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Building Information Modelling (BIM) Applications in the Construction Sector to Improve Project Planning Facilities

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ABSTRACT

Project systems are essential to the success of a construction project since they provide models and techniques recommended for construction planning. Performance is the most important part of the planning process. Despite the fact that the construction industry has traditionally been afflicted by insufficient planning and overdependence on tradition integrated planning, building information modelling (BIM) technology has frequently in recent years been proposed to increase the effectiveness of project performance in construction planning facilities. The practical goal of this research is to apply of BIM to enhance the effectiveness and efficiency of structural planning. A quantitative questionnaire was used to summarise the benefits and capabilities of these technological advances in the field of construction planning. As a result, the questionnaire was constructed based on prior research that dealt with positive benefits, and topics were generated in the research areas of cost, time, communications, conflicts, documentation, and other key indicators in the design phase and feasibility studies. The results were calculated from the relative means of the questionnaire filled for this purpose, and the average rate was 0.816 percent, reflecting the importance of this technique. Hence, the relative importance of structural planning will be relatively high due to its effectiveness in the built environment.

1. Introduction

Project planning is described as a set of actions focused on completing the work in a planned manner, such that it counts on a range of scenarios and techniques to realise the organisation's goal; it is among the early processes typically followed after the contracting process [1]. A project's success relies on some factors, particularly proper planning, which would be the project's backbone [2]. Construction planning is an essential facet of several specific units, like those concerned with scope, budgets, timeframe, collaboration, documentation, risks, etc. [3]. It has already been proposed that projects may be separated into phases for management. Stages of definition, planning, execution, and accomplishment; the term "project life cycle" covers all of these stages [4]. It is one of the most effective tools in managing projects, and conventional methods are planned for assignments employing different methods, such as Gantt charts, PERT charts, and critical paths [5].

Public works projects suffered from shortcomings in planning, particularly if adopting the traditional methodology. In terms of feasibility studies, it is a neglected and misused segment, in addition to confusion and ignorance for planning activities [6].in terms of

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design error, it is suffering from many issues, including; change order [7], delays [8], risk management, conflicts [9], scheduling, and risk management [10]. Despite the difficulties commonly faced when utilising conventional planning techniques, the building information modelling technology has emerged, which has enhanced several facets by providing a comprehensive view of the project and accurate and consistent facilities during the design and initiation phases, in addition to its numerous benefits for the project as a whole [11]. Some objectives should be achieved as follows;

- An analysis of BIM's relevance in construction planning.
- Identify the features of BIM in feasibility studies.
- Verification of the BIM framework in the design phase.

2. Research background

BIM technology is an essential tool in project management due to its effectiveness in managing design-phase issues saving construction costs and wasted time [12]. The facilities and above technology enabled a digital visualisation of the the modelling of the necessary engineering data involved in the project, which includes parameter function, material properties, tables, quantities, and specifications, which are all stored with the prototype (one model with details, documentation, and comprehensive data) to levels of transparency for stakeholders and at all stages of the project [13]. Implementing this method provides several advantages for project stakeholders (visualisation, analysis options, sustainability, verification of quantities, cost estimation, site selection, representation of the schedule in a 4D model, and maintenance) [14]. These studies provide an overview of this technique's purpose in construction planning. Then there are the following priorities:

2.1 BIM Related to feasibility analysis

Feasibility studies in building information modelling technology are very effective because of their many beneficial features towards green buildings and the manner to create them by offering more sustainable alternatives, supplying a schedule represented in a four-dimensional form, accessibility of comprehensive cost-benefit analysis, and other factors that make the work of the planning phase powerful, which that deal with purpose in the introduction of this study [15].

2.2 BIM Related to Design Stage

Building information modelling technology impacts the time and cost of a project by increasing the efficiency of the design phase, this fulfills the purpose of the BIM framework at the design stage and as its roles have been described by performing multiple tasks, as for effective risk management that includes a risk plan and training syllabuses for project team members, and achieving a risk-free schedule [16]. A current communications plan based on effective computer mediated communication (CMC), that enhanced collaboration between designers and stakeholders which will be improve efficiency of design stage [17]. In addition, have advanced the documentation system [18] , conflict detection [19] . In compared to conventional projects, BIM provides a better basis for decision - making, particularly in terms of design planning [20].

