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Assessing the Quality Control Implementation in Iraqi Construction Projects and the Use of BIM to Control the Quality of Construction

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ABSTRACT

The construction business regards as one of the most important industries in Iraq, contributing significantly to the Iraqi economy. The purpose of this research to assessing the quality of execution in engineering projects (in the public and private sectors) that based on the level of quality of execution control assessment. Construction project management is responsible for quality control in Iraqi construction projects, as well as how far the use of modern technologies such as building information modeling (BIM) to regulate the quality of implementation. This study was carried out accreditation, and the descriptive-analytical technique was applied by distributing questionnaires via a field survey. In addition, the SPSS program was used in order to process the collected data 60 questionnaires were distributed to contractors and engineering offices. 50 useful questionnaires were received from respondents with an 83% response rate. The study found that the construction projects in Iraq still suffer from weaknesses in the quality control of construction projects as well as poor construction project management responsibilities of quality control and that BIM is still not utilized to implement quality in Iraqi construction projects.

1. Introduction

The construction sector considers one of the most vital sectors in Iraq. The researcher points, one of the administrative issues that construction project in Iraq managers face is updating information and data to know the quality of performance [1]. Construction project management must have a clear vision and goal in order to plan, execute, and evaluate its performance on a continuous basis, especially in an uncertain work environment [2].

The reality of the field of construction projects in Iraq is related to the need for developing performance also improving quality, time, and cost management. Therefore, there is a need to use Modern Technologies such as Building Information Modeling (BIM) to control the quality of execution.

Quality is one of the main factors in the success of construction projects. Quality of construction projects, as well as project success, can be regarded as the fulfilment of expectations. Some design professionals believe that quality is measured by the aesthetics of the facilities they design. The standards of any product, service or an organization can be characterized by the term “quality”. In the past, there was no clear definition established to define the term “quality”. From few decades, philosophers such as Feigenbaum, Deming, Crosby, Ishikawa, Juran, Taguchi and others have put their thought to define the term quality and also accomplished tothe quality management principles.The contributions of their philosophies have enlightened the engineers and managers to focus on the performance[3].

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Quality may also be defined in terms of function, based on how well the project adheres to its specifications. A high-quality project may be defined by phrases like the ease of understanding plantings, number of conflicts in schemes and specifications, construction economics, operation ease, maintenance ease, and energy efficiency. Quality may also be defined in terms of function, based on how well the project adheres to its specifications. Quality in the construction sector is described as satisfying the needs of the owner, designer, regulatory bodies, and the constructor. while a new term for quality has emerged is quality 4.0 is an extended approach to quality management, where recent technologies are being integrated with traditional quality practices (QC, QA, TQM) to expand the quality management scope and to improve quality activities.[4]

Science and technology are developing by the day. BIM was merely a moniker expressing a cutting-edge notion a few years ago for most people. It is now widely used and popular in the Architecture/Engineering/Construction (AEC) profession in the majority of nations throughout the world to quality inspection (QI) as a primary approach used by general contractors to improve building project management. BIM is the process of developing a digital representation of a facility's physical and functional attributes.[5]. It's as a system for building lifecycle management, improves cooperation among designers, engineers, builders, and facility managers [6].

One of these techniques, which represents a technical and operational shift in the construction industry is BIM [2]. As a new approach, BIM has immense potential for integrating throughout the life cycle of a building project [7]. BIM is a sophisticated technology and technique that combines virtual features, systems, and concepts in a single environment [8].

Several BIM applications may be utilized to aid in quality inspection constructability, control, analysis, scheduling, cost estimates, and time sequencing [9], [10]. One of the key advantages of BIM is the accurate geometrical representation of architectural elements within an integrated information environment [7]. BIM implementation necessitates careful planning and a coordinated strategy that takes into account implementation and innovation management [11].

The purpose of this study is to examine the reality of assessing implementation quality in Iraqi engineering projects in both the public and private sectors by experts, in addition to the extent to which project management is in responsible of quality control in Iraqi construction projects, as well as how far new technologies such as (BIM) are used to govern implementation quality.

2. Methodology

In this study, the researcher used the questionnaire method as it includes questions within two parts that are distributed to know the opinions of the selected sample of experienced engineers in the field of construction projects. The questions were set depending on the reasons or factors that may lead to poor quality in Iraqi projects. An approved scientific method based on the strategy of idea generation and problem solving to reach collective decisions that the individual person (the researcher) cannot reach alone. In order to obtain necessary data for the objectives assigned to the study the contribution of the test of the survey model and its hypotheses.

