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Analytical Study of Risk affecting time, cost and quality of road construction project in Iraq

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ABSTRACT

This paper aims to identify and assess the risk factors that affect the primary elements, time, cost and quality, in the roadway construction project in Iraq. The paper uses the quantitative approach, in the form of questionnaire, in order to achieve the objectives of the study. Detecting such risk factors that lead to delay, increase of cost and bad quality may help taking early actions in order to address these factors that ensure the mitigation of their effects and the success of the project as much as possible. The researcher examined a number of risk factors affecting the roadway construction projects in Iraq, some of them have significant impact on time, cost and quality of such projects, including the financial corruption, security situation and lack of engineering control in such projects.

Keywords: Iraq, Cost, Time, Quality, Factors, Road, Construction, Study, Risk and analytical.

1. Introduction

The importance of the road as an infrastructure of countries is unavoidable, and most governments all over the world invest in infrastructure projects. However, the main three constraints of a certain project are the effective time, cost, and quality of the project's final product. In addition, one of the most influencing factors which affect the achievement of project objectives is risks and uncertainties analysis and management.Risk analysis and management is a key project management practice to assure that the least number of unexpected events occurs while the project is in progress**[**13]. Previous literature inspected the factors affecting performance in the road construction sector, especially in Iraq, that identified a number of such factors, including but not limited to lack of contractor experience, bad work conditions, delay, planning lack, inaccurate scheduling, missing and bad materials, unsuitable technology and equipment, fluctuation of prices and unskilled workers [1].
Furthermore, it is assumed that risk is not always easy to be evaluated since the probability and consequence of occurrence are usually not measurable parameters. Accordingly, they are required to be estimated either statistically or by any other methods[11]. Such risks are to be identified and estimated in order to develop the management strategies that include operations, tools and techniques that help the project management in a way that mitigates such risks throughout the project lifecycle[7]. There are various risks associated with the construction projects, including but not limited to financial, environmental, socio-economic and construction related risks[22].
Risk Management therefore becomes a pivotal instrument that help us deal with the culling of various risks, their analyses, and the remedial steps that could be taken to avert them in particular project[9]. The management of risk in projects is currently one of the main topics of interest for researchers and practitioners working in the area of project management[21].

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For the aims of identification and assessment of risk factors affecting the primary element in the roadway construction project in Iraq, the researcher uses the risk management tools using quantitative method to analyze such risk factors. The researcher seeks to clarify the main stages of road construction projects in Iraq, clarify the methods and stages of risk management in construction and roads construction projects in Iraq and understand, identify and assess such risk factors. In achieving such goals, the researcher provided a literature review of road construction projects in Iraq and the affecting factors. Then, a questionnaire was designed to collect data from Site Engineers, Owners, consultants and contractors about factors affecting performance. Statistical package for the Social Sciences (SPSS) was used to analyses and rank factors according to their significant. Finally, several conclusion and recommendations are reached after the discussion of results. The main limitations included the planning, design and implementation phases and included 5 projects in the in Iraq and for the period from 2021-2022 .

2. Generalized Fr´echet bounds

Data collection is a critical process and requires a professional tool; many tools are used to collect data, such as questionnaires, interviews, observations, and records[14]. Due to the risky environment as to the Covid-19 pandemic, the questionnaire was considered the most effective tool according to the other tools.

Questionnaire Assessment

The questionnaire was submitted to various Road Engineers and Professors in civil engineering collages to be considered as arbitrators in this study, with the first part being the arbitration of the contents of the scientific questionnaire and what the questions are, and how they connect to the questionnaire's objective. The second section dealt with statistics, as well as the accuracy and scientifically of statistical analysis.

In addition, the researcher uses the statistical validity approach intendedto determine whether or not the tool was appropriate for the task at hand[15]. The internal and external validity were the two types that were used. Regarding the internal validity, the measurement was carried out independently for each element (question) inside the section. The portion of the elements impacting time in Iraqi road construction projects was tested in the research. By computing the correlation coefficient individually for each of them [16]. Table (1) shows spearman's Rho coefficient and (P-values) for the part of (Factors affecting on time in Iraqi road construction projects).