3. Methodology

The methodology for this research is based on administering questionnaires concerning the application of building information modelling technology to enhance the planning process in general. This clearly shows the use of a quantitative method which has statistically significant results about the target population sample by expressing it with statistical results about the personal views that individuals retain in order to test the theory by experiments conducted or surveys and evaluating the results mathematically [21]. Figure (1) describes how the questionnaire did the research.

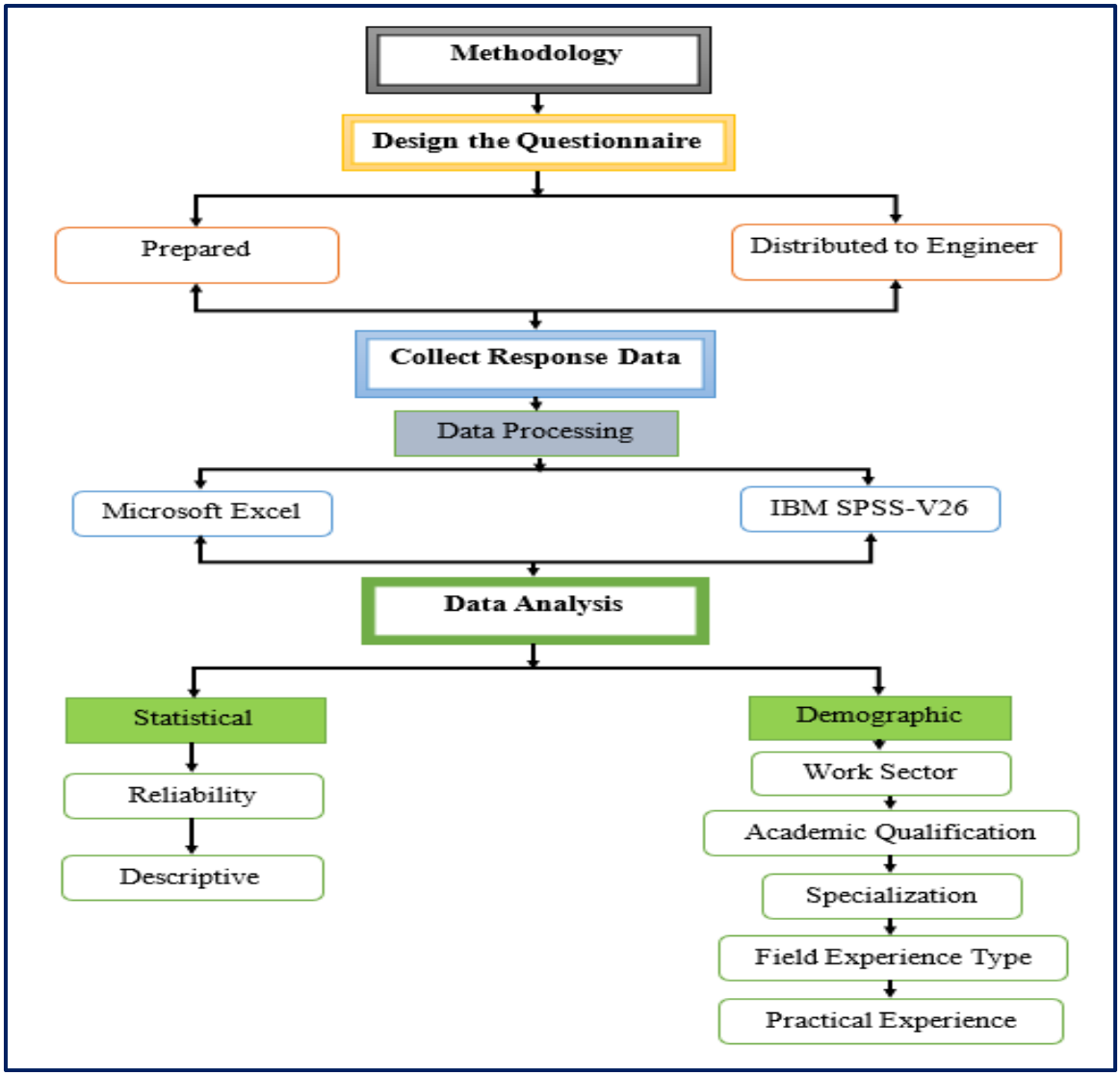

Figure 1. Explains the methodology of using questionnaire approaches

3.1 Design of the questionnaire

The questionnaire has been made in two sections, as follows:

3.1.1 Preparation

The descriptive method is employed, and the questionnaire has been designed as regards:

- Step one: personal information includes "(Gender, occupational sector, academic qualification, specialisation, career classification, and years of practical experience)".
- Step two: open-ended inquiries regarding the relative importance of (BIM) in the construction planning phase (12 questions) of the 5-Likert scale had been applied "(strongly agree, agree, neutral, disagree, and strongly disagree)".

The following are the questions:

1. BIM is regarded as the most effective technique in planning construction projects.
2. Specialists utilize BIM technology for planning small and large projects.
3. BIM is used to undertake feasibility studies at the project initiation to plan construction projects.
4. BIM helps the design stage by estimating costs.
5. BIM minimizes construction project conflicts.