(60) Questionnaire forms were provided to engineering specialists and engineering experts involved in the implementation and administration of construction projects in Iraq.

However, because some of the receipt forms had marginal and incomplete replies or were not filled out, (50) questionnaire forms were included in the study and appraised. The distribution of the questionnaire forms is shown Table (1) illustrates the names of governmental institutions and private companies that have been conducting the questionnaire with their specialists. As well as respondents from the private sector which, represents the research Population.

Table 1: Distribution of forms for the questionnaire

Foundation Name	Distributed	Received
Ministry of Higher Education and Scientific Research	9	9
Ministry of Construction, Housing and Municipalities and Public Works	20	15
Ministry of Water Resources	13	11
The Ministry of Electricity	8	6
Private sector	10	9
Total	60	50

First, the researcher used the interview method with the questionnaire distribution where personal visits and meetings were conducted with each engineer during which they studied and discussed the contents of the questionnaire form in order to clear up any misunderstandings if the questions were unclear. Second, all responses were thoroughly scrutinized to ensure that the questionnaire form was correctly completed. Finally, to evaluate the reliability of the questionnaires, statistical analysis was done using the statistical program social science (IBM SPSS-V26). In comparison to other approaches, such as the online questionnaire, the personal interview has a relatively high response rate and decreases the possibility of inadequate or erroneous responses [9].

2.1 Design of questionnaire

The questionnaire has consisted of four parts as shown in the figure (1) using the descriptive approach, the researcher designed the questionnaire as follows:

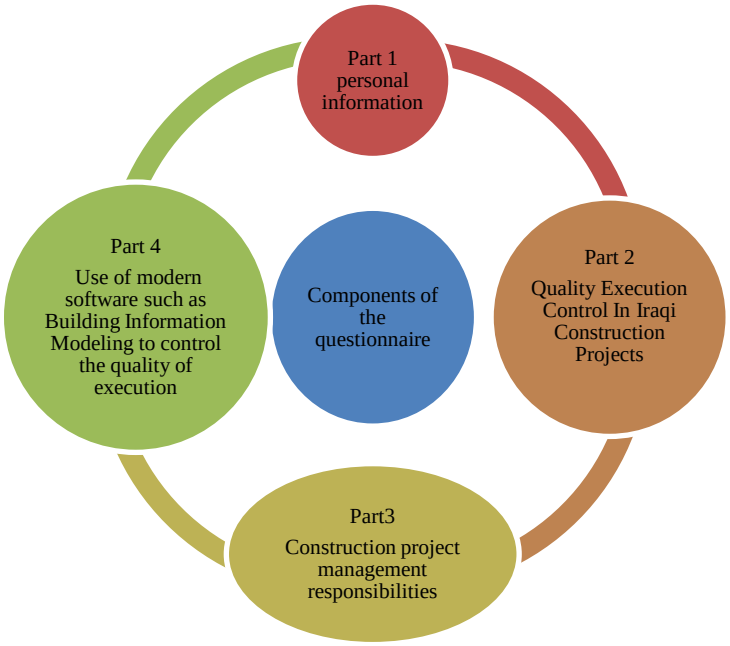

Figure 1. Components of the questionnaire (Researcher)

1. **Part I (General Information):** This part contains basic information about the responder.
2. **Part II Quality Execution Control in Iraqi Construction Projects**: This part includes clarifying the current indeed quality execution control In Iraqi construction projects, A Quality Management System (QMS) is an important process that you must put in place in the projects. QMS basically takes a critical look at the set of policies, processes, and procedures in a company. It helps you to plan and execute the core

business areas of the projects such as production, development, and service.

3. **Part III Construction Project Management Responsibilities:** This part includes the main responsibility of the management in the projects regarding the execution of the quality, its performance, and dimensions.
4. **Part IV Use of Modern Software as Building Information Modeling to Control the Quality of Implementation:** This part included the possibility of using BIM in the implementation of quality in construction projects.

The second and third sections of the questionnaire use a five-point Likert scale. The weighing scale is (1: not available, 2: rarely, 3: sometimes, 4: often, 5: always). Each respondent was asked to rate each question on a scale of one to 5 based on his perceptions of the Iraqi construction sector's climate. [12]. While the last section includes a (yes, no) question.

