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# Diagnostic and Assessment Benefits and Barriers of BIM in Construction Project Management

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**Abstract**

This paper aims to diagnostic and assessment the benefits and barriers of Building Information Modelling in the construction project management. Both open and closed questionnaire was used to explore the views of a number of Iraqi engineers; in order to investigate the level of BIM implementation in Iraq construction sector. Questionnaire indicated an acceptable awareness of (BIM) in Iraq, especially among the young generation of engineers which indicates the arrival of the evolutionary stream of BIM in the next few years. Moreover, questionnaire showed that the most important advantage of implementing BIM in the Iraqi construction sector was the ability to generate accurate 2D plans at any stage, while the least important advantage was the ability to provide a careful planning of the site facilities, with a relative importance of (82 %) and (33 %) respectively. Furthermore, the most important barrier to its implementation was the unspecified responsibilities for data content, as presented by questionnaire, while the least important barrier was the lack of programs efficiency in data exchange and internal collaboration, with a relative importance of (81 %) and (34 %) respectively.

*Keywords:* Building Information Modelling; Questionnaire; Personal Interview; Barriers; Construction Project Management.

## 1. Introduction

Building Information Modelling, basically, is the process of fabricating the actual reality within the virtual reality by combining the design with a database based on introducing parameters to develop various significantly rich information to simulate each object's properties, creating extra dimensions to be represented; in order to reach the optimized solutions for different aspects of the building (such as building design, construction duration, construction cost, building sustainability, facility management, safety management and risk management) before initiating the actual construction. The idea of Building Information Modelling (BIM) and its use in construction industry has been conceptualized for less than thirty years. However, the development in this area was significant and included multiple applications in the construction sector, including but not limited to the highly accurate visualization of the model, the capability to produce accurate two dimensional plans extracted from the three dimensional models, time control, cost control and sustainability [1].

## 2. Research problem

Although building information modelling is widely adopted around the globe, yet it is a relatively new philosophy in the Middle East; as a result of the slow evolution in the construction industry. It is often argued that Iraq, as a developing country, is considered to be one of the slowest Middle Eastern states in adopting new technologies; thus, an

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idea was emerged to study the awareness amount for the Iraqi engineers about building information modelling in construction industry.

## 3. Research Objectives

The purpose of this study is investigation the impact of the application of Building Information Modelling in Iraqi construction sector. In order to achieve the aim of the study, following objectives have been identified, from the point of view of the Iraqi construction sector engineers:

a) Determine the knowledge amount in the building information modelling in the engineering Iraqi society, as well as

b) Assessment the benefits from applications of BIM

c) Diagnostic the barriers against implementation of BIM

## 4. Research Importance

This research provides a great benefit for researchers and academics in the field of scientific research, in addition to providing a great service for engineers and planners in the project management field, in addition to making the BIM as a part of the culture of the Iraqi engineer in everyday life. Also, this study can be provided to construction companies in Iraq as a guide in order to using it in project management

## 5. Research Methodology

After an extensive review for the literature about building information modelling, interviews with experts in the Iraqi architecture, engineering and construction (AEC) industry were conducted; in order to explain the culture of BIM in terms of a practical knowledge for the members of the Iraqi construction sector. Based on the interviews conducted, an electronic questionnaire was developed and created using the cloud computing technology, represented by the esurv website. The research methodology consists of four steps:

a) Theoretical study.

b) Preliminary meetings (Open questionnaire).

c) Design questionnaire form.

d) Result analysis.

### 5.1. Theoretical Study

Many authorities have defined building information modelling according to their own understanding or use of the term. For example the United States' National Building Information Modelling Standard (NBIMS, 2007), issued by the National Institute of Building Sciences, states that BIM is "a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward" [2].This definition is also used by the American Institute of Architects (AIA) in the "AIA, 2008"[3]. While the "Contractors' Guide to BIM", issued by the Associated General Contractors of America (AGC), defines BIM as "the development and use of a computer software model to simulate the construction and operation of a facility. The resulting model, a Building Information Model, is a data-rich, object-oriented, intelligent and parametric digital representation of the facility, from which views and data appropriate to various users' needs can be extracted and analysed to generate information that can be used to make decisions and improve the process of delivering the facility."[4]. Simultaneously, in the book entitled "Building Information Modelling (Planning and Managing Construction Projects with 4D CAD and Simulations)", Kymmell defines building information modelling as "a virtual representation of a building, potentially containing all the information required to construct the building, using computers and software. The term generally refers both to the model(s) representing the physical characteristics of the project and to all the information contained in and attached to components of these models. When BIM is used in a sentence, it will depend on the context whether it means building information model or building information modelling. A BIM may include any of or all the 2D, 3D, 4D (time element – scheduling), 5D (cost information), or nD (energy, sustainability, facilities management, etc., information) representations of a project."[5]

However, the (Eastman et al., 2011) [6] presented in the book entitled "BIM Handbook: A guide to building information modelling for owners, managers, designers, engineers, and contractors", which is considered to be the fundamental reference for understanding building information modelling, illustrates building information modelling as follows:

"We use BIM as a verb or an adjective phrase to describe tools, processes and technologies that are facilitated by digital, machine – readable documentation about a building, its performance, its planning, its construction and later its operation. Therefore BIM describes an activity, not an object. To describe the result of the modelling activity, we use the term "building information model," or more simply "building model" in full."[6]

In the researcher's opinion, Building Information Modelling, basically, is the process of fabricating the actual reality within the virtual reality by combining the design with a database based on introducing parameters to develop various significantly rich information to simulate each object's properties, creating extra dimensions to be represented; in order to reach the optimized solutions for different aspects of the building (such as building design, building sustainability, facility management, safety management and risk management) before initiating the actual construction.

### 5.2. Preliminary Meetings (Open Questionnaire).

A personal Preliminary meeting, also called as a face-to-face meeting, is a survey method that is used when a specific target population is involved. The purpose of conducting a personal interview survey is to explore the responses of the engineers to gather more and deeper information. The scientific method was prepared the questionnaire according (Al-Zwainy and Al-Marsomi, 2016)[7] and (Al-Zwainy et al,2016)[8], as following steps:

a) Five of Preliminary meetings conducted with engineers and programmers who have an experience in BIM, working in the ministry of Industrial and Minerals in Republic of Iraq.

b) Preliminary meetings began initially with eight questions. The questions were divided into two sections, section background of the interviewee; and other section about the application of BIM in Iraqi construction sector.

c) Personal qualification of the meetings involved in this research was compared as summarized in Table 1. It shows that one of the interviewees are given the position as head of department and two of them as project manager, All of them have more than five years working experience in the construction sector in Iraq.

