factors Related

Cause	significance index score	Rank	Factor Related
Inability of owner to finance the project	0.54	1	Owner
Awarding the design to unqualified Designers	0.532	2	Consultant
Poor qualifications, skills & experience of contractor and technical staff	0.468	3	Contractor
Design errors or defective design	0.455	4	Consultant
Poor qualifications and supervision of owner's engineer	0.454	5	Owner
Long wait for approval of tests and inspection	0.449	6	Management
Poor planning and scheduling of the project by the contractor	0.437	7	Contractor
Financial failure of the contractor	0.426	8	Contractor
Inaccurate project program	0.425	9	Management
Poor site supervision by contractor	0.413	10	Contractor
Poor qualifications of supervisory staff of the consultant engineer	0.397	11	Consultant
Actual quantities differ from the contract quantities	0.392	12	Consultant
Absence of accurate feasibility studies for project	0.388	13	Management
Delay in the approval of contractor submittals to the owner	0.385	14	Owner
inaccurate Cost estimation	0.384	15	Management
Delay in progress payments by the owner	0.382	16	Owner
Gaps between the Implementation and the specifications due to misunderstanding of drawings and specifications	0.365	17	Contractor
Delayed disputes resolutions	0.363	18	Management
Shortage of skillful workers	0.358	19	Labour & Equipment
Design changes by the owner	0.344	20	Owner
Suspension of work	0.339	21	Management
Compliance of material to specifications	0.333	22	Material
Changes in the scope of the project by owner	0.327	23	Owner
Poor communication by contractor with parties involved in project	0.322	24	Contractor
Rework due to errors during construction	0.317	25	Contractor

4.10. Top Respondents Perceptive of Impact of Risks on Cost of Construction projects

Table (11) shows the results for (15) Major risks out of (50) that affect the cost of construction. As indicated, rise in the prices of materials, poor cost control, design change by owner, inaccurate cost estimation, law efficiency of equipment, design errors or defective design, change in material types and specifications during construction, design change by consultant, changes of the scope of work by owner, and not coordinated design, respectively. The results of the study indicate that management factor is the most significant factor that affects the cost of projects. So management methods should be reviewed and changed to minimize the risk associated with management process. To reduce cost overrun of construction projects, efforts should be made to mitigate increase in material cost through adequate planning and budgeting and adequate forecast about market demand, also a proper cost controlling system, as well as taking into consideration other risk factors such as design changes.

Table (11): Top Respondents Perceptive of Impact of Risks on Cost of Construction projects

Cause	RII	Rank	Related factor
Rise in the prices of materials	0.833	1	Material
Poor cost control	0.791	2	Management
Design change by owner	0.753	3	Owner
Inaccurate cost estimation	0.716	4	Management
Law efficiency of equipment	0.690	5	Labour & Equipment
Design errors or defective design	0.686	6	Consultant
Change in material types and specifications during construction	0.676	7	Material
Design change by consultant	0.666	8	Consultant
Changes of the scope of work by owner	0.656	9	Owner
Not coordinated design	0.638	10	Consultant
Absence of accurate feasibility studies		11	Management
Lack of coordination between project parties	0.605	12	Management
Inaccurate project program	0.593	13	Management
Labour and management relations	0.576	14	Labour & Equipment
Frequent change of subcontractors because of their inefficient work	0.558	15	Contractor

4.11. Top Respondents Perceptive of Impact of Risks on Time of Construction Projects

The impact of the (50) risks on time duration of construction projects was analyzed. The results are ranked in table (12) for major (15) causes that affect time duration, in which suspension of work, poor planning and scheduling of the project by the contractor, slow decision making process by owner, inability of owner to finance the project, delay in progress payments by owner, delay in the approval of the contractor submission to the owner, delay in material supply, availability of construction material in the market, Availability of construction material in the market, delayed dispute resolution, and long wait for approval of tests and inspection respectively. The results show that owner factor is the main cause of risks that affect time duration of a project. Management factor and external factor comes in second place, and material in third place. Proper planning and budgeting, proper project organization structure, adequate forecast about market demand should be put into consideration to reduce time overrun of building construction projects.

Table (12): Top Respondents Perceptive of Impact of Risks on Time of Construction Projects

Cause	RII	Rank	Related factor
Suspension of work	0.933	1	Management
Poor planning and scheduling of the project by the contractor	0.935	2	Contractor
Slow decision making process by owner	0.926	3	Owner
Inability of owner to finance the project	0.896	4	Owner
Delay in progress payments by owner	0.86	5	Owner
Delay in the approval of the contractor submission to the owner	0.82	6	Owner
Delay in material supply	0.801	7	Material
Availability of construction material in the market	0.791	8	Material
Delayed dispute resolution	0.746	9	Management
Long wait for approval of tests and inspection	0.733	10	Management
Difficulty to access the site	0.725	11	External