Second Part:

The second part consisted of (12) questions concerning the things in terms of quality control throughout project execution. Table (5) depicts the analysis of the second part's elements, as well as the arithmetic mean and standard deviation for each paragraph in the part. A five Likert scale was used (always, often, sometimes, rarely, never (no)) Questions about the second part:

1. The presence of a quality guide that explains the quality system in compliance with the quality policies and objectives of the project.
2. The presence of a process manual that outlines the operations of the departments in order to apply the quality aspects.
3. The presence of a quality control information system that is integrated.
4. The existence of defined administrative and technical relationships, as well as authorities and duties for quality control.
5. The availability of skilled and qualified technical experts for quality control tasks.
6. The presence of engineering awareness, demonstrating the necessity of quality control for engineers on both the implementation and oversight sides.
7. Cadres are being trained to improve their ability to regulate quality in building projects.
8. The availability of training and courses for current programs to improve workers' competence and efficiency in the field of quality.
9. The installation of efficient and contemporary devices and equipment
10. Commitment to delivering building supplies on schedule and according to technical criteria.
11. Agreement to hold project-related coordination meetings on a regular basis (owner - designer - contractor)
12. The project partners' interest in the project's cost exceeds the needed quality.

Third part:

The third part includes (13) questions concerning construction project management responsibilities, which are detailed more below. Table (6) displays the analysis of the third part's elements, as well as the arithmetic mean and standard deviation for each paragraph and the total average. A five Likert scale was used (always, often, sometimes, rarely, never (no)).

Questions about the third part:

1. The approach to the quality policy is determined by the project management.
2. Contractors with project quality management experience are chosen.
3. Commitment to quality objectives and orientations by the company in which you work.
4. Commitment to the construction project's quality specifications
5. Quality standards are integrated into the company's policy.

6. Simplified quality requirements are announced
7. Job quality specifications that satisfy the employer, as the work is received without complaint quality specifications are constantly monitored and reviewed during implementation.
8. Quality requirements are regularly monitored and revised during implementation.
9. An attempt is made to adhere to and get a certificate of conformity to the specified specifications.
10. The existence of an organization of powers and responsibilities to ensure quality.
11. Existence of continuous plans to improve quality.
12. Personnel working on the project's quality system receive frequent training.
13. The presence of an explanation, statement, and justification for the construction project's quality system.

Fourth Part

This part shows the current use of BIM in assessing the quality of the construction projects including (5) questions below. Table (7) displays the analysis of the last part's elements, as well as the arithmetic, mean, and standard deviation for each paragraph while the last section used a (yes, no) question.

Questions about the third part:

1. Are BIM applications utilized to control the quality of building project implementation?
2. Have you heard of BIM (Building Information Modeling)?
3. Do you employ BIM technology in any of your projects?
4. Do you realize how beneficial it is to employ contemporary software such as (BIM) to improve the quality of building project implementation?
5. Do you believe there is a relationship between the usage of (BIM) technology and improved implementation quality?

2.2 Sample description

The characteristics of the questionnaire sample are depicted in the figures below: Figure (2) depicts the percentage of respondents by work sector, with the public sector accounting for 76% and the private sector accounting for 24%.

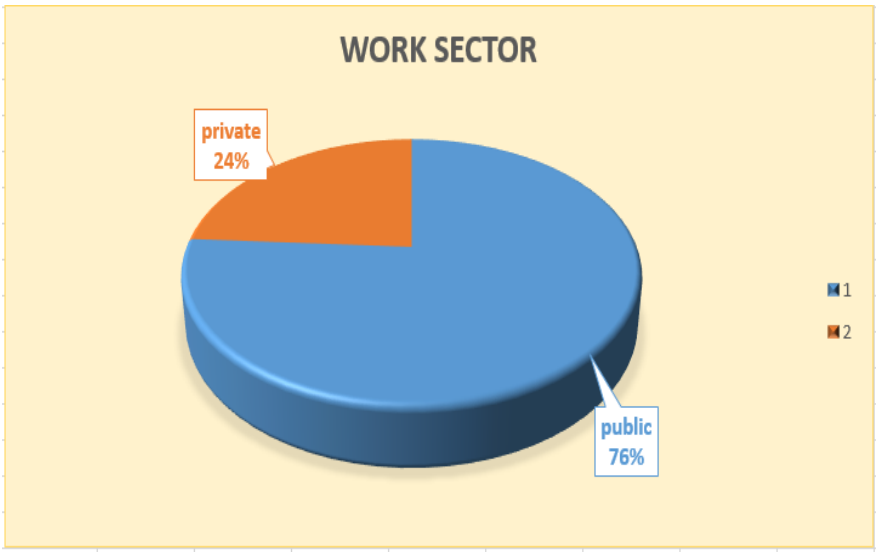

Figure 2. The percentage of respondents according to work sector

Figure (3) reveals the age proportion of respondents, with a percentage of 25-35 years equaling 20%, 36-45 years equaling 54%, 46-55 years equaling 22%, and more than 55 years equaling 4%.