6. BIM is superior to other techniques in the design stage.
7. BIM is superior to traditional methods of the stakeholder communication process.
8. BIM-based planning is more costly than traditional approaches.
9. BIM provides a documented database that can be accessed at any time.
10. Planners need to have experience in Bim.
11. BIM creates the environment to achieve sustainability in construction projects.
12. BIM supplies organizations and contractors with bills of quantities, documents, contracts, etc.

3.1.2 Distribution sample size and response rate

Questionnaires were distributed to specialists in construction planning only, and due to their limited number in this sector compared to specialists in other areas, a response of 70% of the target sample was obtained, which gives an acceptable percentage for the sample of the questionnaire.

3.2 Collect response data

the researcher used an electronic method of data collection tool. One of the most recent methods of distributing the questionnaire and receiving the reply is in the online environment. Afterward, the information was processed and converted to make it ready for analysis.

3.2.1 Data processing

After the survey responses are collected, data processing is a critical step. It is the procedure of transforming or modifying data into practical effects using a statistical tool and then arranging it in a way that answers the research question.

3.3 Data Analysis

The following two steps appearances the analysis of the questionnaire sample:

3.3.1Demographic Description

Figure (2) describes the occupational sector percentage of respondents; the public sector is equal to 90.5%, and the private sector is equal to 9.5.