Factors	Correlation Coefficient	P-Value
T1	0.467	0.00
T2	0.467	0.00
T3	0.420	0.00
T4	0.433	0.00
T5	0.545	0.00
T6	0.456	0.00
T7	0.545	0.00
T8	0.385	0.00
T9	0.485	0.00
T10	0.485	0.00
T11	0.408	0.00

Table. 1: Spearman's Rho Correlation for Factors affecting on Time.

The values of coefficient correlation in Table (1) were between (0.385-0.545), and all of (P-values) were below (0.05), which means there is a correlation among the factors, and the test can be measured.

Factors	Correlation Coefficient	P-Value

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C1	0.407	0.00
C2	0.527	0.00
C3	0.527	0.00
C4	0.533	0.00
C5	0.528	0.00
C6	0.499	0.00
C7	0.439	0.00
C8	0.512	0.00
C9	0.390	0.00
C10	0.410	0.00
T11	0.427	0.00

Table. 2: Spearman's Rho Correlation for Factors affecting on Cost.

The values of coefficient correlation in Table (2) were between (0.390-0.533), and all of (P-values) were below (0.05), which means there is a correlation among the factors, and the test can be measured.

Factors	Correlation Coefficient	P-Value
Q1	0.308	0.00
Q2	0.308	0.00
Q3	0.257	0.00
Q4	0.510	0.00
Q5	0.232	0.00
Q6	0.510	0.00
Q7	0.322	0.00
Q8	0.340	0.00
Q9	0.407	0.00
Q10	0.407	0.00
Q11	0.340	0.00

Table. 3: Spearman's Rho Correlation for Factors affecting on Quality.

The values of coefficient correlation in Table (3) were between (0.232-0.510), and all of (P-values) were below (0.05), which means there is a correlation among the factors, and the test can be measured.
Regarding the external validity that is used.Table (4) Spearman's Rho Correlation Coefficient between Questionnaire's parts. The Correlation coefficient values were 0.463, 0.472 and 0.358, and (P-values) were below (0.05), which means there is a correlation among the factors, and the test can be measured.

Factors	Correlation Coefficient	P-Value
T	0.463	0.00
C	0.472	0.00
Q	0.358	0. 00

Table. 4: Spearman's Rho Correlation Coefficient between Questionnaire's parts

For the examination of reliability of the tool of the study, the statistical reliability has been used as a method for that, and the most famous test is the Alpha (Cronbach) Model. Before beginning the measurement, a categorization of this approach

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should be provided. Figure (5) shows this categorization. (Morgan, George A., et al. IBM SPSS for introductory statistics: Use and interpretation. Routledge, 2019.).

Cronbach's Alpha	Degree of Reliability
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Table. 5: Alpha Cronbach Classification

In our case, this test was made for each part severally. Moreover, the results are shown in Table (5).

Item	α Value	Reliability Degree
Time	0.759	Acceptable
Cost	0.838	Good
Quality	0.847	Good

3. Applications of an inequality by Ky Fan

The statistical analyses would be calculated using the mean, standard deviation, and rank in this situation. As a result, the factors in each of the three items (Time, Cost and quality) were sorted according to their mean, indicating that the most significant. Other elements were presented in order of their importance.

The mean of each component was computed manually using a formula, and the researcher selected three samples, one from the item (Time, cost and quality). This test compared the results of manual calculations with those of (SPSS) computations.

First Sample of T1

In the first step, the mean and standard deviation of the population were calculated as the following:

Mean =((1*1)+(2*7)+(3*22)+(4*74)+(5*88))/192

Mean=4.255

S.D =√((1-4.255)2*1+(2-4.255)2*7+(3-4.225)2*22+(4-4.255)2*74+(5-4.255)2*88)/((192-1))

S.D = 0.839.

These results are in line with the results of the SPSS test.

First Sample of C1

Mean =((1*1)+(2*5)+(3*33)+(4*54)+(5*99))/192

Mean = 4.1041

S.D =√((1-4.1041)2*1+(2-4.1041)2*5+(3-4.1041)2*33+(4-4.1041)2*54+(5-4.1041)2*99)/((192-1))

S. D= 0.8120

Also, these results are in line with the results of the SPSS test.