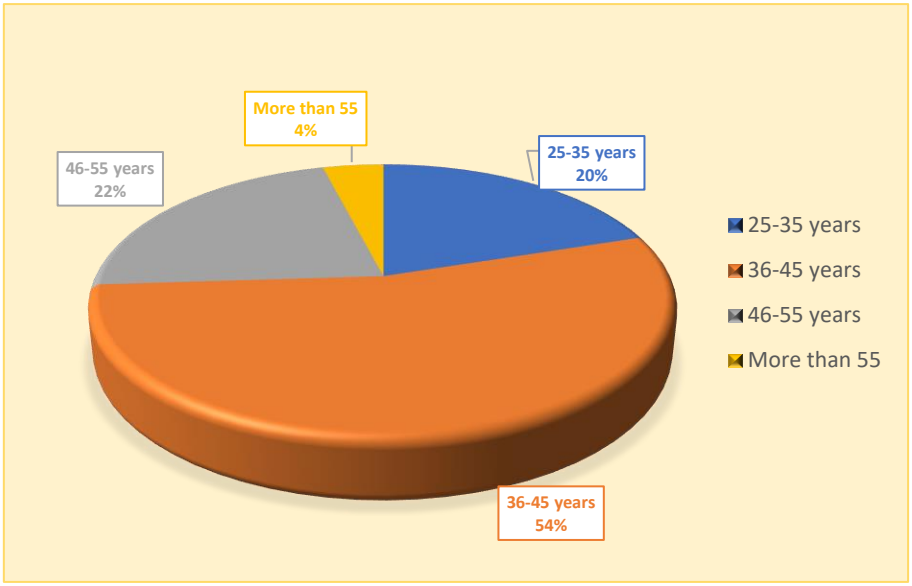

Figure 3. The age proportion of respondents

Figure (4) shows the academic qualification of respondents where the percentage of Technical Diploma is (4%), Bachelor (56%), High Diploma (4%), Master (24%), and Ph.D. (12%).

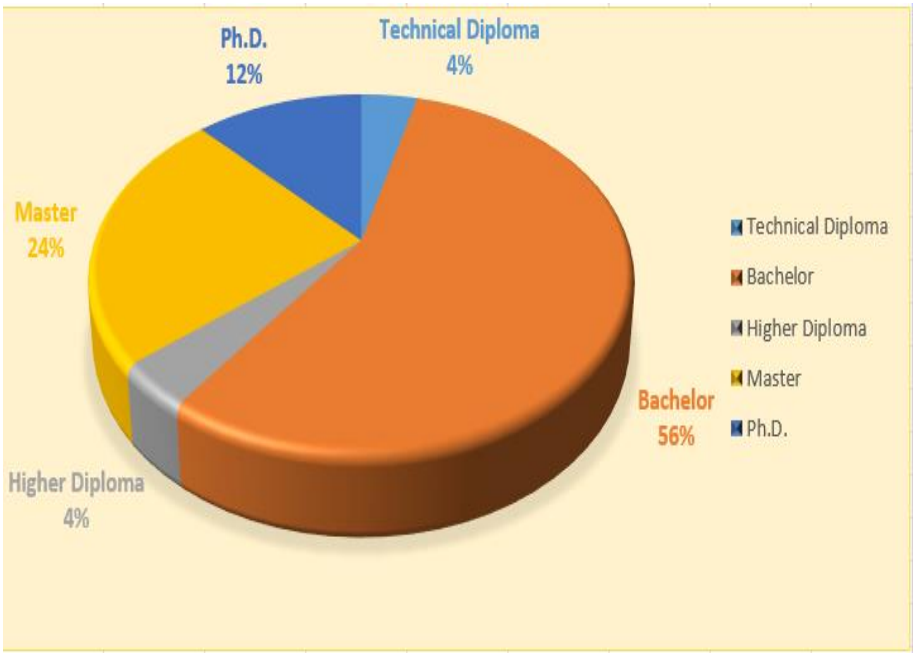

Figure 4. Respondents' educational levels

Figure (5) illustrates the specialization of respondents where the percentage of Architect is (8%), Civil Engineer (60%), Electrical Engineer (12%), and Mechanical Engineer (20%).