**Table 1. Personal Qualification of Engineers Interviews**

| Name | Academic Qualification | Experience Year | Functional Position |
|---|---|---|---|
| Mr. A | Ph.D. | 20 | Head department |
| Mr. B | M.Sc. | 15 | Project Manager |
| Mr. C | M.Sc. | 12 | Project Manager |
| Mr. D | B.Sc | 7 | programmer |
| Mr. E | B.Sc | 5 | Resident Engineers |

### 5.3. Design of questionnaire form.

Questionnaire is one of the means of communication with experts and skilled specialists and engineers; to take advantage of their information available and relied upon in making the right decisions and accurate (Al-Zwainy et al., 2016) [9],(Al-Zwainy and Jaber, 2014) [10]. Questionnaires are a great way of collecting data, in this study questionnaire was prepared to collect data and information related with performance evaluation of construction residential complexes. The scientific method was prepared the questionnaire according (Al-Zwainy, 2009)[11], (Sarhan et al, 2012) [12] (Sarhan et al, 2013) [13], (Al-Zwainy and Neran, 2015)[14] and (Faiq et al, 2015) [15] and, as following steps:

1). Making the questionnaire form and establishing the lines of questions based on the information acquired from the literature review and personal meeting.

2). The success of a questionnaire process, which aims to collect and analyze information and facts, depends on the success of the sample selection, and because of the impracticality, even impossibility, of the participation of all engineers involved in all disciplines of the construction process; it has been decided that a sample of the population should be chosen. The targeted sample should be able to satisfy the objectives of the study; therefore, it was identified with certain characteristics:

a) The respondent should be an Iraqi citizen.

b) The respondent should be working inside Iraq.

c) The respondent should, at least, has a minimum knowledge in using computer and the World Wide Web.

3). Questionnaire distribution strategy and its justification: The regular method to investigate a population such as the participants in the architecture, engineering and construction (AEC) industry in a given geographical area is to distribute the paper based questionnaire in construction projects inside the investigated area; in order to contain the study sample. Although, it is believed that the aforementioned method will provide a reliable assumption on satisfying the first condition of the previously mentioned study sample’s characteristics; because it is safe to assume that most of the participants will be Iraqis, in addition to perfectly fulfilling the second condition; as a result of conducting the study inside Iraq, however, the issue of satisfying the third condition will be questionable; because it will be difficult to prove the computer skill capability. In order to overcome these obstacles and to satisfy the study sample’s characteristics; a strategy was developed and adopted. To begin with, two questions were added to the questionnaire which was inquiring about the nationality and the region of work of the respondent, in order to investigate the fulfilment of the first and second conditions respectively. It is believed that the answers to these two questions are strongly reliable, taking into consideration that the participants in the study did not have any previous knowledge concerning the study sample's characteristics. On the other hand, in order to achieve the last condition of the study sample's characteristics and because determining whether or not the respondents have the knowledge to use computers and the World Wide Web using a "question" will be indecisive; a different approach had to be developed. Being one of the easiest and most commonly used website not only among social networks but also on the internet as general, Facebook was used as a ground level for the capability to use the computer and the World Wide Web; because, nowadays, having an account on Facebook is considered to be taken for granted for anyone who has the simplest knowledge to browse the internet. Therefore, and based on that logic, everyone without a Facebook account will, automatically, be excluded. In addition to having a Facebook account, the participants had to have the capability to use Facebook adroitly, for example, the participants should have the ability to utilize the groups and the pages in Facebook. Therefore, an electronic questionnaire's link on esurv was published in many of the Iraqi engineering groups and pages on Facebook, with a post stating "the researcher would like your participation in this questionnaire". There were neither instructions on how to go from Facebook to the questionnaire's website nor instructions on how to take the questionnaire; in order to restrict the participation to those who had the ability to use the computer and the World Wide Web.

To sum up, the procedures used to satisfy the three study sample's characteristics were as illustrated in Table 2. below:

**Table 2. The study sample's characteristics and the procedures used to satisfy them**

| | The required condition | The procedure |
|---|---|---|
| 1 | The respondent should be an Iraqi citizen. | A question inquiring about the respondent nationality was added. |
| 2 | The respondent should be working inside Iraq. | A question inquiring about the respondent place of work was added. |
| 3 | The respondent should, at least, has a minimum knowledge in using computer and the World Wide Web. | 1. The respondent should have an account on Facebook.<br>2. The respondent should have the capability to navigate through the groups and pages of Facebook.<br>3. The respondent should have the capability to use a click – on link to navigate to a different website.<br>4. The respondent should have the capability to deal with the tick boxes in the questionnaire. |

4). Questionnaire's structure: After conducting the interviews with the experts in the Iraqi construction sector, taking into consideration that BIM is, in fact, a relatively new philosophy in the Middle East; the questionnaire was developed using, as much as possible, an understandable terms to the engineers; in order to overcome the differences in culture between building information modelling approach and the traditional approach. Before assuring the respondent's confidentiality, the study title and the college, on which behalf it is conducted, was identified. Followed by the first section of the questionnaire, which included general information about the respondent such as nationality, work location, academic certificate, engineering discipline, years of experience in the AEC – industry, nature of the working sector and the job description, while the second section concentrated on the relationship between the respondents and their firms on the one hand and building information modelling on the other hand. The third and the fourth sections were the most beneficial sections in the study; because instead of asking the respondents about their opinions in the applications of building information modelling; in the third section, they were asked for their opinions about the importance of the benefits that would be gained by utilizing the building information modelling applications, while in the fourth section the respondents were asked for their opinions about the importance of the barriers against the implementation of BIM.

## 5.4. Result analysis

The previously mentioned strategy, of publishing the questionnaire's link in Facebook, was significantly productive until Facebook was banned in Iraq due to political decisions, in addition to the unstable situation in the country, which led to a decrease in the participation in the questionnaire.

The total number of responses was (45), with two uncompleted forms and one respondent from Iraq but works in the United Arab Emirates, which disqualify these three forms from the study. So, out of the (45) responses, the percentage of participation was more (93 %), Table 3. illustrates a matrix of the respondents numbers classified in two dimensions; the engineering disciplines and the academic certificates of the respondents, while the numbers and percentages of each dimension's categories was illustrated in Figures 1 and 2. respectively.