First Sample of Q1

Mean =((1*1)+(2*5)+(3*18)+(4*68)+(5*100))/192

Mean= 4.315

S.D =√((1-4.315)2*1+(2-4.315)2*5+(3-4.315)2*18+(4-4.315)2*68+(5-4.315)2*100)/((192-1))

S.D =0.764.

Also, these results are in line with the results of the SPSS test.

Research Hypothesis

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This test compares the Z score to that of the significant test. In this example, a two-tailed test with a confidence interval percentage is employed (95%). As seen in Figure (3.3). (Volchok, Edward. "Clear-Sighted Statistics: Module 1: An Introduction to Statistics." (2020.(.(
Figure (8) shows critical region or rejection area. Every Z. score of any question that occurred in this area, the hypothesis of this question was rejected.
The hypothesis H0 null and H1 was assumed as follows:
H0: Factors don't effect Time, Cost & Quality of road construction projects in Iraq.
H1: Factors effect Time, Cost & Quality of road construction projects in Iraq.

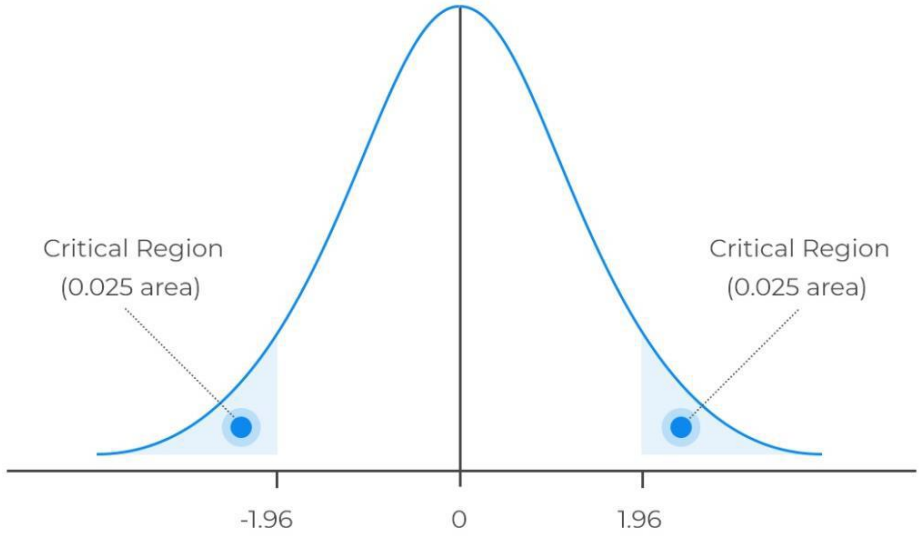

Figure. 2: Two-tailed tests with confidence interval percentage of (95%)

Z. Score was calculated manually to compare it with the SPSS Z. score value. This equation is clarified as follows:
$Z=(\dot{x}-\mu)/(\sigma/\sqrt{n})$
$\dot{x}$: Sample mean
μ: Population mean
σ: Standard deviation
n: Number of samples

The following formula can calculate μ:
$\mu=(1+2+3+4+5)/5= 3$
Each factor's Z. score was manually computed using the formula stated above. Moreover, the researcher picked three samples, one from the section as follows, Time, Cost and Quality. This test compared the results of manual calculations to those of (SPSS) computations.
3.9.1 First Sample of T1
$Z=(4.1832-3)/((0.8141)/\sqrt{192}) =20.12$

This value is almost equal to the value calculated in SPSS that's valued is (3.10). So, the calculation is correct.
3.9.2 Second Sample of C1
$Z=(4.0417-3)/((0.77819)/\sqrt{192}) =18.548$
This value is almost matching to the value calculated in SPSS that's valued is (18.548). So, the calculation is correct.
3.9.3 Second Sample of Q1

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Z=(4.1927-3)/((0.75151)/√192) =21.991
This value is equal to the value calculated in SPSS that's valued. So, the calculation is correct.