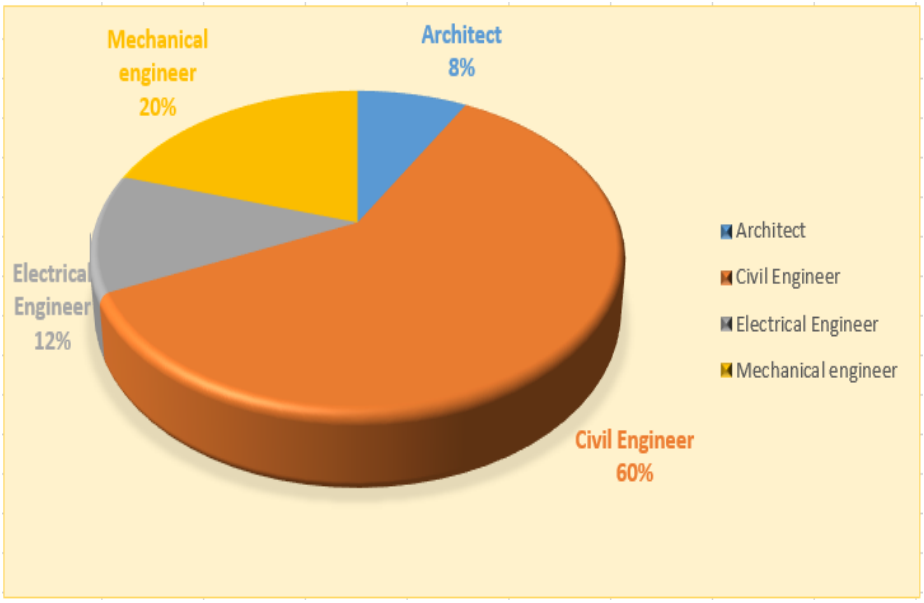

Figure 5. Respondents' specialization

Figure (6) depicts the respondents' group, where the percentage of project managers is (8%), consultants (8%), Department Manager (20%), Division Officer (24%), site engineers (30%), contractors (4%), and Academic (6%).

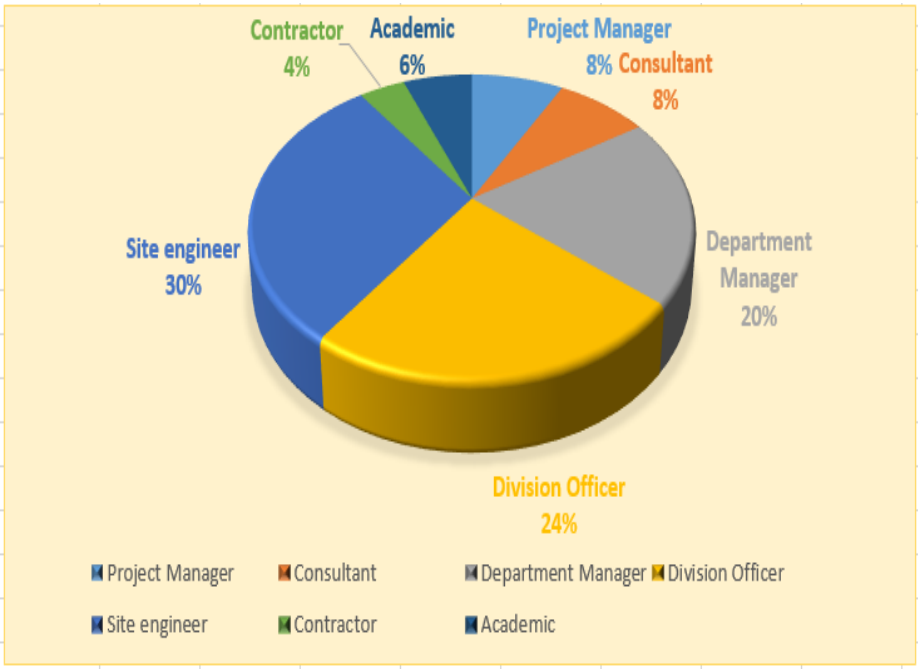

Figure 6. The respondents' group

Figure (7) evinces the respondents' practical experience. The percentages are as follows: less than 5 years (2%), 5-10 years (16%), 11-15 years (30%), 16-20 years (38%), more than 20 years (14%).

