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RISK ASSESMENT PROCESS FOR CONSTRUCTION PROJECTS IN IRAQ USING MCDM FRAMEWORK BY APPLYING TOPSIS-SWARA COMBINED METHOD

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Abstract

The construction industry is one of the reliable indicators of economic and technological development. There are various overlapping uncertainties called risks that act as obstacles to this industry. In Iraq, projects are gaining a bad reputation due to exceeding duration and cost due to ignoring risks. As well, not dealing with them in a systematic approach. This study focused on applying risk management for construction projects in Iraq. This study aims to give a clear picture of the obstructing accidents through the procedures of identifying, risk assessment, allocation, and handling methods. Questionnaire techniques, interviews, and TOPSIS-SWARA methods were used to complete the stages of these procedures. 52 risks and 7 assessment criteria were distinguished. Also, the risks were classified according to their type into 9 groups. Results showed that the contractor's inefficiency is the most dangerous risk, followed by the risk of bad designs, then the contractor's financial failure. The study showed the government authority's important role represented in the legislation that reduces the risks to which construction projects are exposed. The study also made it clear that action and reaction tactics, without organization, and by using previous available experience, are the way to carry out the risk management implementation in construction projects in Iraq. The study recommended increasing the effectiveness of this governmental role through emphasizing licensing and classifying the contractors, quick in resolving disputes between the parties to the project, and reducing the overlapping of powers between the ministries and the governorates administration. In addition to that, inserting courses into the curricula in engineering colleges to increase awareness and apply risk management in construction projects.

1. INTRODUCTION

Construction projects are one-off attempts with many uncommon characteristics such as long duration, multifarious processes, and difficult circumstances, financial vast and complicated administrative systems. All of that, in addition to the multiplicity of the project's parties from contractors, designers, suppliers, owners, and their opposing interests contribute to raising the level of risks[1]. There are many descriptions for risks, including what Francisco et al., it is obstacles that may occur to the project and cause a delay in the delivery time and increase the cost of the project[2]. According to Petr, the risk is an accident that is not certain to happen, its impact may be negative or positive on one or more of the project's objectives, which is delivered within a specified time, cost, and required quality[3].

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many Statistics of economic activities confirm the exceptional importance of the construction sector on the gross domestic product (GDP) in the economies of countries, and Iraq is one of them[4],[5],[6]. This is one of the reasons for the interest in this industry figure (1). This importance comes from providing job opportunities, revitalizing industry and trade movement, in addition to providing services to people more broadly.

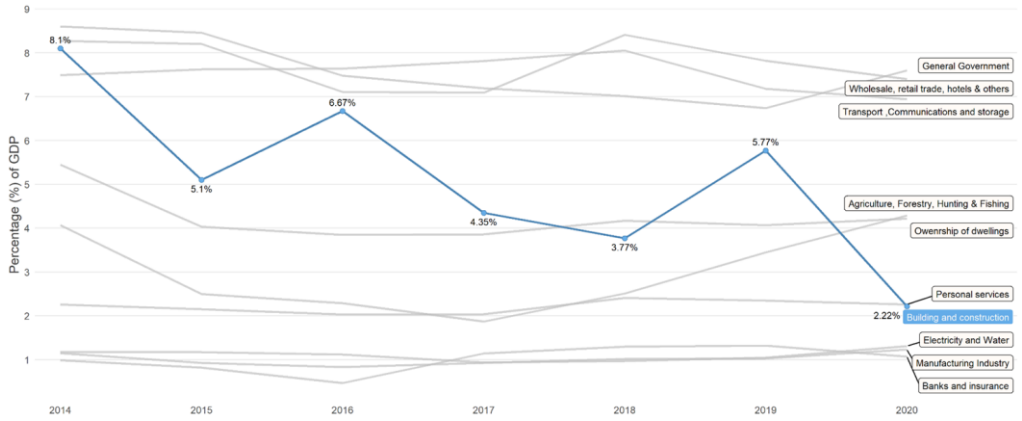

Fig 1: Contribution of Construction Industry to the GDP in Iraq

The impact of risks and the possibility of their occurrence in construction projects increases due to the complexities of the procedures followed before and during the implementation process or what is called the project life cycle (PLC). It is usually associated with issues of design, resources, safety, and sustainability requirements. All of this made project management pay more attention to risk management strategies to reduce harmful results on projects in terms of time, Cost and quality[7]. Increasing the volume of construction projects certainly leads to an increase in the level and scope of risks[8]. Incidents related to uncertainty and of little impact, with their association with other incidents, may increase the possibility of them turning into serious obstacles and producing unsatisfactory results for the project parties[9]. The results of these risks can appear even after the completion of implementation and use of the facility, and they are often related to design and quality works[7]. One of the risks identified in studies in the developing countries is the lack of engineering work teams, including project managers have the competence and experience in the fields of Project management(PM), especially risk management(RM)[10].

