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RESEARCH PAPER

Challenges Facing the Implementation of Building Information Modeling (BIM) Techniques in Iraq.

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A B S T R A C T:

Building Information Modeling (BIM) technology is a modern technology in the construction industry that has seen widespread and implementation in construction projects around the world in recent years. Developing countries trying to follow up on the newly developed methods and technologies in terms of the architecture, engineering and construction (AEC) industry. Iraq is one of these countries that depends on the traditional methods for design and managing construction projects. This paper aims to review and analyze the most important constraints and challenges (barriers) that stand against the implementation of BIM technology in the AEC industry of Iraq. This paper is part of an ongoing master thesis that in dedicated to the application of BIM technology in the Iraqi AEC industry. A comprehensive literature review has been made beside a face-to-face interview with specialists in the AEC industry along with a questionnaire survey directed to the specialists involved in the process of building and construction and some expert academic parties. The reliability has been approved statically, and the analysis showed that the most influential barriers are lack of demand, lack of authority's support, absence of a national standard for BIM, lack of experts, and the social and habitual resistance to change. The results gained were discussed and compared to the previous studies. More effort must be taken by authorities to overcome these barriers to improve the AEC industry and to take BIM techniques into implementation in Iraq.

KEY WORDS: BIM Barriers, building information modeling, construction project, Iraq.
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1.INTRODUCTION:

For the last two decades, the Iraqi construction industry is known for being at the end of the track in terms of the management and modern techniques in the architecture, engineering and construction (AEC) industry. This is due to several factors which take time to discuss, in addition to the circumstances experienced by Iraq, the most important factor is the lack of professionals and experts in terms of modern technologies. It is worth mentioning that the process of construction and project management in Iraq is still done in the old traditional method which depending on two-dimensional drawings, paper documents, and hand calculations especially in preparing bill of quantity (BOQ) and cost estimations besides the total absence of using software tools (rare use) in this term, as well as the process of collaboration and communication, is very weak between the project's stakeholders. These old methods can no longer accommodate large, modern megaprojects, as they have proved low efficiency in dealing with complex buildings and overlapped events (Penttilä, 2006). Therefore, the method of implementing and managing Iraqi

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architecture, engineering and construction (AEC) industry should be developed through the adoption and the use of modern techniques that can reduce problems and mistakes, and risks in the AEC industry, like reducing time and cost overrun, improve the quality, reducing wastes in materials, etc. Mahdi and Ali (2019) as well as Wali and Othman (2019) highly recommended the use of advanced technologies such as BIM technique to reduce problems like reducing wastage of construction materials and reducing risks in the Iraqi AEC industry. it can be said that the most important and advanced technology is the building information modeling (BIM) techniques. BIM technique has proven high efficiency in providing solutions to most of the AEC industry's problems. It must be mentioned that Iraq is the only Middle Eastern country that did not take BIM technique into consideration yet (Egyptian, 2017).

In the BIM handbook, Eastman et al. (2011) describe BIM as one of the most promising developments in the architecture, engineering, and construction (AEC) industries; as beginning to change the way buildings look, the way they operate and the way they are built. Also mentioned that BIM is not only software but a human activity that basically involves broad changes in the construction process. Eastman continued that BIM is a computer-aided technology used for generating and modeling building information, as well as the related processes of procurements, production, communicating and collaboration.

Due to the approved benefits, sustainability and the solutions provided by BIM techniques around the globe, it is important to take serious steps to adopted this technique in the country. This paper is part the ongoing master thesis that is dedicated to the application of BIM technology in the Iraqi AEC industry, and it aims to review, study and analyze the most effective constraints and challenges (barriers) that stand against the implementation of technology in the AEC industry of Iraq.