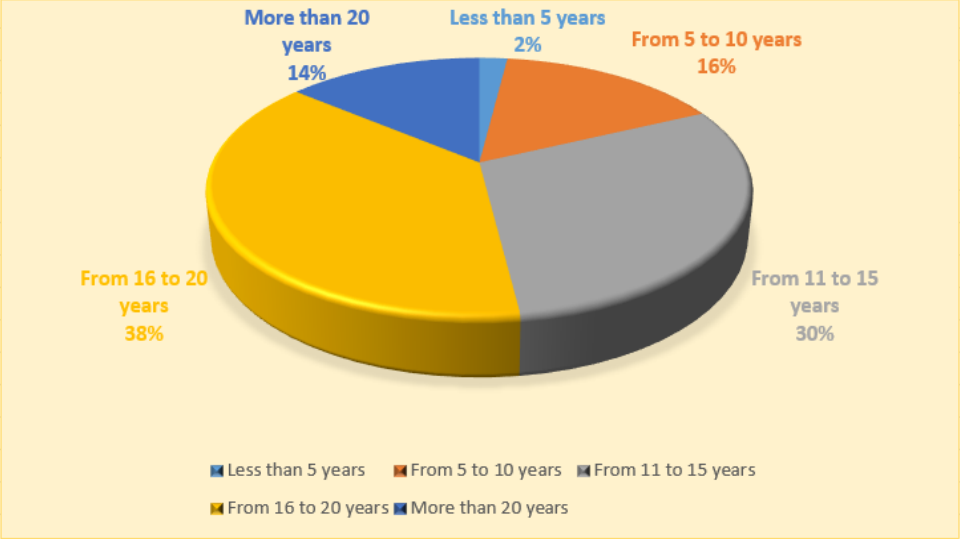

Figure 7. The respondents' practical experience

2.3 Reliability of questionnaire

The Alpha Cronbach constant, which runs from 0 to 1, is one of the most often used techniques of calculating reliability. If the result is near one, it implies a high level of reliability [13]. Table (2) below represents a classification for the degree of reliability according to the value of the Alpha-Cronbach coefficient.

Table 2: Reliability cutoff values [13]

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

The results were judged to be within the Alpha Cronbach system's good limits for the questionnaire, which supports the reliability of the questionnaire. Table (3) shows the values for those portions of Alpha Cronbach.

Table 3: Value of alpha cronbach for questionnaire's parts

Items	Value of α	Degree of reliability
Quality Execution Control in Iraqi Construction Projects	0.832	Good
Construction Project Management Responsibilities	0.844	Good
Use of Modern Software as Building Information Modeling to Control the Quality of Implementation	0.849	Good

2.4 Relative important index

To investigate the significance of quality execution control in Iraqi construction projects and construction project management responsibilities, a list of each was presented to the respondents, who were asked to evaluate each item in a five-grade system, which was already weighed on a scale of zero to one hundred, [14] as shown in Table 4, and the

relative importance of each item was calculated using the equation [15].

$$R.I = \frac{\sum_{i=1}^{i=n} Xi.Fi}{N} \quad (1)$$

Where:

R.I = Relative importance of item (i).
Xi = Grading range's average of item (i), see table (8).
Fi = Frequency of responses in item (i).
N = Number of respondents.

Table 4: Five – grade system[15]

NO.	Grade	Range		X_i
		Lower limit	Upper limit	
1	Unimportant	0	20	10
2	Slight importance	20	40	30
3	Average importance	40	60	50
4	Important	60	80	70
5	Very important	80	100	90

3. Results and discussion

From the results in a Table (5), the results showed that the project partners' interest in the project's cost exceeds the needed quality. is the highest percentage of response level based on the opinions of experts (mean =4.0, SD=1.03). This high proportion can be linked to construction projects' usual reliance on cost reduction at the expense of project quality, which implies that quality is rarely applied in construction projects throughout the execution stage.

The result of question no. (3) The presence of a quality control information system that is integrated. based on expert judgments (mean=1.6, SD= 0.86). This result is consistent with the absence of a quality control information system in Iraqi construction projects.

The result of question no. (8) The availability of training and courses for current programs to improve workers' competence and efficiency in the field of quality. is (always = 1.6 %, mean=1.6, SD= 0.91). construction projects suffer from a lack of training and courses for modern programs which makes is weakness in the skill and efficiency of workers in the field of quality.

Finally, from the results in a Table (5) based on expert judgments as shown of total average for (mean=2.3, SD=0.93) This result is consistent with Iraqi building projects suffering from low quality, implying that quality control is rarely used in construction projects, particularly during the execution stage.