Previous studies have shown that the practice of risk management is linked to the economic policy that countries follow. Because risk management has an ultimate economic goal in reducing costs, this is not a priority for closed economic systems[7],[11].

In Iraq, terrorism, low oil prices, and corruption were the main risks that led to the delay and suspension of many construction projects in 2014[7]. At present, the impact of these factors and the likelihood of their occurrence has been changed. New factors have emerged with new criteria for assessing these risks[12],[13]. What this study tries to clarify is that the risk factors are not fixed with time and place due to security and economic

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variables, laws, and others. However, fixed methodologies can be developed based on risk management in finding and analyzing those risks. The main objective of this study is to prepare an ideal model for the practice of the risk management process by identifying and evaluating the risk factors that face construction projects in Iraq through the opinions of experts and engineers within the parties involved in the projects.

2. RISK MANAGEMENT

Time, cost, and quality are the Project performance indicators, also called project objectives. The relationship between them is intertwined. However, the failure to reach the level of success in one or more means the failure of the project. The practice of efficient and realistic risk management from the project management team is an effective way to implement the project schedule, Specific cost, and required quality. The risk management process is aimed to diminish the impact and probability of undesirable events. As well as boost the probability and impact of a desirable event[10]. risk management is as the actions and tools that help decision-makers in project management (PM) in identifying and evaluating risks that impede the success of the project[14], or it is a methodical set of steps to support project management to contain the risk that works to influence the success of the project[15]. There are two types of risk management strategies, preventive and remedial. The first one includes dealing with the expected risks before the project implementation phase, and the second one, its philosophy is based on handling threats when they occur during the implementation phase[16],[17]. This means that risk management is a process of overlapping and integrating the two strategies together[18]. This requires a team with experience in monitoring and evaluating risks and handling them during the project stages[19], and most importantly a project manager who has a strong personality and knowledge of the sectors from which risks arise and his ability to exploit resources and distribute tasks and close control and make the right decision[11],[13],[20].

The risk management process includes several coordinated activities and procedures that most studies summarized in four steps[21],[20],[22],[15]:

a. Risk Identification

The first stage in the (RM) system is to identify the risks .this process implemented in the first phase of project. Then, will be monitored and updated throughout the rest phases of the project[23]. The main objective of this process is to create a list of risks professionally and accurately with the characteristics of each risk, cause, and results. To make the benefit in the remaining stages of risk management to the implemented project so as for future projects as a repetitive and renewable process[24]. This means, it should not be restricted to identifying incidents, but furthermore, the sources of uncertainty and correlated reactions. This is intended to formulate a comprehensive approach and focuses on doubts about who, what, from where[23]. This step is done by several techniques: brainstorming, checklist, Delphi technique and questionnaires.

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b. Risk Analysis

The importance of the risk assessment process comes from determining the importance of risks and their impact on the objectives of the project according to a qualitative or quantitative scale in order to conclude the priority of handling with them. In general, there are two main types under which assessment methods fall: qualitative and quantitative[22]. The qualitative risk assessment is done according to the principle of probability and impacts Through the degree of impact of the risk on the project and the probability of its recurrence[2]. This technique depend on expert's opinions. While quantitative analysis employs different tools.it calculates the amount of impact and consequences digitally, giving elaborate results and providing a better diagnosis of the probability and impact of risks But requires more data[16],[25].

c. Risk Response

It is a basic and vital stage in risk management that includes forming an idea and identifying the most suitable technique to handle risk. Previous research and experiences summarized these techniques with four measures: avoidance, reduction, transfer, and acceptance[15],[20],[22],[26]. Practically, the response philosophy should be based on choosing the optimal response from several alternatives in terms of cost, time, and ability to exploit resources.

d. Risk Monitoring

IS0 9100:3100 (2015) has diagnosed Risk Monitoring as one of the important (RM) strategies. During the lifetime of the project, periodically there is a metamorphosis in the impact and recurrence of some risks due to the changing surrounding circumstances[27]. This makes the project management in a continuous cycle of re-evaluating risks, in addition to re-assigning new risks that cannot be overlooked[25]. In addition to that, monitoring of the project generally and observing any modifications that may cause new risks or a change in the level of old risks are distinguished, Observe predetermined response techniques, their level of utility, and possibly suggest modifications on it. Also Through this process, we can update the risk register of the project for future use[28].