2. LITERATURE REVIEW

There are many issues facing building information modeling (BIM) implementing, and there are many challenges and opportunities for architectural, engineering and construction (AEC) industry exists in the term of (BIM). Apparently, some of these issues have been solved over time by the advancement of related technologies; yet, various problems are arising when dealing with the implementation of BIM. In his research, Chan et al. (2019) aimed to identify and evaluate the possible benefits of and barriers to the implementation of BIM in the construction industry of Hong Kong. The significant barriers were related to habitual resistance to change by AEC stakeholders, lack of organizational support, and lack of BIM standards. On the other hand, Ullah et al. (2019) from Estonia presented a paper as part of doctoral research that aims to define the barriers to the adoption of BIM and to develop a framework for effective implementation of this technique. Lack of awareness about BIM benefits, Lack of BIM experts, Lack of demand on BIM were the highest barriers determined. One of their objectives, Hasan and Rasheed (2019), was to investigate the challenges facing 5D-BIM implementation. The main barriers that facing BIM were culture resistance to change, believing that current software and the traditional methods are fare enough and no need for new technologies.

In his research, Sardroud et al. (2018a), studied the barriers facing (BIM) implementation in the construction industry. The researcher aimed in his study to summarize the available information related to (BIM) application in the construction industry and to focus on the most repetitive challenges and barriers. The most critical challenges facing the implementation of this technology found in this study were the contract and legal barriers, management system, cultural problems, and economic and security issues. On the other hand, Hatem et al. (2018) adopted a quantitative approach by conducting a questionnaire directed to professionals to investigate BIM barriers. Their results showed the weakness of the government's efforts, shortage of specialists in (BIM) field, resistance to change and Poor knowledge about the benefits of (BIM) are the highest potential barriers of using (BIM).

In his study, Ahmed (2018) from Bangladesh aimed to identify the most crucial barriers to the implementation of Building Information Modeling (BIM) and to develop a relative rank with their relative impact on these issues. The results of this

study showed that the five most crucial barriers to the implementation of BIM are social and habitual resistance to change, Traditional methods of contracting, Training expenses, High cost of software purchasing, Lack of awareness about (BIM). The researcher highlighted the importance of government support to adopt this technology.

Both (2012) from Germany studied the potentials and the barriers for Implementing (BIM) in the AEC industry. He aimed to analyze the existence of (BIM) practices and the difficulties facing its implementation in his country. The researcher determined the potentials, barriers, and constraints of the application of (BIM) in the different processes as well as the target groups. The Assessment showed that the highest barriers facing BIM were technological, educational, economic, and normative barriers. The conspicuous differences in the assessment of the BIM barriers between BIM-users and Non-BIM users show the high necessity of education and information by AEC associations and chambers.

3. QUESTIONNAIRE FORMING AND DESIGN

Through the process of reviewing previous researches and studies, it is likely to find a large number of obstacles to the application of BIM technique. These obstacles differ from one author to another, from one country to another as time progresses, but the main factor in their diversity and multiplicity is the degree of development of the construction industry in each country.

Thus, to achieve the objectives of this paper, a questionnaire form will be adopted as the main source of data. Eleven important barriers have been selected in this research. The selection was made through a deep comprehensive literature review, published articles, and other resources, as well as face-to-face interviews with engineers, experts involved in the process of building and construction and some expert academic parties. Table 1 below shows the selected BIM barriers according to previous researchers.

Regarding the design of the questionnaire, all information that could help in achieving the study objectives was collected, reviewed and formalized to be appropriate for the survey study. The first part of the questionnaire inquires the respondent's general information like experience, knowledge, and positions in the AEC industry. While the second part, which is the core of the survey, investigates the impact of each of the selected barriers on BIM implementation in Iraq. The importance of these barriers depends on the three points scale, where (3 = high), (2 = moderate) and (1 = low). After collecting of data, they will be analyzed using the statistical packaging for social science (SPSS) software version 25 Microsoft Excel.

The questionnaire was distributed personally and by email to 75 members of the top and middle management in different construction companies, and different other specialists in the field of the construction industry. Only 63 valid questionnaires were received and analyzed with a response ratio of 84%.

Table (1) The selected BIM barriers according to previous researchers.