Table 5: Statistical Analysis of Items for the Second Part

Item	Percentages of response levels%					Mean	S.D
	Always	Often	Some times	Rarely	Never (NO)		
Q1	2.1	8	16	34	36	2.1	1.18
Q2	2.1	8	16	34	38	2.1	1.11
Q3	1.6	2	6	30	60	1.6	0.86
Q4	2.4	4	22	60	8	2.4	0.93
Q5	2.3	6	18	64	8	2.3	0.87

Q6	2.4	4	24	62	6	2.4	0.83
Q7	2.1	6	14	54	24	2.1	0.90
Q8	1.6	4	4	30	60	1.6	0.91
Q9	2.3	6	18	58	14	2.3	0.93
Q10	2.8	10	52	32	2	2.8	0.80
Q11	2.5	6	30	54	6	2.5	0.86
Q12	4.0	46	10	6	4	4.0	1.03
Total Average						2.3	0.93

As shown in figure (8) it is clear that "The project partners' interest in the project's cost exceeds the needed quality." is relatively the most important (80 %). Approximately, based on expert judgments in terms of quality execution control, the Iraqi construction industry is on the same track. Signs of low quality in Iraqi projects.

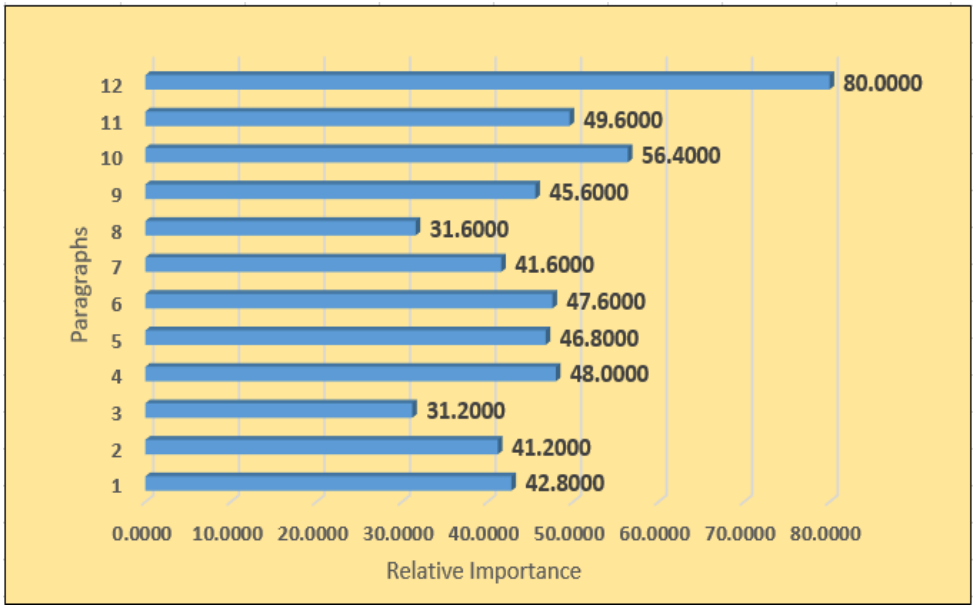

Figure 8. The relative importance of the quality execution control

Table (6) shows that: The results of question no. (10) Showed that "The existence of an organization of powers and responsibilities to quality assurance" is the highest percentage of response level based on the opinions of experts with (always =20.0%, mean =3.50, SD=1.147). Where the management of projects is concerned with the organization of powers for quality assurance is important as each person performs the specifications and requirements for quality assurance. This result agrees with researchers from other countries. [16].

The results about question no. (11) showed that "Existence of continuous plans to improve quality." is the lowest result based on the opinions of experts with (always =0 %, mean=1.5, SD=0.7١). This result shows that there are no plans for continuous improvement and development of quality control methods in projects to adopt traditional methods of project management.

Finally, the results in Table (6) as shown by total average for (mean=2.33, SD=0.92) this result shows that there is a weakness in the responsibilities of the project management to monitor and ensure quality. This result agrees with researchers [17].