3. RESEARCH METHODOLOGY

This study attempts to place risks facing the construction industry in Iraq in point focus. In addition to that, review of risk management methods and techniques utilized to deal with these risks. The literature has been extensively reviewed Such as articles, academic books, journals, and university research as a first step in the research methodology to identify risks, taking account of the appropriate for local construction projects. Then use the interview with experts in conjunction with a survey questionnaire of participating engineers in projects to make a model for risk assessment. The presented model will represent the most risks shared by construction projects in Iraq, so the results of this process will serve as a complementary tool for the various participating parties in the construction industry.

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A. Questionnaire

Conducting a closed questionnaire was the procedure used in obtaining the research results. In parallel to that, implementing an open questionnaire through an interview at the same time. The interviews were executed in two sessions, the first one (interview A) focused on choosing the appropriate criteria for assessing risks in construction projects in Iraq after reviewing the literature. While the main goal of the second session (interview B) was to identify the weights of these criteria. As for the closed questionnaire, it was designed in two parts. The first, (questionnaire 1) aimed to obtain an ideal and classified list of risks, the most important step, (questionnaire 2) was concerned with ranking the risks based on criteria that were previously found. The first section of the questionnaire included general information relating to the respondent. The responses in this section were taken on a Likert scale, based on 1 = “very low” and 5 = “very high”.

(SWARA) method

This method (Step-Wise Weight Assessment Ratio Analysis) is used as one of the tools for decision making by analyzing and ranking data, which collect by depending on specialists' opinions, and this is what distinguishes it from other methods. It was developed by Kersuliene et al. in 2010[29],[30],[15],[31]. In this study, this method was used to determine the weights of criteria set that utilize to assess the specific risks in the construction sector in Iraq.

B. (TOPSIS) method

The (Technique for Order Preference by Similarity to Ideal Solution) method was presented by Yoon and Hwang in the 1980s as one of the numerical techniques of multi-criteria decision making[32]. This method considers now common, effective, and has been used in many studies with multiple sectors to determine the best alternatives .it is based on the concept of computing the relative closeness of re-sampled and weighted criteria to the best alternative[33],[34],[35]. This includes a conception of minimizing the distance to the negative best alternative and maximizing the distance to the positive best alternative. This method applied widely in the last three decades because it is vastly applicable with an uncomplicated mathematical model. In addition, depending on computer support, it is a suitable pragmatic method[34].

C. Sample size

Sampling is choosing representative units of a population for the study in a research experiment[26]. There are three options of mechanisms for selecting probability samples. In this study, the targets respondent is engineers working in the construction projects sector with experience of more than 10 years. Their fields of work ranged as academics, project managers, consultants, and executive engineers, all of them were at three levels in terms of experience, 10-15,15 -20, and more than 20 years. Therefore, the sample size was chosen based on the option of stratified samples so as give more beneficial and broad outcomes for this type of questionnaire.

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When the population size is known and specified, the sample size can be calculated through several equations, which give convergent results. In this study, the appropriate sample size was determined according to the Richard Geiger equation.

$$n=\frac{(\frac{z}{d})^2.(p)^2}{1+\frac{1}{N}\left[(\frac{z}{d})^2.(p)^2-1\right]}$$

Where n is sample size, N is population, Z is the standardized variable met confidence level, p is Percentage picking a choice, while d represent the margin of error.

At Confidence level 95% then, z=1.96; d=0.05; p=0.5; N=135; response rate=50%.

If we correct the response rate to 85% then the recommended sample size will be n= 81.

85 questionnaires were distributed to the selected sample of engineers.

4. RESULTS

After a wide review of the published literature, especially that focuses on the risks confronted the construction projects in Iraq and developing countries[15],[26],[3],[7],[36], two preliminary lists were organized, The first consisted of 66 risk factors to be submitted to the questionnaire. The second list was had 10 assessment criteria to be debated in the interviews. Five academics of engineers and management specialists had participated in two rounds of semi-structured interviews to review, modify and evaluate the list of criteria. The results after these two sessions show identifying seven of benefit and cost criteria for risk assessment, with a sequence them according to the experts' opinions.