**Table 3. Academic certificates and engineering disciplines matrix**

| | | Engineering disciplines | | | | Total |
|---|---|---|---|---|---|---|
| | | Civil | Architect | Mechanical | Electrical | |
| Academic certificates | Diploma | 0 | 0 | 0 | 0 | 0 |
| | B.Sc. | 25 | 5 | 0 | 1 | 31 |
| | M.Sc. | 4 | 2 | 0 | 1 | 7 |
| | Ph.D. | 2 | 0 | 1 | 1 | 4 |
| **Total** | | 31 | 7 | 1 | 3 | 42 |

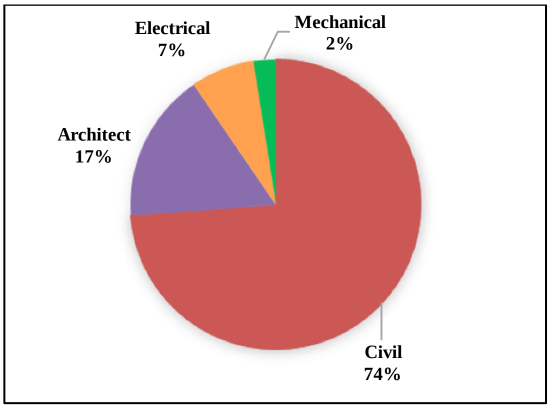


**Figure 1. Engineering disciplines**

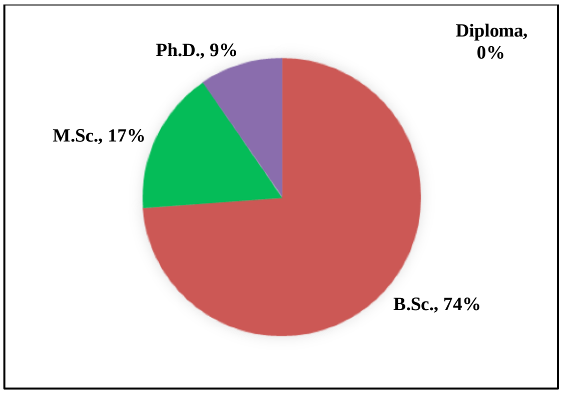


**Figure 2. Academic certificates**

The respondents working sector was classified into two categories, private sector and public sector, as illustrated in Figure 3, while their job descriptions is shown in Figure 4.

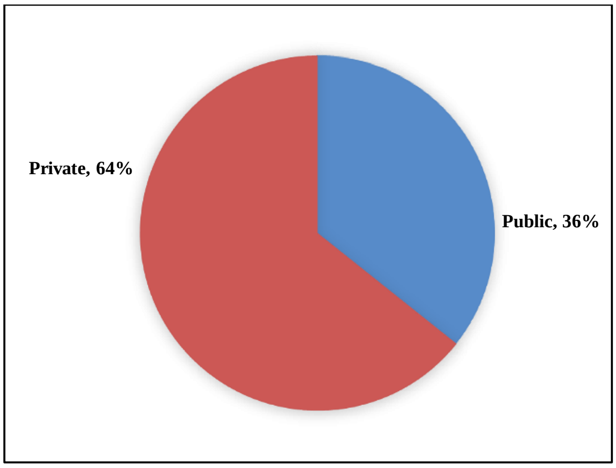


**Figure 3. Working sector**

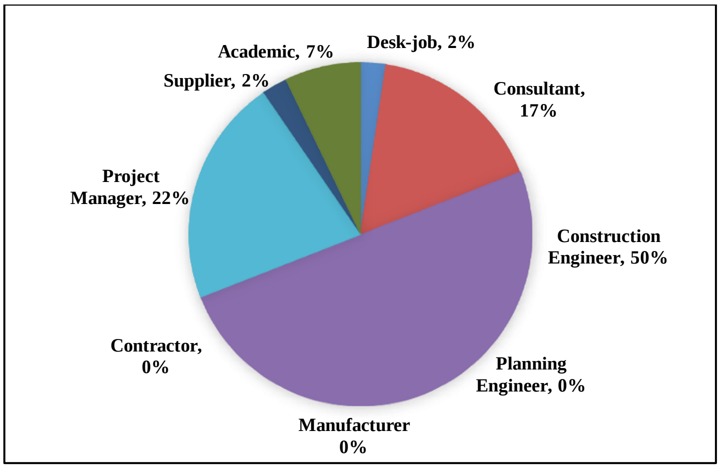


**Figure 4. Job description**

When asked to specify there years of experience in the construction sector, the respondents' answers varied from a minimum of two responses chose "more than 25 years" to a maximum of fifteen responses chose "0 – 5 years", as illustrated in Figure 5.

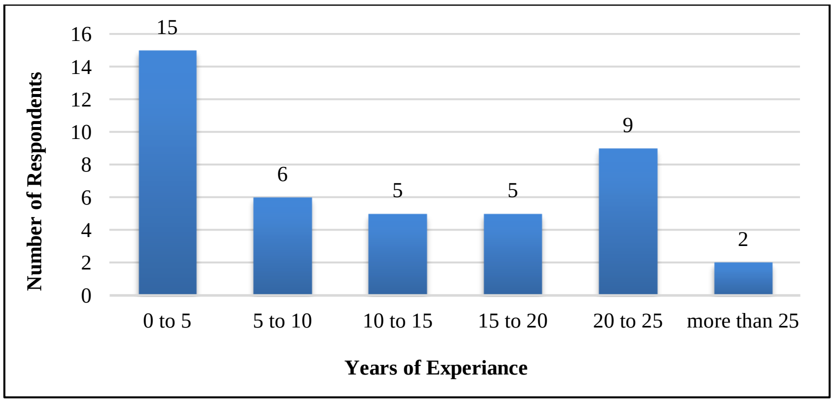


**Figure 5. Years of experience in the construction sector**

In general, the study articulated that while the personal knowledge in BIM is concentrated in less than (24 %) of the respondents, as indicated by the fact that ten out of forty two respondents have worked on two BIM projects at least, more than (54 %) of the respondents have never worked on a BIM project, which is considered to be a normal percentage; due to the novelty of the subject in the Middle East. However a significant percentage of more than (21 %) had just started to be involved in the new philosophy, which is indicated by the fact that nine out of the forty two respondents had worked on a single BIM project, as illustrated in Figure 6. The importance of the single – project category is that it represents a trend towards the new technology.