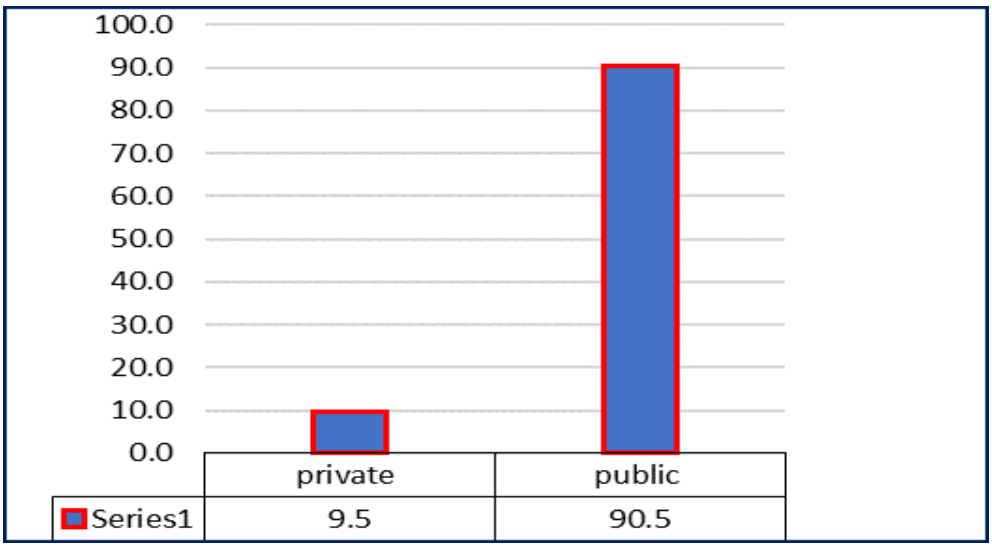

Figure 2. Occupational Sector

Figure (3) expressions the percentage of the educational levels of respondents, Bachelor is (71.4%), Master (19%), PhD (4.8%), and high diploma (4.8%)

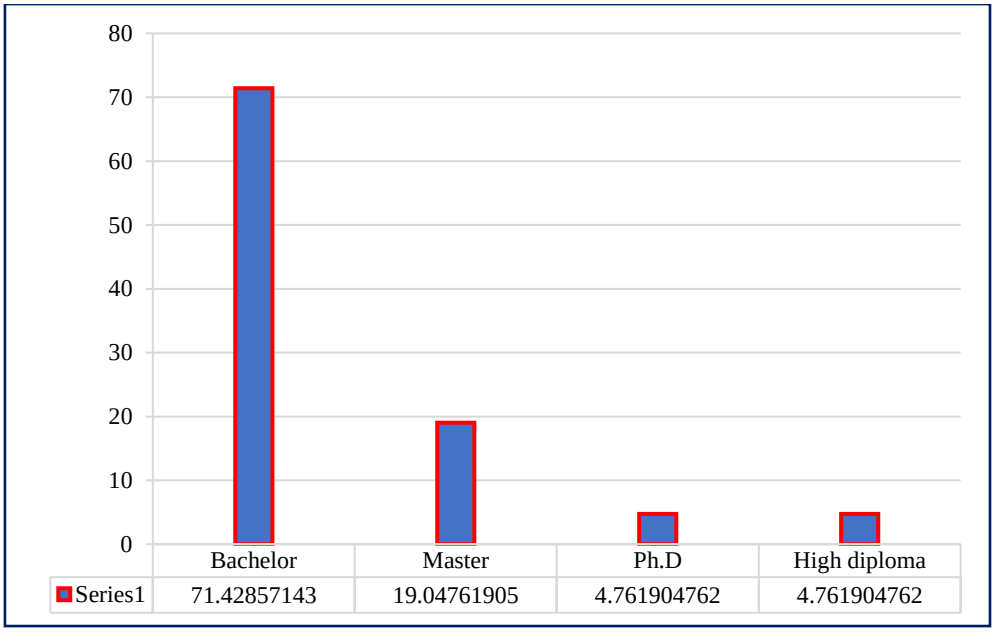

Figure 3. Educational Level

Figure (4) delicts of engineering specialisation; civil engineers (71.4 per cent), electrical engineers (4.8 per cent), and mechanical engineers (23.8 per cent).