Criteria	Descriptions	Sort
The prediction	Ability to expect & prevent risk when or where	Benefit (+)
Risk likelihood	the probability degree of risk occurrence	Cost (-)
Replicability	Possibility of risk occurrences	Cost (-)
Acceptability	Ability to accept risk without interference	Benefit (+)
Risk conjunction	The effect degree on other risks	Cost (-)
Impact	The effect degree of risk on project goals	Cost (-)
Response efficacy	Degree of handle effectiveness and disposal speed from risk	Benefit (+)

By using the SWARA method for analyzing the resulting data, we have a criteria list with their resulting weights. Shows the results for this stage.

Criteria	Code	Comparative importance of average value S_i	Coefficient $Ki=Si+1$	Recalculation $w_i=\frac{w_{i-1}}{k_i}$	Weight $Q_i=\frac{w_i}{\sum w}$
impact	C1	-	1	1	0.182
risk conjunction	C2	0.125	1.125	0.889	0.162
Risk likelihood	C3	0.048	1.048	0.848	0.154
Replicability	C4	0.082	1.082	0.789	0.1435
response efficacy	C5	0.089	1.089	0.719	0.131
the prediction	C6	0.126	1.126	0.639	0.116
acceptability	C7	0.043	1..043	0.613	0.1115
				5.4969	

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Questionnaire

The initial risk list of 66 risks gathered from the previous studies was submitted to the questionnaire to make a final and idealistic list of risks to which construction projects in Iraq are exposed. This done in the first stage of the questionnaire, then assessment and rank these risks using pre-determined criteria and their weights resulting from the SWARA method as another stage.

Seventy-two completed satisfied forms were collected from the questionnaire. The respondents excluded 17 items from the initial list and added 3 risks. The result was a list of 52 risks, which were categorized into nine groups that construction projects in Iraq are exposed to.

classification	ID	code	The Risk
Legal	R1	L1	a legal or real estate dispute in fixing the boundaries of the site
	R2	L2	Legal disputes during implementation among the parties of the contract
	R3	L3	Changes in laws, permits and regulations.
Management	R4	M1	giving a Limited authority for project manager
	R5	M2	Weakness of personality of project manager
	R6	M3	Wrong decisions from project executives
	R7	M4	Poor communication between involved parties
Resources	R8	Re1	Contractor inefficiency
	R9	Re2	Lack of equipment or tools inefficiency
	R10	Re3	Lack of safety requirements
	R11	Re4	Lack of security guards for the project / incidents of theft or sabotage`
	R12	Re5	bad electricity, water, communication networks, and internet in project site
	R13	Re6	Inefficiency of the subcontractor
	R14	Re7	Low-efficiency of owner engineering staff
	R15	Re8	Unavailability of nearby sources to supply materials
	R16	Re9	Supply low quality or defective Martials
	R17	Re10	Delays in arrival of imported main materials or equipment
	R18	Re11	Some tasks need a new technology
	R19	Re12	Incompetent engineering consultant office
Financial	R20	F1	Delayed in payments on contract
	R21	F2	Increased material cost locally
	R22	F3	Exchange rate fluctuation
	R23	F4	The financial failure of executing company
	R24	F5	changes of imported price materials globally
	R25	F6	dropping in oil price Globally
project	R26	P1	contractor bad survey on site plan before bidding
	R27	P2	moving site plan
	R28	P3	Obstacles such as groundwater, rocky or gypsum soil
	R29	P4	Difficulty to access the site /very far
	R30	P5	Delayed tests results
	R31	P6	Project initiation overdue as schedule
	R32	P7	Failure of soil tests
	R33	P8	Failure in concrete mix test results

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	R34	P9	Gaps between the Implementation and the specifications due to misunderstanding of drawings and specifications
	R35	P10	Financial and administrative corruption/ bureaucracy
	R36	P11	Misestimate/shortness of Project duration
security and political	R37	Sp1	Terrorist acts, military operations, or security curfews
	R38	Sp2	A lot of security checkpoints around project
	R39	Sp3	Political turmoil, demonstrations, or government change
	R40	Sp4	Authority overlapping between concerned ministry and the governorate
	R41	Sp5	pressure of political parties or a politician on project
	R42	Sp6	The inability of foreign companies or experts to work due to unsafe circumstance
Design	R43	D1	Inaccurate quantities /Mismatch between listing quantities, drawings and specifications
	R44	D2	The designs are not suitable for the local environment
	R45	D3	The designs are not compatible with the amounts allocated for the project
	R46	D4	Incorrect structural designs /contradict between (electro-mechanical construction ....) designs
	R47	D5	Changing designs during implementing
Culture &	R48	C1	The project is located in a clan conflict area
	R49	C2	Cultural differences such as, education, work culture, and language With foreign companies implementing
	R50	C3	Non-acceptance of project due to social or environmental concerns
Environmental and destiny	R51	E1	natural disasters /heavy Rainfall, high temperatures, or High gale
	R52	E2	Covid 19 epidemic or the emergence of advanced versions of it