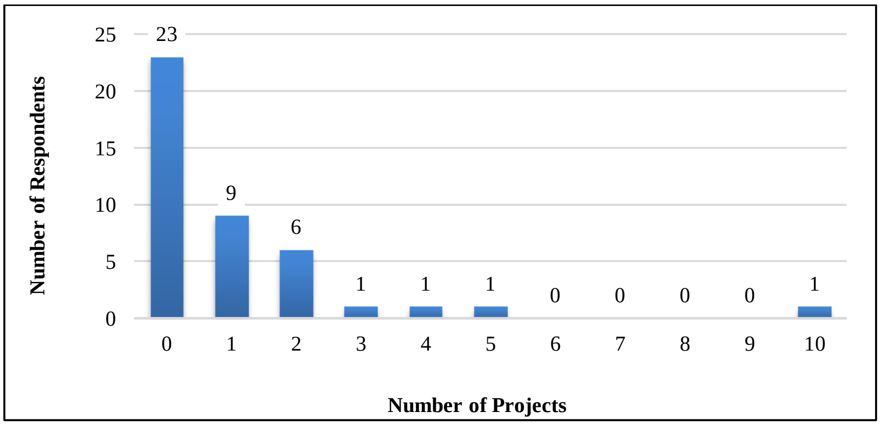


**Figure 6. Number of BIM projects worked on by the respondent**

However, when combining the respondents' years of experience in the construction sector, Figure 3-5, with the number of BIM projects worked on by each respondent, Figure 3- 6, although the twenty three participants, who have never worked on a BIM project, are distributed over the six categories of experience, as illustrated in Figure 3-7, which indicates a general case of BIM's knowledge lack, it is significantly important to notice that more than (44 %) of the respondents who had worked on a single BIM project are new engineers which indicates that an urge towards the new technology had emerged to the surface with the new generation of engineers.

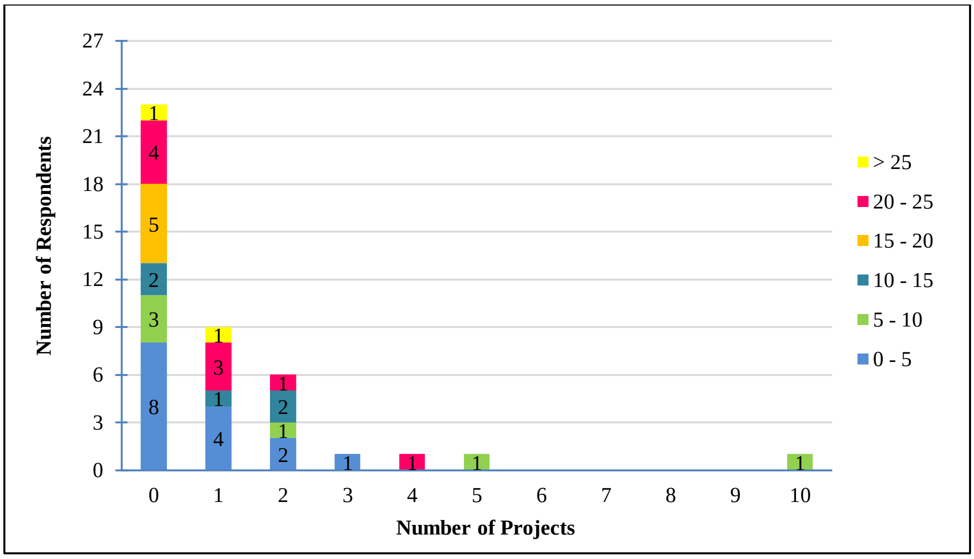


**Figure 7. Years of experience in the construction sector and the number of BIM projects worked on by each respondent**

Although the study sample was distributed over the six categories of experience in the construction sector, Figure 5. the experience in utilizing BIM is extremely undistributed, as presented in Figure 8. where more than (97 %) of the study sample has an experience of less than five years, a justified percentage by the immaturity of BIM in the Middle East.

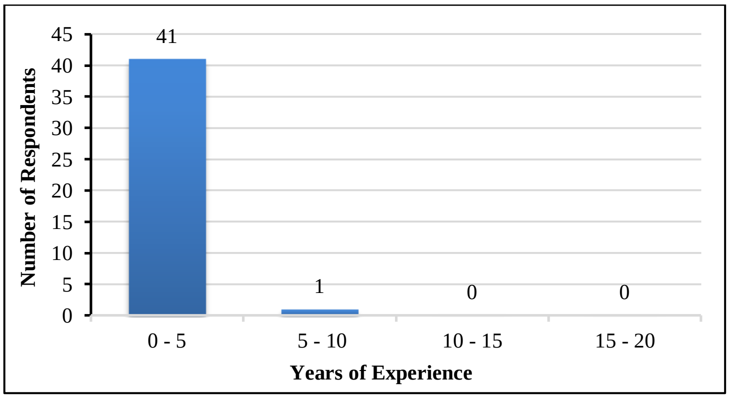


**Figure 8. Years of experience in BIM**

When asked about the number of the respondent's firm's projects in which BIM is used, Figure 9 a. one of the responses was (60 projects) which is an extreme value compared to the other obtained values. Therefore a histogram of intervals of two values was produced, instead of individual values, to minimize the gap with the (60 projects) answer. In order to examine the frequencies of each number of projects, the extremist value had to be excluded; in order to produce a new histogram, Figure 9 b. When categorizing the firms' projects according to the working sector of the firms, combining Figure 9 b. with Figure 3. as presented in Figure 10. the data shows a wide domination by the private sector, although a concentrated amount of projects in a single firm in the public sector, presented by the nine – projects answer. It is highly important to notice that while the general majority of the responses, with more than (58%), in the zero – project category is shared equally by the two sectors, the initiation percentage of utilizing BIM for the two sectors, presented by the ratio of the single – project category of each sector to the zero – project category to the same sector, is led by the private sector with more than (66 %) against a percentage of less than (9 %) to the public sector, indicating a trend in the private sector to start using the BIM technology.