Equipment availability	0.686	12	Labour & Equipment
Change in the scope work by owner	0.683	13	Owner
Change in laws & regulations by government	0.658	14	External
Adverse weather conditions	0.613	15	External

4.12. Top Respondent Perceptive of Impact of Risks on Quality of Construction Projects

The results impact of risks on quality of construction projects are shown in table (13). The ranking of the results in which, Compliance of material to specifications, awarding the design to unqualified designers, poor qualification and supervision of owners engineer, poor qualification, skills, & experience of contractors technical staff, inability of owner to finance the project, poor site management and supervision by the contractor, shortage of skillful workers, poor communication by contractor with parties involved in project, financial failure of the contractor, and design errors or defective design, which impacts on quality of construction projects respectively. The study indicate that the contractor is the most significant factor that affect the quality of work, while material factor is the least factor affect it. A special care is needed while awarding the contract tender, and choosing a contractor not only on the bases of price but also making a detailed review on his work history to ensure the quality of work and minimize the cost and time overruns. To improve the quality of construction projects, efforts should be made to curb corruption practices which most often will result in inadequate funds left for the actual project execution, encouraging the award of contract not just based on the lowest bidder but also based on some degree of quality assurances, providing detail construction material, schedules as part of contract documents, involving all stake holders to have input during design stages of the projects and encouraging skill acquisition in construction trades and training of construction craftsmen so as to mitigate shortage of skillful workers in the construction industry.

Table (13): Top Respondent Perceptive of Impact of Risks on Quality of Construction Projects

Cause	RII	Rank	Related factor
Compliance of material to specifications	0.900	1	Material
Awarding the design to unqualified designers	0.866	2	Consultant
Poor qualification and supervision of owners engineer	0.855	3	Owner
Poor qualification, skills, & experience of contractors technical staff	0.805	4	Contractor
Inability of owner to finance the project	0.772	5	Owner
Poor site management and supervision by the contractor	0.758	6	Contractor
Shortage of skillful workers	0.738	7	Labour & Equipment
Poor communication by contractor with parties involved in project	0.694	8	Contractor
Financial failure of the contractor	0.690	9	Contractor
Design errors or defective design	0.672	10	Consultant
Frequent change of subcontractors because of their inefficient work	0.655	11	Contractor
Gaps between the Implementation and the specifications due to misunderstanding of drawings and specifications	0.643	12	Contractor
Change in management ways	0.600	13	Management
Lack of coordination between project parties	0.575	14	Management
Labour and management relations	0.553	15	Labour & Equipment

5. Conclusion

In this paper, the findings of the questionnaire survey is presented and discussed. A total of 50 risks were detected, which divided into 7 risk factors based on a comprehensive assessment of their risk–index/score, comprising both the likelihood of occurrence (probability) and magnitude of consequence (impact), on project objectives. The results reveal the top major risks identified to be put into consideration in the risk process.

1- Projects are typically influenced by multiple risk factors. The systematic management of a large and complex project must identify the potential risks as part of the risk-management process.

2- The significant risk-contributing factors found are: inability of owner to finance the project, awarding the design to unqualified designers, poor qualifications, skills & experience of contractor and technical staff, design errors or defective design, poor qualifications and supervision of owner's engineer, and long wait for approval of tests and inspection, respectively.

3- These significant factors are from four major categories i.e., owner, management, contractor, and consultant respectively. These types of risks have a considerable impact on project performance in terms of cost, time and quality.

4- The study reviled the risks that have the most significant effect on the cost of a projects are, rise in the prices of materials (material related), poor cost control (management related), design change by owner (owner related), inaccurate cost estimation (management related), and law efficiency of equipment (labour & equipment related), respectively.

5- The risks that have the most significant effect on the duration of a project are, suspension of work (management related), poor planning and scheduling of the project by the contractor, (contractor related), slow decision making process by owner (owner related), inability of owner to finance the project (owner related), and delay in progress payments by owner (owner related), respectively.

6- The study showed that the compliance of material to specifications (material related), awarding the design to unqualified designers (consultant related), poor qualification and supervision of owners engineer (owner related), poor qualification, skills, & experience of contractors technical staff (contractor related), and inability of owner to finance the project (owner related), respectively are the risks that have a significant effect on the quality of a project.

7- Risk management is rarely used by the participants in construction projects. The participants generally use to handle the risks with an informal approach. This technique is not employed because of less knowledge and awareness among the construction industry.

6. Recommendations

1- Future study can be carried out to understand criticality of each factor. That kind of study will help the construction industry to work on certain important and most critical factors so that risk can be properly managed.

2- The risk management technique should be applied into any construction project at the initial stage of the project to get maximum benefit of the technique. It is very crucial to identify the key risks at the earlier stage and minimize the negative consequence brought by the risks at the later stage. Hence, there is thriving need to have a well-documented procedure which should be a one stop solution to all hazards that are likely to occur during project life cycle.

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