	References	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
1	(Chan et al., 2019)	*	*	*				*		*	*	*
2	(Hamada et al., 2016)	*	*								*	*
3	(Hamada et al., 2016a)		*	*	*	*	*		*		*	*
4	(AWAD, 2017)			*		*		*		*		*
5	(Babatunde et al., 2019)		*	*			*	*		*	*	*
6	(Banawi, 2017)			*			*	*	*			
7	(Sardroud et al., 2018)		*	*	*	*		*	*	*		
8	(Saleh, 2015)	*	*	*	*	*	*	*			*	*
9	(Kiani et al., 2015)	*	*			*					*	*
10	(Hosseini et al., 2015)		*	*			*			*	*	*
11	(ALHUMAYN et al., 2017)	*				*			*	*	*	*
12	(BEKR, 2017)	*	*						*	*	*	
13	(Shaban and Elhendawi, 2018)			*	*	*			*	*	*	
14	(Beitelmal et al., 2017)				*		*		*	*	*	
15	(Al-Zwainy et al., 2017)		*	*	*	*		*	*		*	
16	(Matarneh and Hamed, 2017)		*	*	*	*	*			*		*
17	(Yan and Demian, 2008)	*	*	*	*	*						
18	(Newton and Chileshe, 2011)			*	*	*						
19	(Kassem et al., 2012)	*	*	*		*		*			*	
20	(Ku et al., 2011)					*		*	*	*	*	
21	(Kjartansdóttir, 2011)	*		*	*	*						*
22	(Hamidimonazam et al., 2016)	*	*			*			*			*
23	(Thurairajah and Goucher, 2013)			*	*	*	*			*	*	
24	(Ahmed et al., 2014)		*	*	*	*	*		*	*	*	
25	(Kushwaha, 2016)			*		*	*				*	*
26	(Crowley, 2013)			*			*			*		*
27	(Abubakar et al., 2014)		*	*	*	*	*	*	*		*	
28	(Liu et al., 2015)				*	*	*				*	*
29	(Hosseini et al., 2016)	*		*				*		*	*	*
30	(Hamidimonazam et al., 2016)	*	*				*			*		*
	Frequency	**12**	**17**	**21**	**14**	**20**	**14**	**11**	**12**	**17**	**20**	**17**

***B1**: Believing the current used technology is enough. **B2**: People refuse to learn / Social and habitual resistance to change. **B3**: The high cost of training for BIM software. **B4**; The cost of hiring BIM specialists and additional staff. **B5**: The cost of BIM software and the cost of its updates. **B6**: Lack of support / Lack of BIM related investments. **B7**: Uncertainty of the benefits of BIM implementation. **B8**: Traditional methods of contracting (BIM need special contracting conditions). **B9**: Absence or incomplete national standard for BIM. **B10**: Lack of BIM experts. **B11**: Lack of demand from customers or other companies for projects implemented using BIM technologies.*

4. STATISTICAL RELIABILITY

One of the basic requirements in any research paper is maintaining accurate measurements and acceptable results. So, a pilot survey was conducted to check the validity and reliability of the questionnaire form. the researcher performed internal consistency measuring and used Cronbach's alpha as it is one of the most important common methods for testing reliability (Yockey, 2017). the results of internal consistency giving the values of the Spearman's rho correlation and p-values are shown in Table 2. It shows that p-values were less than 0.05 which means that all the items are consistent and valid.

Table (2) Questionnaire's Internal Consistency.

Factor	Correlation Coefficient	P-Value
B1	.650**	0.00
B2	.749**	0.00
B3	.700**	0.00
B4	.731**	0.00
B5	.703**	0.00
B6	.822**	0.00
B7	.722**	0.00
B8	.587**	0.01
B9	.773**	0.00
B10	.777**	0.00
B11	.738**	0.00

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Table 3 shows the classifications of reliability according to Cronbach's alpha value. By conducting these methods to test the questionnaire reliability, the result gained by using SPSS 25 showed that the value of Cronbach's alpha is on the good scale, as shown in Table 4 and Table 5 below, which confirm the questionnaires' reliability.

Table (3) Cronbach's alpha Reliability Classifications (Yockey, 2017).