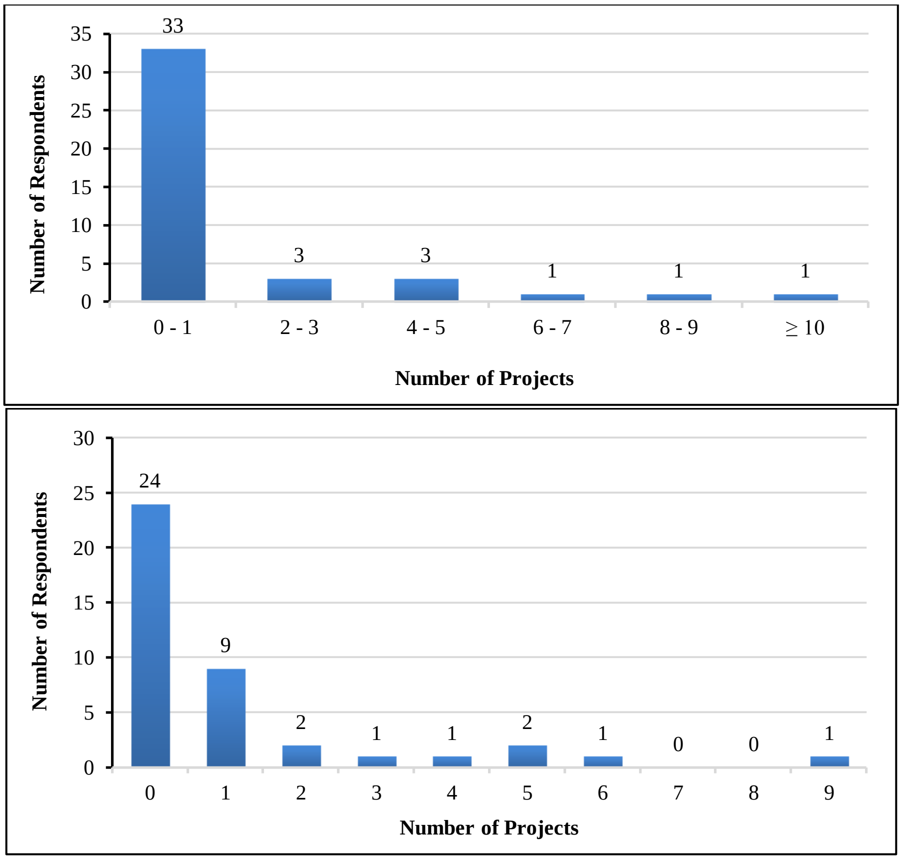


**Figure 9. (a) Number of firm's projects in which BIM is used (Including the extreme value) (b) Number of firm's projects in which BIM is used (Excluding the extreme value)**

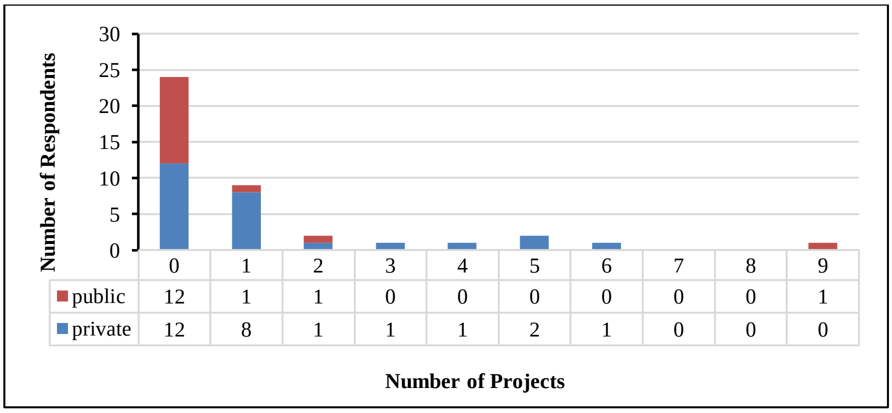


**Figure 10. Number of projects utilizing BIM in their firms and the working sector**

From their point of view, the respondents were asked to rate the general perception of BIM in their firms within five stages; no knowledge, low knowledge, medium knowledge, high knowledge and very high knowledge, as shown in Figure 11. While approximately (69 %) of the respondents believed that their firms does not have any knowledge of BIM, more than (26 %) thought that their firms have a low knowledge of BIM and less than (5 %) thought that their firms have a medium knowledge of BIM.

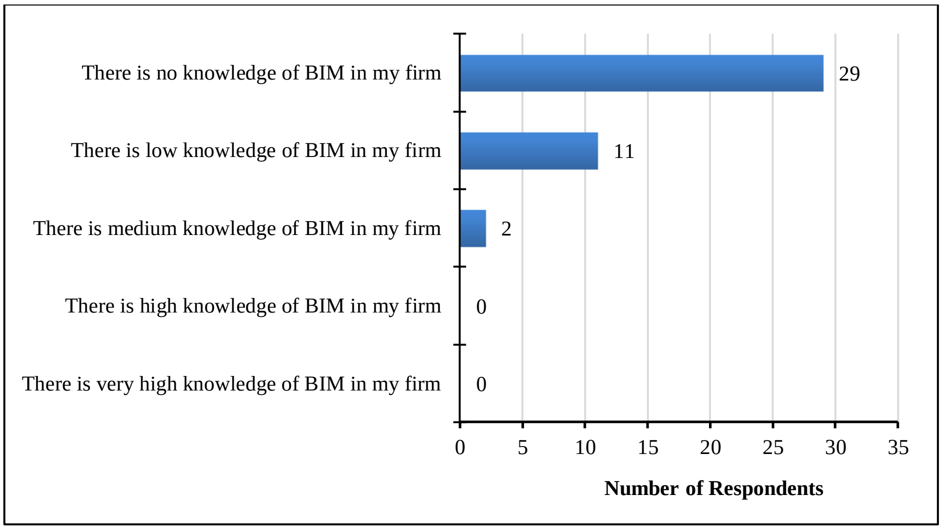


**Figure 11. General perception of BIM in the respondents' firms**

A list of building information modelling software was presented to the respondents to specify all the software they worked on, as illustrated in Figure 12. Although the list contained nineteen software, ten following software has not been selected:

1. Bentley Generative Components.
2. VICO.
3. Nemetschek Vectorworks
4. Innovaya.
5. Dassault Systems CATIA.
6. Bentley Structure.
7. Solibri Model Checker.
8. Synchro Project Constructor.
9. Bentley MEP.
10. Gehry Technologies Digital Project