The next round of Questionnaire was the risk assessment process within the MCDM approach by the TOPSIS method. According to respondents' assessment of each risk and each criterion. After collecting data and using TOPSIS to calculate the significance of each risk, the results are as shown in The participants chose the risk Re1 (the contractor's inefficiency) as the most negative risk impact on the project, then the risk D4 which is about (Incorrect structural designs). After that came the risk F4, (the financial failure of the contractor) ranked third in terms of importance. The fourth level was risk D5 (change the design during the implementation of the project). As for the fifth grade, the risk was P9 (Gaps between the implementation and the specifications). The last three grades in the list of risks were P5, C3, and Re6 respectively (Delayed tests results), (social or environmental concerns), and (Inefficiency of the subcontractor). Figure

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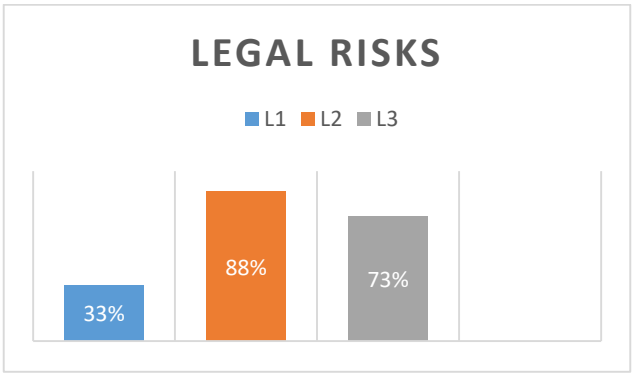
Risk code	Si +	Si -	Cci	rank	Risk code	Si +	Si -	Cci	rank
L1	0.0337	0.0424	0.5569	36	P2	0.0358	0.0386	0.5189	31
L2	0.0419	0.0247	0.3710	7	P3	0.0392	0.0305	0.4371	22
L3	0.0406	0.0305	0.4283	15	P4	0.0256	0.0494	0.6588	49
M1	0.0400	0.0303	0.4308	16	P5	0.0230	0.0454	0.6638	50
M2	0.0427	0.0259	0.3777	10	P6	0.0358	0.0272	0.4320	18
M3	0.0228	0.0431	0.6535	48	P7	0.0391	0.0304	0.4375	24
M4	0.0293	0.0380	0.5646	38	P8	0.0238	0.0415	0.6351	43
Re1	0.0545	0.0130	0.1931	1	P9	0.0468	0.0197	0.2965	5
Re2	0.0436	0.0261	0.3746	9	P10	0.0431	0.0334	0.4361	21
Re3	0.0315	0.0394	0.5553	35	P11	0.0427	0.0251	0.3708	6
Re4	0.0254	0.0441	0.6348	42	Sp1	0.0338	0.0339	0.5015	29
Re5	0.0244	0.0430	0.6383	46	Sp2	0.0326	0.0361	0.5256	33
Re6	0.0233	0.0493	0.6793	52	Sp3	0.0360	0.0393	0.5216	32
Re7	0.0350	0.0343	0.4945	28	Sp4	0.0395	0.0270	0.4063	11
Re8	0.0275	0.0459	0.6254	40	Sp5	0.0231	0.0407	0.6374	45
Re9	0.0388	0.0281	0.4201	13	Sp6	0.0381	0.0289	0.4311	17
Re10	0.0401	0.0296	0.4248	14	D1	0.0408	0.0244	0.3739	8
Re11	0.0359	0.0292	0.4485	25	D2	0.0355	0.0274	0.4356	20
Re12	0.0232	0.0404	0.6346	41	D3	0.0406	0.0311	0.4336	19
F1	0.0373	0.0290	0.4374	23	D4	0.0487	0.0159	0.2465	2
F2	0.0349	0.0334	0.4893	27	D5	0.0455	0.0180	0.2830	4
F3	0.0347	0.0394	0.5320	34	C1	0.0260	0.0432	0.6246	39
F4	0.0475	0.0163	0.2552	3	C2	0.0269	0.0485	0.6433	47
F5	0.0376	0.0389	0.5083	30	C3	0.0239	0.0494	0.6743	51
F6	0.0376	0.0351	0.4828	26	E1	0.0280	0.0491	0.6370	44
P1	0.0315	0.0401	0.5599	37	E2	0.0423	0.0295	0.4115	12

Chart, shows the arrangement of legal risks and shows that L2 (disputes between the parties to the project) is the most important among the three risks, as it got a relative importance of 88%. While L1 risk) dispute on the boundaries of the site (was the less one and got 33%.