Cronbach's alpha	Degree of reliability
α≥0.9	Excellent
0.9>α≥0.8	Good
0.8>α≥0.7	Acceptable
0.7>α≥0.6	Questionable (Moderate)
0.6>α≥0.5	Poor
0.5>α	Unacceptable

Table (4) Cronbach's alpha Reliability.

Case Processing Summary			
		N	%
Cases	Valid	63	100.0
	Excluded[a]	0	.0
	Total	63	100.0

a. Listwise deletion based on all variables in the procedure.

Table (5) Cronbach's alpha Reliability.

Reliability Statistics	
Cronbach's Alpha	N of Items
.907	11

5. DATA ANALYSIS METHOD

In terms of data analysis, the analyzed data including the descriptive analysis shows (frequencies, means,) and relativity importance index (RII) will be used to rank (R) each selected factor questionnaire. The effectiveness index will be calculated for the data collected using the below formula (Saleh, 2015).

$$RII = \frac{\Sigma W}{A * N} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

where

W: The weight given by respondents for each component (ranging from 1 to 3);

A: Represents the highest weight (which equals 3);

N: Represents the total number of respondents.

6. RESULTS AND DISCUSSION

6.1. RESPONDENTS' PROFILE

The characteristics of target respondents are presented in Table 6 gives the percentage of each category, while Figure 1 shows the percentage of respondent's knowledge about BIM.

Table (6) Cronbach's alpha Reliability Classifications (Yockey, 2017)

Information	Categories	Percentage (%)	Information	Categories	Percentage (%)
Sector	Public	49.2	Group (Job)	Designer	19.0
	Private	19.0		Consultant	30.2
	both sectors	31.7		Project manager	7.9
Gender	Male	76.2		Site engineer	39.7
	Female	23.8		Other	3.2
Age (years)	21 – 30	11.1	Use of BIM	Yes	9.5
	31 – 40	39.7		No	90.5
	41 – 50	17.5	Use of CAD	Don't use the CAD	9.5
	More than 51	31.7		Use only 2D CAD	63.5
Academic qualification	Diploma	3.2		Use only 3D CAD	1.6
	Bachelor	69.8		Use both 2D & 3D	25.4
	Master	6.3	Software	Autodesk AutoCAD	40.6%
	Ph.D.	19.0		SKETCH UP	9.8%
	Other	1.6		MS EXCEL	24.1%
Specialization	Architect	27.0		MS PROJECT	4.5%
	Civil	66.7		PRIMAVERA	1.5%
	Electrical	1.6		REVIT structural	3.8%
	Mechanical	4.8		REVIT architecture	6.8%
Practical experience	≤ 5	7.9		ARCHICAD	2.3%
	6 – 15	42.9			
	16 – 25	28.6			6.8%
	More than 26	20.6		3D MAX	

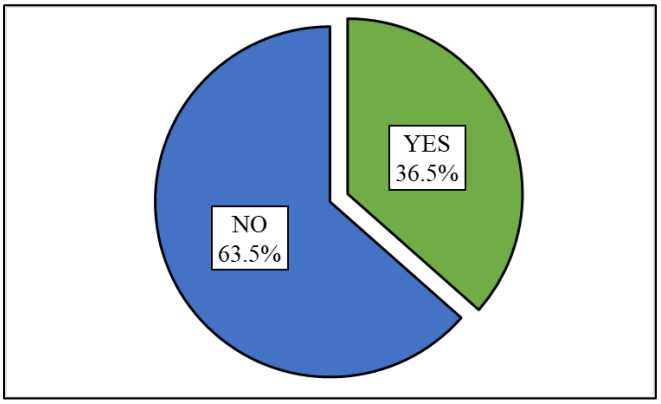

Figure 1: Respondent's Knowledge about BIM Technique

Table 6 shows the description of the participants in this study. The results obtained from the questionnaire show that, 49.2% of respondents working in the public sector, 19.0% work in private sector while the rest of them work in both sectors. Males represent 76.2% of the respondents, 39.7% of the participants were aged (31 – 40) years old, 69.8% has a bachelor's degree, 66.7% were civil engineers, 30.2% were consultants and 42.9% have a (6 – 15) years of experience. The survey showed that around 9.5% of participants use BIM technology, in other words, they use only a few parts of the BIM technique like cost estimation. Only 6.8% and 3.8% using REVIT architecture and REVIT structural respectively, and around 2.3% using ARCHICAD which are BIM-based software. By asking the respondent, have you ever heard of the applications and solutions of BIM? the results showed that only 36.5% of them know about BIM, see Figure 1. Moreover, the source of respondent's knowledge about BIM is represented in Table 7 below.