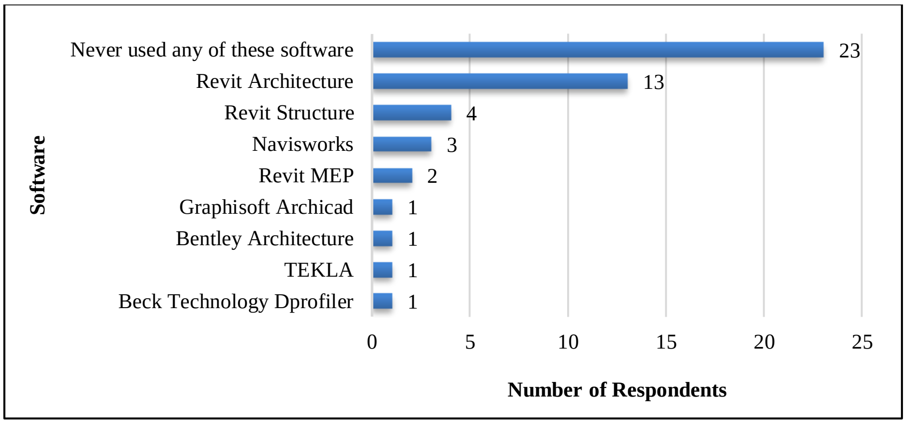


**Figure 12: BIM's software usage according to the respondents**

When the respondents were asked if their firms were involved in contracts with a requirement of using BIM, more than (92 %) answered with (No), as shown in Figure 13. Despite the fact that this percentage clearly indicates a significant lack of interest in building information modelling from the owners' side which may be attributed to their lack of knowledge in this regard, when applying these data to the number of projects utilizing BIM in the respondents firms and the working sector in Figure 10, excluding the zero – projects category and the sixty – projects answer, a self – motivated tendency towards BIM is significantly noticeable with a percentage of (100 %) of the respondents from the public sector's firms and more than (85 %) of the respondents from the private sector's firms harness the new technology without forcing it by the owner as a requirement, see Figures 14a and 14b.

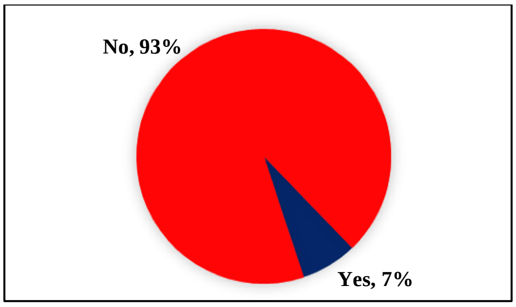


**Figure 13. Was your firm involved in contracts where using BIM is a requirement?**

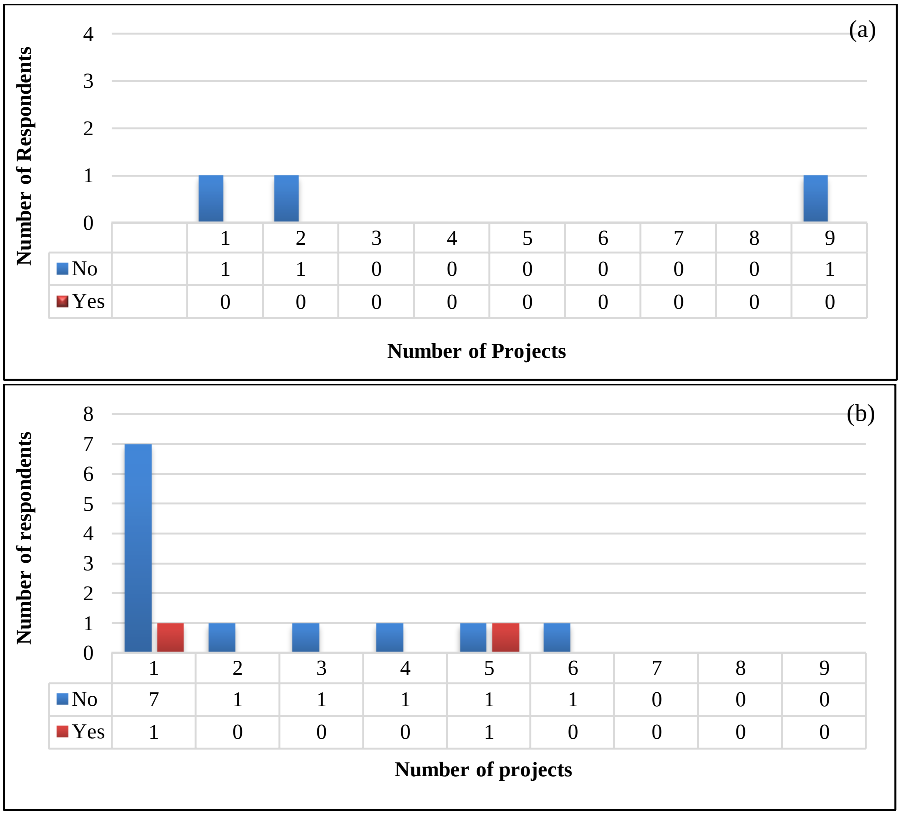


**Figure 14. (a) Public sector, (b) Private sector**

When asked about the advantages which led to the use of BIM in the participants' companies, the responses were scattered as illustrated in Figure 15. Despite the fact that more than (40 %) of the responses were "Did not use it", the highest two utilities were "Creativity and Development" and "Competition with other companies" with a percentage of less than (17 %) each. While the "3D design" achieved a percentage of more than (15 %), neither "Sustainability" nor "Improve performance" had reached the (4 %). Moreover, the most noticeable percentage was "Reducing the cost", which was expected to be low; due to the lack of knowledge in the subject of BIM, however the percentage of "Reducing the cost" did not even reach the expectations with a percentage of less than (2 %).

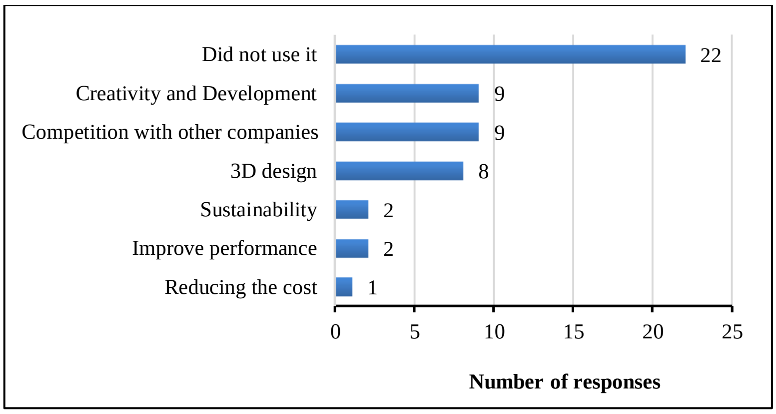


**Figure 15. Advantage led to the use of BIM in the respondents' firms**

The respondents were asked to choose the field of implementing BIM in their firms, Figure 16, however these "fields" were, in fact, levels of implementation and they were as follows:

1. Three dimensional designs.
2. Visualization and perspective.
3. Contract documents: plans, bills of quantities, schedules, etc.
4. Semi – usage: from the conceptual design to delivery.
5. Full – usage: from the conceptual design to the end of the useful life.