Chart, clearly shows that M3 that is about (decisions from project executives) have the weakest effect on the management risk group with 10% also, M2 risk that relating to (personality of project manager) is the most influential with 83%.

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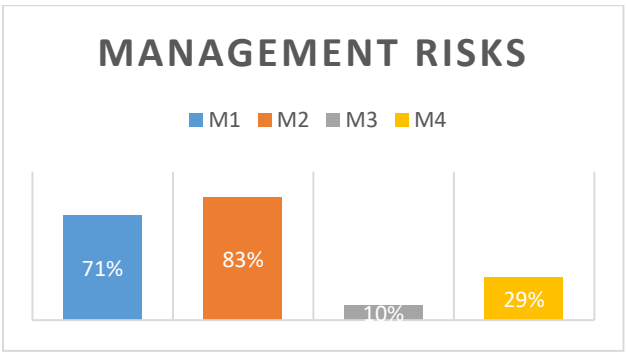
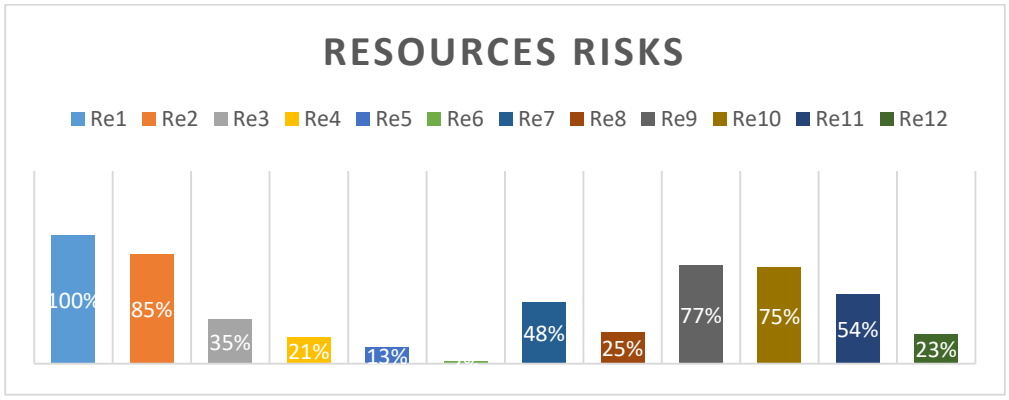


As for the resource risk group, it includes 12 factors. The results showed a discrepancy in their importance, as Re1 risk (Contractor inefficiency) was the most important one among the 52 risks.it take 100% of importance, followed by Re2, Re10, and Re9. While the risk Re6 (Inefficiency of the subcontractor) was the least important (2%), in addition to that, the rest of the risks Re4, Re5, Re7, Re8, Re12. Have similar importance Medium importance range between (13-48%) as Shawn in Chart,) shows that most of the financial risks have a medium-level importance ranging (37-52%), except for F4, which is related to the (financial failure of the contractor), which is the greatest importance with a 96% relative importance.