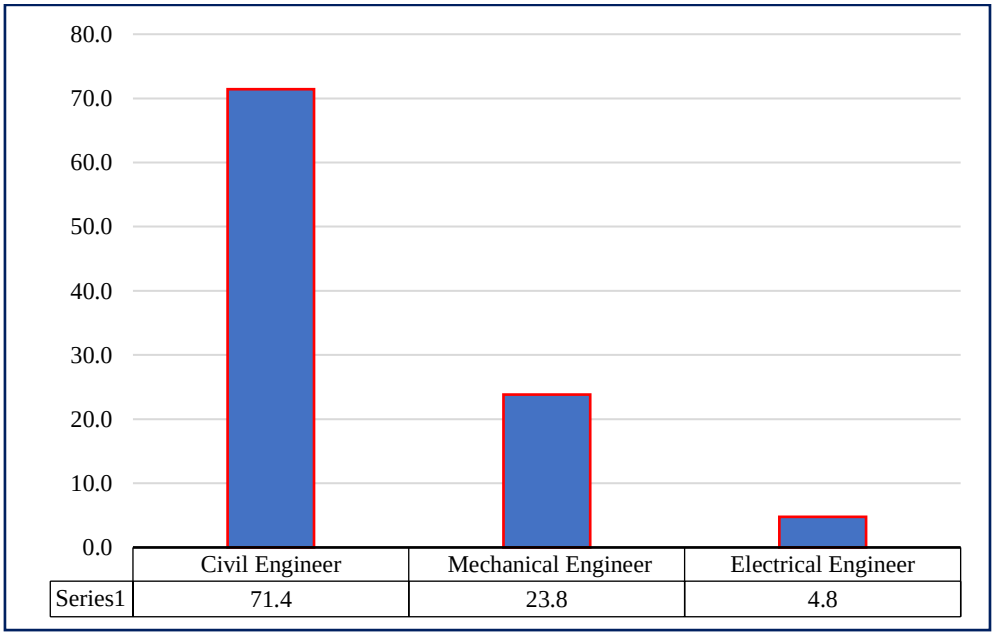

Figure 4. Academic Specialisation

Figure (5) shows the job title breakdown, with respondents having consultants at 23.8%, project managers at 4.8%, site engineers at 28.6%, and resident engineers at 42.9%.

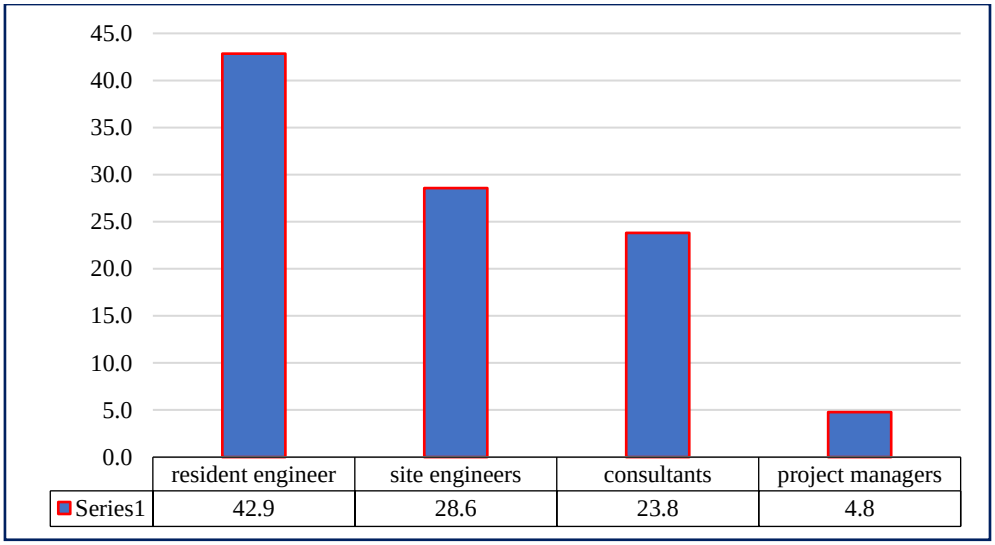

Figure 5. Job Title

Figure (6) depicts the respondents' years of field experience. The ratios are as regards: under five years (19%), 5-10 years (14.3%), 11-15 years (19%), 16-20 years (38.1%), and more than 20 years (9.5%).