With a percentage of less than (33 %), the highest rate of responses chose "Did not use it". While the "3D design" and the "Perspective and Visualization" had a relatively high percentage of responses of more than (28 %) and (25 %) respectively, the "Contract document" could not reach (11 %). However, as expected, neither "Semi – usage" nor "Full – usage" were chosen by any of the responses.

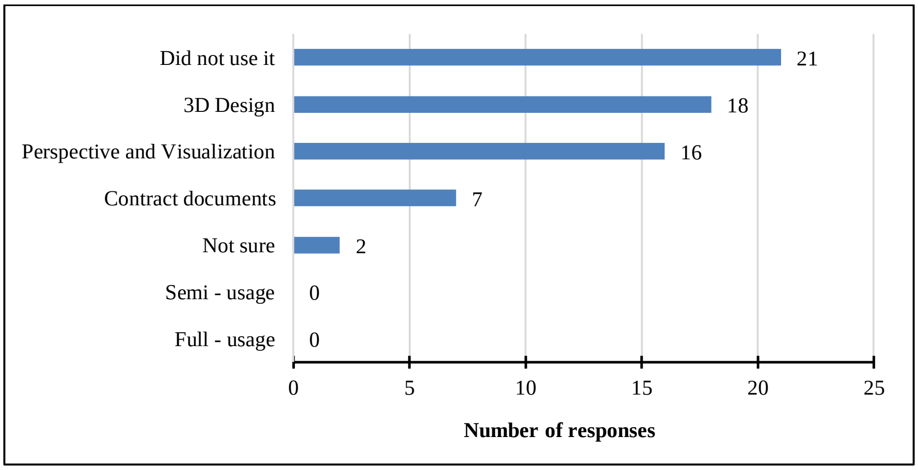


**Figure 16. BIM levels of implementation**

When neutralizing the parties involved in the AEC – industry, three major barriers emerge, which the respondents were asked to choose from, as illustrated in Figure 17. The responses gave the lead to "Not required by owner" with exactly half the responses leaving the "lack of experts in this field" with less than (40 %) while the "Cost" had just exceeded (10 %).

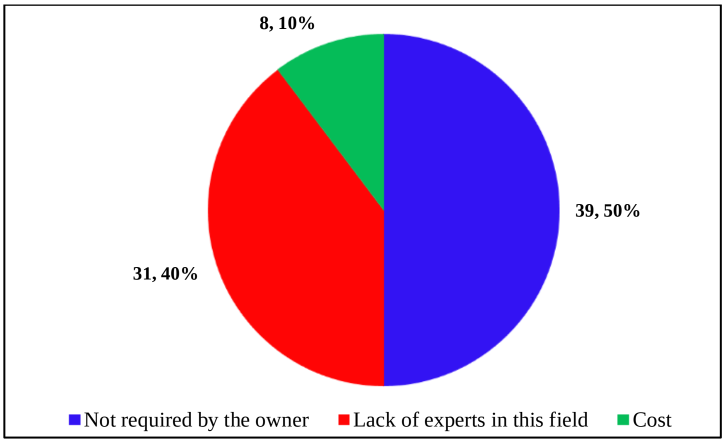


**Figure 17. Barriers of using BIM**

However, when the participants were presented with a set of barriers preventing the implementation of BIM and asked to select whatever choice (or choices) that could relate to their companies, the responses were distributed between the seven choices as illustrated in Figure 18. With a percentages of more than (21 %) and more than (18 %) of the responses, the "Difficulties in communicating with users of traditional methods" and "The difficulty of merging with the construction sector", respectively, had taken the lead pointing out traditional problems severed from wherever BIM is implemented. The necessity of a proper training was obvious with the percentage of more than (16 %) achieved by "Absence of training programs".

Moreover, it is significantly noticeable that "The used software" was the lowest barrier with a percentage of less than (6 %), while it is considered to be one of the biggest barriers facing the small companies as well as the large companies around the globe in implementing BIM; this might be attributed to the power of the black market in Iraq.

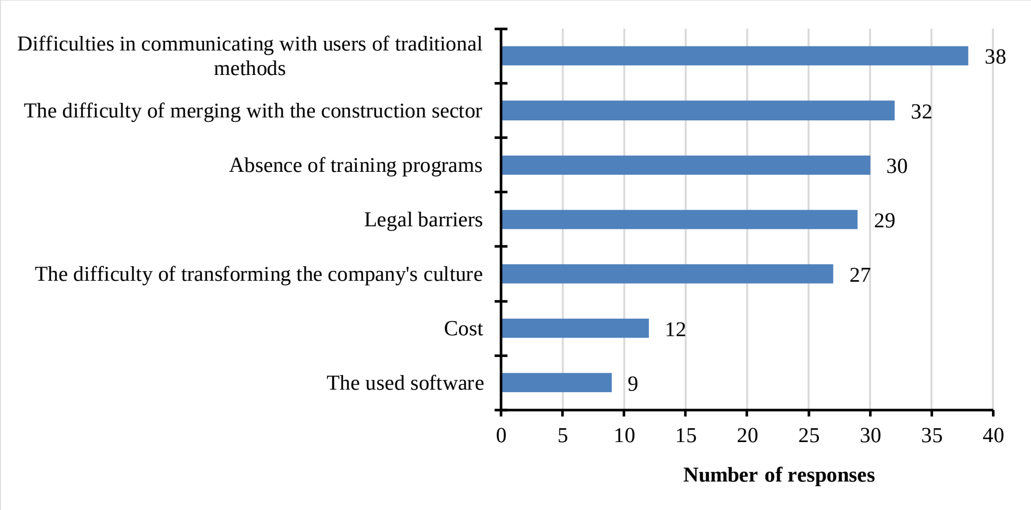


**Figure 18. Barriers preventing the implementation of BIM**

In order to study the importance of BIM advantages and barriers; a list of each was presented to the respondents to evaluate each item in a five – grades system, which were already weighed in a scale of zero to one hundred, as shown in Table 4, then the relative importance of each item was calculated using the equation:

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

Where:
R.I = Relative importance of item (i).
$X_i$ = Grading range's average of item (i), see Table 4.
$F_i$ = Frequency of responses in item (i).
N = Number of respondents.

**Table 4. Five – grade system**

| i | Grade | Range | | Xi |
|---|---|---|---|---|
| | | 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 |

Instead of listing the benefits of building information modelling and asking the respondents to grade them in a BIM point of view; the effects of implementing BIM in the construction sector are presented to the respondents and they were asked to evaluate them according to their own engineering sense, experience and perspective. The relative importance of each item, as calculated from the responses, is illustrated in Table 5.