4. Discussion

The results show that 58% of the respondents have bachelor degree, 3% have Diploma, 22% have master degree and 17% have Ph. D. Regarding the previous experiments, 21% of the respondents have experiments from 1 to 5 years, 18% have 6-10 years, 38% have 11-20 years, 15% have 21-30 years and 8% have 31-40 years of experiments. This gives strength to the questionnaire, as the percentages of respondents' experiences from six years and above represent 79% of the total responses. This indicates the maturity of their engineering mentality and their acquisition of more experience than newly graduated engineers.

For the work sector, in terms of public or private sector, the percentage of respondents who work in the governmental sector was (67%), and the percentage of respondents who work in the private sector was (33%). The highest percentage was for employees in the governmental sector. Government departments have a particular and distinguished administrative style in dealing with incoming and outgoing official correspondences and letters. This gives strength to the government employee and thus a more comprehensive range of answering the questionnaire.

Regarding the specialization, the percentage of respondents who work in the construction sector was (28%); the percentage of respondents who work in the roads and bridges sector was (55%); the percentage of respondents who work in the water and sewage sector was (7%); and the percentage of respondents who work in the university engineering office was (10%). Total percent of Engineers working in Roads and university offices amount other sectors is 65%, which gives a clear picture of the strength and validity that it would bring to the questionnaire. On the other hand, the results also showed that the percentage of respondents who work in the design and engineering consultancy field was (21%), and the percentage of respondents who work in the investment field was (22%). The percentage of respondents who work in the marketing field was (2%), and finally, the percentage of respondents who work in the construction and management field was (52%). A high percentage went to Construction management. This sector is critical because the construction management is a key factor during, before and after the construction process to reduce time and cost and raise up the quality of road projects.

For analysis of factors affecting time, the related part of the questions included 11 questions and (mean, rank, standard deviation) was extracted. Every item of 11 questions was tested by using a (2-tailed) test with a confidence interval percentage of 95%, extracting the Z. score value to examine it with the rejection area.

The items were ranked according to the mean of each one from (high effectiveness) or (significantly effectiveness) downward. Here, the first three factors were discussed according to their importance compared with other factors.

The first factor was (Financial and administrative corruption), which in turn leads to many stopes and issues. Indeed, this factor is significant because Corruption is one of the biggest problems the governments face and it stands as an obstacle to sustainable development. Most projects in Iraq including road construction projects have suffered high deviations not only in time, but effect the cost and quality which lead to wasting public money through exploiting public officers or authorities to achieve personal benefits that destroy the country's economy, this factor have a downside effects of the project scheduled.

Moreover, factor number two in terms of importance was (Delay in payment of the contractor's financial dues). This was particularly critical challenge with a global dimension, often leading to increased construction costs due to time extension or acceleration as well as loss of productivity, disruption of work, loss of revenue through lawsuits between contractual parties, and project abandonment.

The third most important issue was (Delay in resolving disputes between the contractor and the employer). Disputes in the construction sector, as in any industry, usually arise due to the failure of one or more parties to comply with contractual obligations. They can also arise from errors and omissions in contract documentation/design, or suspension/termination provisions (the latter of which is particularly relevant to the Covid-19 crisis). Disputes in road construction projects are often complicated and multifarious, meaning they take a long time to resolve in any event, but they are frequently further delayed by avoidable glitches that occur from the contract drafting stage right through to arbitration proceedings.

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In terms of the hypothesis test, the results of SPSS analysis for all Z-values fell inside the rejection region, rejecting the hypothesis (H0) that there is no influence of variables on project time in Iraqi Road construction projects. As a result, it would be (H1) that all elements influence time in Iraqi road construction projects.

On the other hand and in analyzing of factors affecting the cost, the related part contained 11 questions, and (mean, rank, standard deviation) was extracted. Every item of 11 questions was tested by using a (2-tailed) test with a confidence interval percentage of 95%, extracting the Z. score value to examine it with the rejection area.

The items were ranked according to the mean of each one from (high effectiveness) or (significantly effectiveness) downward. Here, the first three factors were discussed according to their importance compared with other factors.