Table 6: Statistical analysis of items for the third part

Item	Percentages of response levels%					Mean	S.D
	Always	Often	Some times	Rarely	Never (NO)		
Q1	4	2	30	58	6	2.4	0.81
Q2	0	2	6	56	36	1.7	0.66
Q3	8	8	20	38	26	2.3	1.19
Q4	4	8	40	46	2	2.7	0.82
Q5	6	14	30	44	6	2.7	0.99
Q6	4	6	52	30	8	2.7	0.87
Q7	0	6	14	50	30	2.0	0.83
Q8	2	4	50	40	4	2.6	0.73
Q9	4	8	14	46	28	2.1	1.05
Q10	20	34	30	8	8	3.5	1.15
Q11	0	2	6	36	56	1.5	0.71
Q12	2	2	10	42	44	1.8	0.87
Q13	10	8	20	24	38	2.3	1.33
Total Average						2.3	0.92

The most important paragraph, as shown in Figure (9) is the "The existence of an organization of powers and responsibilities to ensure quality" with a relative importance of (70 %), This shows that there is a need to provide a quality department or even a professional as a quality manager, which is clearly tied to project management.

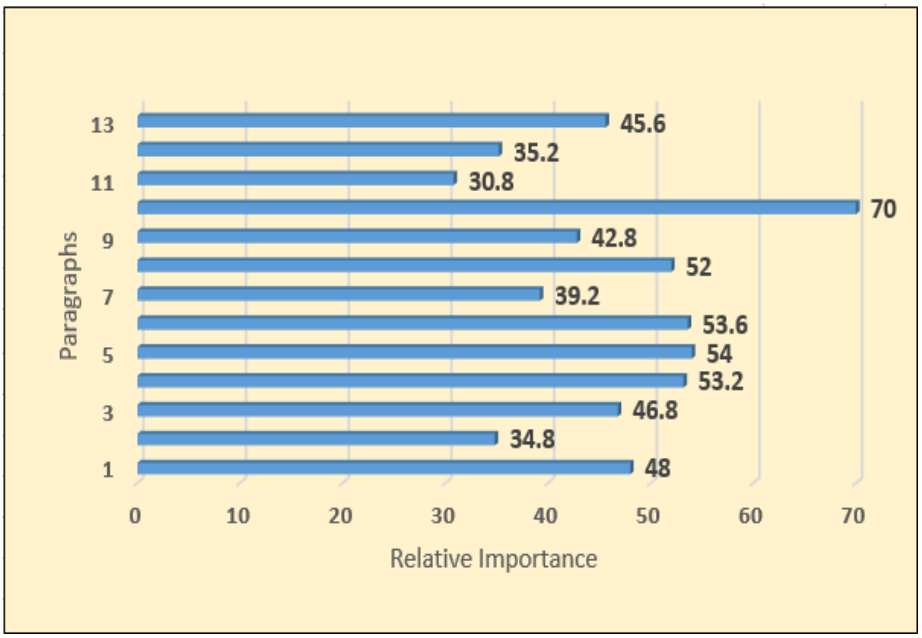

Figure 9. The relative importance of the construction project management responsibilities

According to table (7):

Finally, from the results, as shown in evaluation (NO), and (mean=1.07, SD=0.16) based on expert judgments this result provides a total average, indicating that BIM is not employed in Iraqi building projects. This finding is supported by researchers [7].

Table 7: Statistical analysis of items for the fourth part

ITEM	Percentages of response levels%		Mean	Std. Deviation	Evaluation
	YES	NO			
Q1	0	100	1.00	0.00	NO
Q2	30	70	1.30	0.46	NO
Q3	0	100	1.00	0.00	NO
Q4	2	98	1.02	0.14	NO
Q5	4	96	1.04	0.20	NO
Total Average			1.07	0.16	NO

4. Conclusion

Following an assessment of the actuality of quality in building projects and an analysis of replies, the researcher came to the following conclusions:

1. There is a deficiency in the execution quality of building projects, particularly in the public sector, where foundations continue to rely only on traditional quality control techniques.
2. A lack of specialized divisions for quality management, tasked with auditing processes from start to finish.
3. Construction projects suffer from a lack of training and courses for modern programs which makes is a weakness in the skill and efficiency of workers in the field of quality.
4. In Iraq, modern engineering software such as (BIM) is not used for quality control in building projects.

Recommendations

1. The necessity of paying attention to the quality of construction project execution, particularly in the public sector, by entities operating in the construction industry in Iraq.
2. Use innovative methods and advanced technical tools to ensure the quality of Iraqi building projects.
3. Provide quality management expert departments or even a professional as a quality manager for the follow-up job of auditing processes from start to finish.
4. It is necessary to give training and courses for contemporary programs (BIM) in order to improve the ability and efficiency of field employees of quality control.

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