Table (7) Respondents' source of knowledge about BIM.

Source of Respondent's knowledge about BIM	Read researches related to BIM	51.4%
	participated in conferences or meetings related to BIM	17.1%
	part dealt with in my university	11.4%
	I am training on the use of the BIM programs individually	17.1%
	Other	2.9%

6.2. CHALLENGES (BARRIERS) FACING BIM IMPLEMENT IN IRAQ

Table 8 shows the results of the most eleven selected barriers to the implementation of BIM technology in Iraq. it shows the values of the mean, standard deviation, relative importance index RII and the ranking for each Barrier. The values of the relative importance index are ranged from 0.63 to 0.8. B6 and B11, (Lack of BIM related investments and Lack of demand from customers or other companies for projects implemented using BIM technologies) are in the first position and they almost have the same value of RII which equals 0.79 and 0.8 respectively. The last item in the ranking list is for B1(believing the currently used technology is enough) with RII of 0.63. The values of mean were ranger from 1.9 to 2.4, the highest value of mean is for B11 as it ranked first in this part of the survey. In terms of coefficient of variation, the values of standard deviation indicate a good relationship between the data for which it ranges from 0.73 to 0.82.

The absence or incomplete national BIM standard (B9) is another high effected barrier to BIM implementation. Creating and forming such standard needs top support from authorities (i.e. government and engineering union) in Iraq. It is essential to develop such standards to follow up on the development of the AEC industry around the globe including the Middle East region. Egypt for example, as a Middle Eastern country, created its BIM standards and published it in 2018 to control and regulate the implementation of BIM techniques in their AEC industry (EGBIMC, 2019). On the other hand, lack of BIM experts barrier is so related to the social resistance to change with the lack of support and demand as well as the time, cost and effort needed for the training on BIM related software. The uncertainty of the benefits provided by the application of BIM technique has a significant influence on AEC stakeholder refusal to change, this is why most of the respondents are unwilling to spend time and money to train on BIM software. All the barriers

reviewed in this paper are related to each other in a way or another.

It is important to inform engineers and authorities in the Iraqi AEC industry by the benefits of the BIM applications to overcome these barriers. It must be noted that BIM benefits cannot be shown by another Questionnaire survey, but it needs to be supported with a real case study. Education is vital to create a new generation of engineers that are willing to operate advance technologies and methods in the AEC industry. The barriers related to costs were ranked 8, 9, and 10 in this survey. This means if authorities are convinced to support and demand the implementation of BIM techniques, the cost factor will not be a serious issue that stops BIM application. If they realize the amount of the benefits gained out of BIM implementation, the number of monies will be willingly spent on the training and implementation.

Table (8) Challenges (Barriers) on BIM Implementation in Iraq.

No.	Items	Mean	SD	RII	Rank
B1	Believing the current used technology is enough	1.94	0.82	0.63	11
B2	People refuse to learn / Social and habitual resistance to change	2.19	0.74	0.73	5
B3	The high cost of training for BIM software	2	0.76	0.67	8
B4	The cost of hiring BIM specialists and additional staff	1.95	0.71	0.65	9
B5	The cost of BIM software and the cost of its updates	1.9	0.78	0.65	10
B6	Lack of support / Lack of BIM related investments	2.38	0.75	0.79	2
B7	Uncertainty of the benefits of BIM implementation	2.03	0.82	0.68	7
B8	Traditional methods of contracting (BIM need special contracting conditions)	2.13	0.83	0.71	6
B9	Absence or incomplete national standard for BIM	2.32	0.78	0.77	3
B10	Lack of BIM experts	2.24	0.80	0.75	4
B11	Lack of demand from customers or other companies for projects implemented using BIM technologies	2.4	0.73	0.80	1