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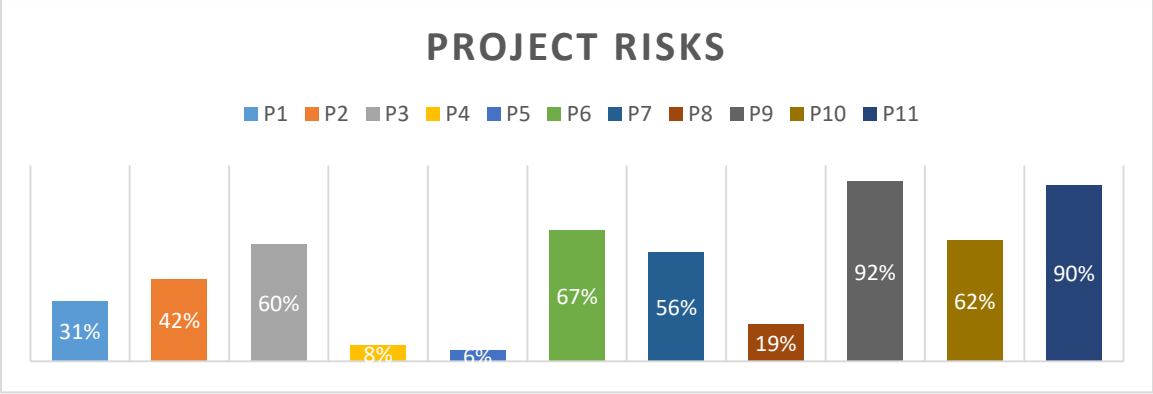
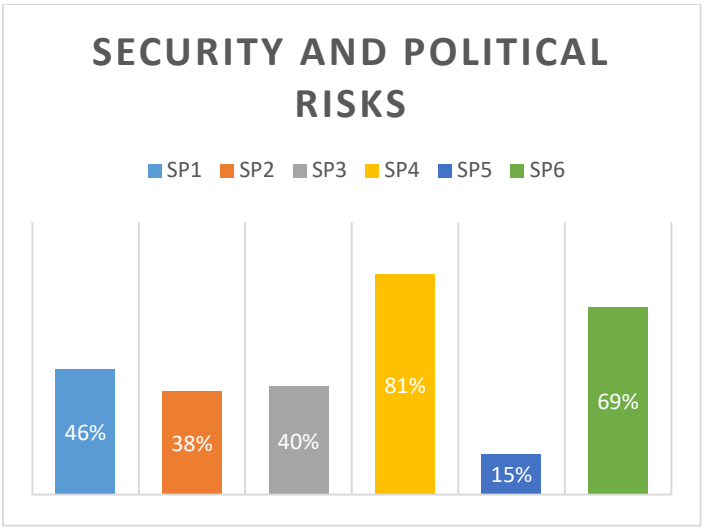
Although there are 11 risks in the category of project risks, only two risks were of paramount importance, which are P9)Gaps between the Implementation and the specifications(and P11)shortness of project duration(, where they have 92% and 90% importance. Risks P2, P3, P6, P7, and P10 were a medium importance averaged (42-62%), and the risks P1, P4, P5, and P8 were a little relative importance ranging (6-31%). P5 (Delayed tests results) have the least important among them all with 6%.



Security and political governorate is considerable class of risks in Iraq, six of which were identified in this study. The results showed that SP4, SP6) authority overlapping between concerned ministry (and (the inability of foreign companies or experts to work due to unsafe circumstance), have 81% and 69% importance respectively. While the risk SP5) pressure of politician on project (was the least significance among it, it got 15%. The risk SP1, SP2, SP3 got a medium and close rating between (38-46%).



The results of the design risk category showed that it is the most important category, risk D4 (Incorrect structural designs) ranking 98% an importance, while the risk D5 (Changing designs during implementing) 94% relative importance. As for the risk D1 (mismatch

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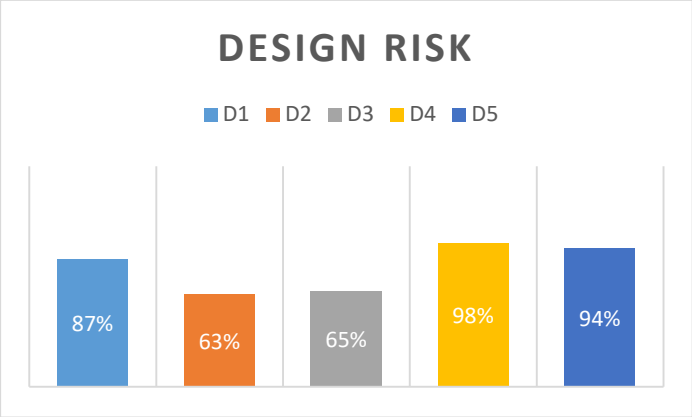
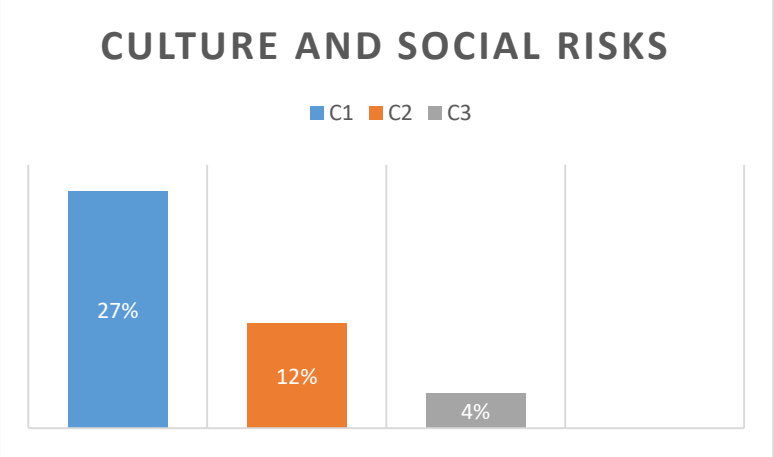
between listing quantities, drawings and specifications), 87% an importance. Risks D2, D3 the results showed that they took average ranks of importance 63%, 65%