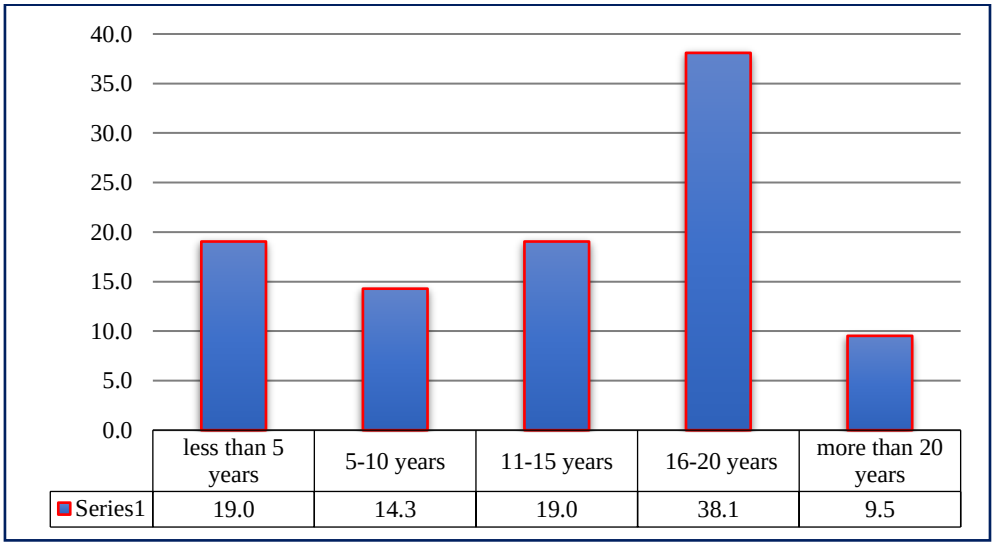

Figure 6. Years of field experiences

3.3.2 Statistical analysis

(IBM Spss-v26) used to statical analysis and conducted two steps as follows:

A-Reliability test

The (IBM-SPSS) programme was used to assess the reliability of the questionnaire provided by applying Cronbach's alpha coefficient on the performance of building information modelling during the construction planning stage.: reliability coefficient = 0.728. Hence, it is equal to 0.728 questionnaires and is stable and valid to achieve the study's objective. Table (1) explain reliability rank by range of alpha limited.

Table 1: explain the reliability rank [22]

Cronbach's Alpha	Reliability Rank
Above or equal to 0.9	Perfect
From 0.8 to 0.89	Valid
From 0.7 to 0.79	Feasible
From 0.6 to 0.69	Doubtful
Under 0.59	Weak Source

B-Descriptive test

While performing the 5-Likert scale questionnaire, the relative index (RI) was used as data analysis. Depending on conditions, the ranking index is defined accordingly, such as "importance index," "awareness index," "frequency index," and so on. The following equation conducts the Relative importance index (RII).

$$RII = \sum \frac{W}{A \times N} \quad \text{Eq. (1)} \quad [23]$$

Where W=weighting has designated each respondent on a scale of (one to five), one indicates the least weight, and five suggests the highest. The maximum weight (in our case, 5) is represented by (A), and the total number of samples is signified by (N).

$$RII = \frac{MEAN}{100} \times 20 \quad \textbf{Eq.(2)} \quad [24]$$

Where mean is represented, arithmetic mean. 20 equals by dividing a hundred on a 5-Likert scale. This equation has been used in SPSS software. The table (2) shows the importance level depend on RII amount.

Table 2: Show the importance level [24]

Mean	Importance Level	RII Amount
Definitely Disagree	Low	0 to 0.2
Disagree	Medium to Low	0.21 to 0.4
Neither/nor	Medium	0.41 to 0.6
Agree	Medium to High	0.61 to 0.8
Definitely Agree	High	0.81 to 1

4. Result and discussion

The relative index (RI) of role BIM in the construction planning process was used to evaluate (12) questions as shown in table (4), and the statistical analysis of the parameters the mean, the standard deviation, and weight of total means that shows in the table (3), This explains that BIM has a high level of agreement in construction planning and (4.0794) total weight means.