From Table 5, it is clear that “Generate accurate 2D plans at any stage” and “Early accurate visualization” are relatively the two most important benefits of BIM with a relative importance of more than (81 %) and (80 %) respectively. The fact that these two benefits are, approximately, in the same importance level among different circles of engineers around the globe, indicates that the Iraqi construction sector has the same trend towards the new technology.

However, while many BIM circles consider the ability to detect clashes in the design as well as improving the estimator’s productivity in quantity surveying highly valuable benefits in BIM, both items scored relatively low importance according to this questionnaire with a percentage of more than (75 %) and (69 %); which might be attributed to the lack of knowledge in the subject.

**Table 5. Relative importance of BIM benefits**

| i | The benefits | R. I. % | Grade |
|---|---|---|---|
| 1 | Generate accurate 2D plans at any stage | 81.9 | Very important |
| 2 | Early accurate visualization | 80.48 | Very important |
| 3 | Improve the cost estimate in all phases of the project | 76.67 | Important |
| 4 | Reducing change orders | 75.24 | Important |
| 5 | Improve the clash detection | 75.24 | Important |
| 6 | Reduce correction problems in design | 74.76 | Important |
| 7 | Reducing the total cost of the project | 74.29 | Important |
| 8 | Improving the quality of design | 71.9 | Important |
| 9 | Increased productivity due to accelerating the process of obtaining the information | 71.9 | Important |
| 10 | Speed up the delivery of projects | 71.43 | Important |
| 11 | Reduce the overall duration of the project | 71.43 | Important |
| 12 | Improve estimator's productivity in quantity surveying | 69.05 | Important |
| 13 | Improve the predictive ability of the project end date and cost | 68.1 | Important |
| 14 | Reduce losses | 65.71 | Important |
| 15 | Facilitate quantitative survey | 61.9 | Important |
| 16 | Efficiency of the re-use of data | 56.67 | Average importance |
| 17 | Improving coordination between the teams during the construction phase | 52.38 | Average importance |
| 18 | Creation of timelines | 50.95 | Average importance |
| 19 | Reducing the cost of occupational safety problems | 50 | Average importance |
| 20 | Improve communication and interaction between success partners | 47.14 | Average importance |
| 21 | Improving the status of occupational safety | 46.19 | Average importance |
| 22 | Energy consumption analysis | 43.81 | Average importance |
| 23 | Enhance the efficiency and sustainability of energy in construction | 43.33 | Average importance |
| 24 | Improve Document Management Division | 43.33 | Average importance |
| 25 | Improve human resources management and the distribution of staff | 43.33 | Average importance |
| 26 | Improve maintenance scheduling | 39.52 | Little important |
| 27 | Improve the management of security and occupational safety information | 37.62 | Little important |
| 28 | Improve site analysis | 35.71 | Little important |
| 29 | Careful planning of the site facilities | 32.86 | Little important |

As in the benefits, the barriers of implementing BIM were also listed and presented to the respondents in order to evaluate their seriousness according to the respondents' experience and perspective. The relative importance of each item, as calculated from the responses, is illustrated in Table 6.

The most important barrier, as shown in Table 6. is the "Unspecified responsibilities for data content" with a relative importance of more than (80 %), which can be related to the legal barriers in Figure 18. This indicates that there is a necessity to provide legal insurance in various aspects of amalgamating BIM with the construction sector. Furthermore, it is significantly noticeable that instead of the usual technical barriers, the highest four barriers are thoroughly related to the administration of the firm.

**Table 6. Relative importance of BIM barriers**

| i | The barriers | R.I.% | Grade |
|---|---|---|---|
| 1 | Unspecified responsibilities for data content | 80.48 | Very important |
| 2 | The need to define the role of "BIM director" in projects | 78.57 | Important |
| 3 | Restructuring the company to absorb BIM philosophy | 75.24 | Important |
| 4 | The need for standard specifications | 72.38 | Important |
| 5 | Lack of knowledge of BIM benefits to the firm | 71.9 | Important |
| 6 | Restrictions set by the employer \ eg because of the ignorance of BIM benefits | 71.43 | Important |
| 7 | The need to formulate contracts customized for BIM | 69.52 | Important |
| 8 | The lack of efficient contractual documents | 69.52 | Important |
| 9 | Restrictions set by the employer because of the high cost | 69.05 | Important |
| 10 | Lack of skilled staff in BIM | 68.57 | Important |
| 11 | Change the company culture towards full collaborative work | 68.1 | Important |
| 12 | Lack of clarity in authorities distribution | 67.62 | Important |
| 13 | Lack of training on BIM | 64.29 | Important |
| 14 | The cost of hiring additional staff | 61.43 | Important |
| 15 | The difficulty of learning | 56.67 | Average importance |
| 16 | Time spent in the application of BIM | 55.71 | Average importance |
| 17 | Refusal of staff (or unwillingness) For learning | 55.24 | Average importance |
| 18 | Modelling cost | 55.24 | Average importance |

| | | | |
|---|---|---|---|
| 19 | Time required to produce the model | 55.24 | Average importance |
| 20 | The cost of training current staff | 54.76 | Average importance |
| 21 | Time required to train the current staff | 52.38 | Average importance |
| 22 | The need to produce digital models of commercial products | 44.76 | Average importance |
| 23 | The inadequacy of some projects for the application of BIM | 44.76 | Average importance |
| 24 | The cost of new software and updates | 43.33 | Average importance |
| 25 | The need for compatibility in the digital data of the design | 42.38 | Average importance |
| 26 | Insufficient information available to the supply chain | 41.9 | Average importance |
| 27 | Unauthorized re-use of intellectual property | 34.76 | Little important |
| 28 | Lack of programs efficiency in data exchange and internal collaboration | 34.29 | Little important |

## 6. Conclusion

After presenting the results to international experts in the subject of building information modeling from the United States of America, the United Kingdom, Canada, the Russian Federation, the Republic of India and the People's Republic of China, through Facebook groups, many of them concurred that although these results are not representative to the BIM level in the Middle East, they are extremely acceptable for a slow developing country such as Iraq. Which indicates the underdevelopment of Iraq compared to other Middle Eastern countries? However, the results also showed a tendency towards the new technology among the young generation of engineers which indicates the arrival of the evolutionary stream of BIM in the next few years. This stream cannot exceed the individual aspect as long as there is lack of stability in the society. Furthermore, in order for the Iraqi construction sector to adopt the BIM technology, it is highly recommended to establish a committee to execute a vertical study to all the barriers in addition to a detailed feasibility study to the entire amalgamation.

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