The first factor was (Financial and administrative corruption) which present as a common factor affecting time and cost at the same level, this factor turns leads to many stopes and issues. Indeed, this factor is significant because Corruption is one of the biggest problems the governments face and it stands as an obstacle to sustainable development. Most projects in Iraq including road construction projects have suffered high deviations not only in time, but effect the cost and quality which lead to wasting public money through exploiting public officers or authorities to achieve personal benefits that destroy the country's economy, this factor have a downside effects of the project scheduled.

Moreover, factor number two in terms of importance was (Unstable security situation). Armed groups threats, attacks, bombings, explosions became the part of daily life in Iraq. Consequently, the threat of terrorism and Armed groups put the Iraqi construction sector especially road construction projects in the face of unique and unusual challenges that not seen on other countries. These challenges can have extensive impact on project cost.

The third most important issue was (Weakness of financial management.). When any company or construction institutions don't have adequate controls in financial management, they don't know the true financial situation of the company and they may report incorrect amounts to authorities for tax and regulatory purposes. Weaknesses in financial management controls have clear causes and remedies. You only have to identify the problem areas, determine why your controls are not effective and apply the corresponding corrective action.

In terms of the hypothesis test, the results of SPSS analysis for all Z-values fell inside the rejection region, rejecting the hypothesis (H0) that there is no influence of variables on project time in Iraqi Road construction projects. As a result, it would be (H1) that all elements influence time in Iraqi road construction projects.

Finally, regarding factors affecting quality, the related part contained 11 questions, and (mean, rank, standard deviation) was extracted. Every item of 11 questions was tested by using a (2-tailed) test with a confidence interval percentage of 95%, extracting the Z. score value to examine it with the rejection area.

The items were ranked according to the mean of each one from (high effectiveness) or (significantly effectiveness) downward. Here, the first three factors were discussed according to their importance compared with other factors.

The first factor was (Inaccuracy of work scope and Drawings), Construction scope of work and drawings are popularly known as blueprint or working drawings and details consist of materials used, installation techniques with quality standards and most importantly describe about what is to build. Mistakes in work scopes or drawings will lead to wasting money, efforts and effects the project quality.

Moreover, factor number two in terms of importance was (Unstable security situation), which present as a common factor affecting Cost and Quality at the same level. Armed groups threats, attacks, bombings, explosions became the part of daily life in Iraq. Consequently, the threat of terrorism and Armed groups put the Iraqi construction sector especially road construction projects in the face of unique and unusual challenges that not seen on other countries. These challenges can have extensive impact on project cost.

The third most important issue was (Lack of engineering supervisors specialized in road construction projects.). Project supervision is the process of ensuring that the project is built in accordance with the requirements of the contract documents, approved plans, specifications, building codes, building code standards and applicable local codes and ordinances. Supervisions give the project implementers useful information about the status of the project as regards tentative and final evaluations, otherwise, poor engineering supervision will have a downside on the project quality.

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In terms of the hypothesis test, the results of SPSS analysis for all Z-values fell inside the rejection region, rejecting the hypothesis (H0) that there is no influence of variables on project time in Iraqi Road construction projects. As a result, it would be (H1) that all elements influence time in Iraqi road construction projects.

5.CONCLUSION

Out of the results of the study tool, it has been found that financial and administrative corruption is the most significant issue affecting the time of road construction projects in Iraq, resulting in time. The second element contributing to time in road construction projects in Iraq was Delay in payment of the contractor's financial dues. The third element contributing to time in road construction projects in Iraq was Delay in resolving disputes between the contractor and the employer. Regarding factors affecting cost, the most significant aspect of improving and decreasing cost overrun in road construction in Iraqi Projects Financial and administrative corruption. The second element contributing to cost overrun in road construction projects in Iraq was Unstable security situation. The third element contributing to Cost overrun in road construction projects in Iraq was Weakness of financial management. Finally, factors affecting quality include inaccuracy of work scope and drawings, unstable security situation, lack of engineering supervisors specialized in road construction projects and the lack of professional members to oversite and run the road construction projects

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