Table 3: Displays the total weight of mean variables

Questions		Strongly Agree	Agree	Neutrally	Disagree	Strongly Disagree	Mean	Std. Deviation
Q1	n	4	11	2	2	2	3.619	1.20317
	%	19	52.4	9.5	9.5	9.5		
Q2	n	1	14	2	2	2	3.4762	1.07792
	%	4.8	66.7	9.5	9.5	9.5		
Q3	n	7	10	0	3	1	3.9048	1.17918
	%	33.3	47.6	0	14.3	4.8		
Q4	n	9	11	1	0	0	4.381	0.58959
	%	42.9	52.4	4.8	0	0		
Q5	n	10	10	1	0	0	4.4286	0.59761
	%	47.6	47.6	4.8	0	0		
Q6	n	7	10	4	0	0	4.1429	0.72703
	%	33.3	47.6	19	0	0		
Q7	n	8	11	1	1	0	4.2381	0.76842
	%	38.1	52.4	4.8	4.8	0		
Q8	n	2	11	6	2	0	3.619	0.80475
	%	9.5	52.4	28.6	9.5	0		
Q9	n	8	12	0	1	0	4.2857	0.71714
	%	38.1	57.1	0	4.8	0		
Q10	n	8	13	0	0	0	4.381	0.49761
	%	38.1	61.9	0	0	0		
Q11	n	6	12	1	2	0	4.0476	0.86465
	%	28.6	57.1	4.8	9.5	0		
Q12	n	9	12	0	0	0	4.4286	0.50709
	%	42.9	57.1	0	0	0		
				Weight of total mean variables			4.0794	

Table 4: Expressions the rank of questions by RII-level

QUESTIONS	MEAN	RII	RII_LEVEL	RANK
5	4.43	0.89	H	1
12	4.43	0.89	H	1
4	4.38	0.88	H	2
10	4.38	0.88	H	2
9	4.29	0.86	H	3
7	4.24	0.85	H	4
6	4.14	0.83	H	5
11	4.05	0.81	H	6
3	3.9	0.78	H-M	7
1	3.62	0.72	H-M	8
8	3.62	0.72	H-M	8
2	3.48	0.7	H-M	9

The relative index analysis in Eq. (1 or 2) could provide ranking results for each parameter sentence (Q).

There would be eight questions. All of which were shown to have a "high" necessary level in BIM use in construction planning with an RII value between 0 and 1 based on these ranking results. As shown in table (4), the following four questions remained had already been (high-medium), which was a significant level of that.

The questions (5 and 12): (The use of BIM methods in scheduling construction projects reduces clash detection. BIM technology provides many facilities to the owner and contractor, such as bills of quantities, documents, contracts, etc.) It was ranked as the first top-rate in RII (0.89) and had a high rate. The second top rate, RII, was a question (4 and

10) (BIM is the best method for cost estimation and control in the planning stage. Planners need to have sufficient experience to deal with BIM technology) has a (0.88) rate, which is considered a high rate. A question (9, 7, 6, and 11) (BIM provides a data storage base that can be referenced at any time.) Coordination in BIM is more accessible than the traditional methods. The use of BIM in the design phase is the best of other software. BIM technology is the best way to obtain a sustainable economy. have (0.86, 0.85, 0.83, and 0.81) slanted gradually as third, fourth, fifth, and sixth) after the second-highest rate in RII. As a result, it has a high rate of importance. The last questions have a rating of (high-medium) in importance level, while the RII numbers have (0.78, 0.72, 0.72, 0.7) sequentially. (BIM is used to conduct feasibility studies in the initial stage of construction to plan construction projects. BIM is currently considered the best new technology in construction project planning in Iraq. Planning in BIM technology is considered more expensive than traditional methods, and BIM technology is used to plan small and large projects by planners.

5. Conclusion

The use of building information modelling technology helps in the improvement of building planning besides concentrating on the findings of this research, which was conducted using research methods that included designing, distributing, classifying, and evaluating the quantitative measure of the questions that focused on the convenient sampling in the construction industry's specialisation and experience. After analysing responses in a demographic description of data were examined by (Microsoft-v19) and mean and standard deviation variables, and (RII) for each item, which has been assessed and rated on (IBM - SPSS 26) statistical software. The average RII of basic questions ranged from (high-medium)-to-(high) to (agree-definitely agree). As a result, the proportion of participants agrees that using BIM technology has significantly enhanced the planning process, especially in cost management, time management, communications management, and other departments.

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