Cultural & Social risk Category is the least influential in the risk categories. Chart shows that the three risks within this category C1, C2, C3 took the last ranks in the list of risks 27, 12, 4%.



concerning the risks of the environment and epidemics, the risk of (Covid19 disease) was the most dangerous, got a relative importance of 79% .while E1 risk have 17% of importance.

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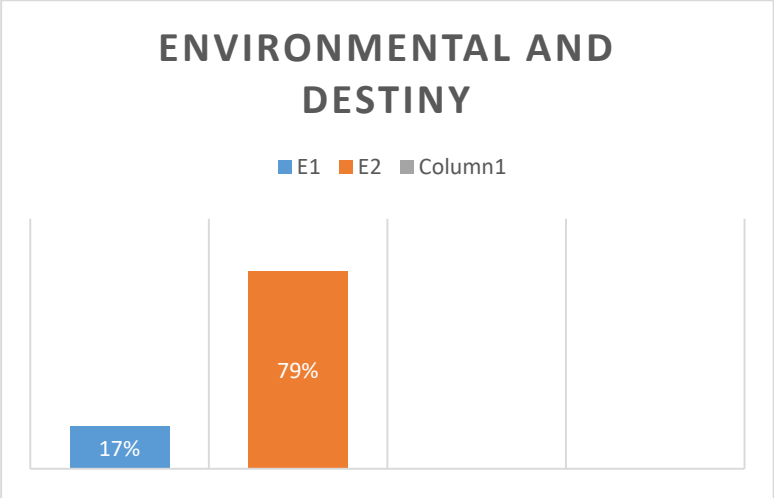

5. CONCLUSIONS

Among the many goals of the construction sector, is the improvement of Gross Domestic Product (GDP), which is an important goal to achieving macroeconomic stability, improving infrastructure, and accelerating the economy of countries. Despite this, this industry has significant obstacles and poor performance in developing countries by exceeding the specified time, cost and not reaching the target quality. This shortcoming occurs because of the multiple risks that construction projects are exposed to. Ignoring the diagnosis of these risks is ignoring an effective part of project management, which is RM risk management. The practice of risk management seriously and frequently leads to reducing the negative effects of risks. In other words, ignoring the implementation of risk management in a systematic way leads to projects failure.

Changing place and time does not change the risk factors only, but also the type and number of criteria that are used to assess those risks. For example, the criteria used in choosing a design for a facility differ from one country to another. In addition, it changes over the years. Like this, risk assessment and criteria of benefits and cost are different in previous studies. MCDM framework was used in risk assessment but with different methods and different criteria. Studies showed that the TOPSIS method is an ideal method for using these tools. It depends on the numerical evaluation of the cost-benefit criteria. It expresses the importance of risks based on the amount of variation in the evaluations between them.

By looking at the results, Contractor inefficiency risk was ranked first because it threatens the whole project and its objectives. The poor design risk and overlap risk was ranked second. After all, it would hurt schedule and cost because it requires rework or remediation of designs. The risk of financial failure for the contractor was the third risk In terms of importance because it means blocking the project and stopping work. We can distinguish that the risks related to designs were mentioned more than others in the top ten risks were, and then come the risks that are classified within the resources. The risk

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of the inefficiency of the subcontractor, Re6, was ranked late and is also unexpected, which according to the respondents' realistic point of view turned out to be not of the utmost importance because the relationship or relationship with the owner is in a large proportion with the main contractor and it is also a part of his responsibility.

The emergence of the Covid 19 epidemic had a significant impact on the management of construction projects during the past two years, which made it rank 12. It may be a risk associated with a period stage and decline in the future.

The risks associated with the security situation 5 years ago in Iraq were of exceptional importance, but their importance declined due to the security stability and the decline of terrorism.

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