By comparing the results gained by this paper with the results of the previous studies showed earlier, there are consistent with the results of Hatem et al. (2018). Poor efforts by the government on BIM implementation comes in the first position followed by a lack of experts and poor knowledge of BIM. Gerges et al. (2017) showed that resistance of change and the belief in the efficiency of the currently used technology come in the first position among all barriers. Lack of BIM experts and lack of demand comes in the second and third positions while Sardroud et al. (2018a) find that the cultural and the financial issues come in as the highest challenges that face BIM implementation. To summarize the comparison with the previous studies mentioned in Table 1 earlier, the data were applying in SPSS software to calculate the percentage of each selected factor over these papers. Figure 2 below expresses the comparison of the chosen barriers between its percentage in the previous studies and RII percentage this paper.

It is clearly noticed that the barrier coded B4 which stands for the cost of hiring BIM specialists and additional staff is high compared with its percentage in analyzed previous studies. Through the literature review, it can be said that the low percentage of this barrier is because all of them have BIM specialists already, so there is no need to hire additional staff (i.e. only a few members if needed) compared with the situation in Iraq.

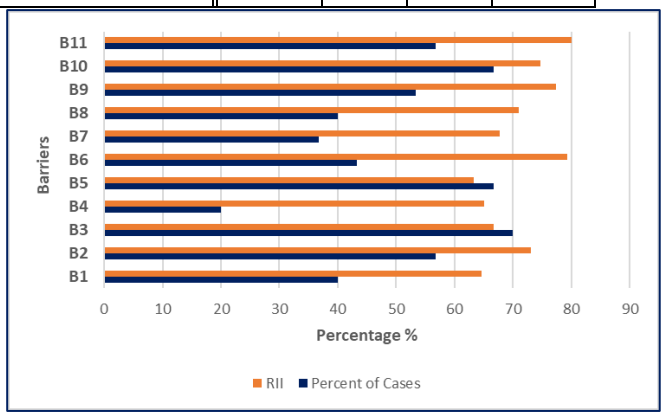

Figure 2: Comparison of Barriers between its Percentage on Previous Studies and this Paper

By comparing this to B10 “lack of BIM experts”, it can conclude that more BIM specialists are always needed to improve the application of this technology and use it on a wide range (i.e. including it in all project types in the AEC industry).

7. CONCLUSIONS AND RECOMMENDATIONS

This paper studied the barriers and challenges facing the implementation of BIM techniques. The barriers were discussed through a comprehensive literature review and extended face-to-face interviews with the specialist in the AEC industry. The results of the questionnaire prepared for the study were analyzed, and the results showed that Lack of demand on using BIM technique and Lack of BIM related investments (Lack of support) are the most effective barriers in the Iraqi AEC industry. Regardless of believing that new methods must be adopted in the industry, yet there is no support from authorities towards implementing new techniques, whether financial or any other types of support.

It is essential to develop a national standard for BIM technology to follow up improvements and to reduce the gap between Iraq and at least the Middle Eastern countries in the term of AEC industry. Lack of knowledge about this technique and the benefits of its application plays a vital role in the implementation of BIM in Iraq. More effort must be taken by authorities to overcome these barriers to improve the AEC industry in Iraq.

Based on the previously identified conclusions, the results obtained from this research, and the comments of respondents through interviews and the questionnaire survey, the following points can be recommended:

- Develop systems and laws to meet the highest international standards for the optimal use of modern technology.
- Develop rules and regulations towards the application of BIM techniques.
- The use of (employ) experts and consultants to assist ministries and government departments in preparing the appropriate plan for the implementation of BIM technology.
- Organizing events, conferences, and exhibitions that promote the benefits of BIM technology.
- Include BIM technology in the engineering curriculum.
- Develop a national standard for BIM technology.

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