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RESEARCH PAPER

Minimizing Time and Cost in The Iraqi AEC industry by Adopting Building Information Modeling (BIM) Technique.

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A B S T R A C T:

The Architectural, Engineering, and Construction (AEC) industry is essential for its direct influence on the development of any country, particularly in terms of economy. Thus, problems related to cost and time arise as a global phenomenon in this industry, particularly in the third world countries like Iraq. The Building information modeling (BIM) technique is considered as the most adequate technique that overcomes the problems facing the AEC industry. This paper aimed to assess the causes of cost issues and time delays in the Iraqi AEC industry and to outline the BIM concept and the benefits of its application for solving these problems. This paper consists of two parts; the first one is the quantitative approach, which was adopted for data collection through a specially designed questionnaire form; these questionnaires were spread among 50 of the top and middle management in different construction companies, and other experts in the arena of AEC industry. The results of the statistical analysis showed that the highest influential factors on cost and time overrun are: inadequate planning and scheduling, selecting inefficient contractors, change orders, and the errors and mistakes in preparing the bill of quantities and materials (BOQ/BOM) with relative importance index (RII) of 0.98, 0.87, 0.83 and 0.82 respectively. The second part of this paper reviewed the benefits of applying BIM and highly recommend this technology to improve the local AEC industry. The application of the BIM technique will lead to more sustainable design, construction, and project delivery in the Iraqi projects. This paper presents a significant set of recommendations that demonstrate how BIM technique can be applied to overcome the challenges of the AEC industry in Iraq. It unlocks the door for further authentic researches on the adoption of BIM technique as an influential and exceptional tool to point out the issues related to time and cost in the AEC industry in Iraq.

KEYWORDS: Building Information Modeling, Construction Management, Cost overrun, Sustainability, Time overrun.
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1. INTRODUCTION:

The Architectural, Engineering, and Construction (AEC) industry stands as a very essential for its direct influence on the development of any country, particularly in terms of economy. From an economic point of view, it contributes to the development of the overall gross domestic product (GDP) of a country significantly. On the other hand, it improves life quality by providing necessary infrastructures like schools and hospitals, for instance, and other essential and basic services (Cantarelli, 2009, Olawale and Sun, 2010). Therefore, its deeply critical to complete the projects successfully within the determined time, cost, and the required quality. Nevertheless, the AEC industry, at all times, facing recurrent challenges like cost overrun, time overrun, low productivity and poor quality, as well as construction waste and others for it is a complicated, miscellaneous industry that based on time tables and schedules (Abdul Rahman et al., 2013).

Cost overrun arises as a global phenomenon in the AEC industry, and there are

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very rare projects that are accomplished within the planned budget (Flyvbjerg et al., 2003). In terms of costs transport infrastructure projects, a worldwide study showed that costs transport does not perform as promised, cost-related issues were recognized as the main challenge where almost 9 of 10 projects experienced cost-related issues in around 50% to 100%. Countries like Malaysia are also dealing with a serious cost-related problem in the building industry where about 37.2% of the private sector projects and around 46.8% of public sector building projects were completed within the planned budget (Abdullah et al., 2009, Razak Bin Ibrahim et al., 2010, Sambasivan and Soon, 2007). The AEC industry in developed countries such as the UK, dealing with these problems as well, where approximately one-third of the client complain that their projects exceed the assigned financial plan (Olawale and Sun, 2010). All that increases the need for new solutions to hold on and control these problems. On the other hand, the construction industry is always improving to overcome the challenges facing the projects' performance and other issues related to the industry. It has witnessed a paradigm shift in the direction of raising productivity, efficiency, sustainability, quality, the value of infrastructures, and in the direction of reducing duplications, overall lifecycle cost besides reducing the time (Arayici et al., 2009). This is consistent with the words of Azhar (2011) as he pointed out that construction projects tend to implement new methods that decrease the project's cost, increase the project's productivity and reduce the project's time, which increases the value of the project. While Mahdi and Ali (2019) highly recommended the use of advanced technologies such as the BIM technique to reduce problems of wastage in construction materials along with Wali and Othman (2019), who recommended the use of advanced technologies to reduce risks in the AEC industry in Iraq.

Building information modeling (BIM) is one of these techniques. BIM is a revolutionary technology and process that transformed and developed the way of design, planning, construction, and operation of buildings (Hardin and McCool, 2015). BIM technique has been defined as the application of a software program for simulating the building and the operation of a project. This model is a digital representation of the project which is rich of the project's data, where the data can be isolated and analyzed to generate the needed information to meet the needs of different users, which will be used to improve decision making and improve the delivery process (AGC, 2005). BIM technique is the most vital sustainable approach to manage and deliver the project within its designed time, cost, and quality (Eastman et al., 2011).

The aim of the research is to present a study explaining the value of BIM technology and its effect in developing the AEC industry, overcoming AEC problems, and to determine the necessity of applying this technology to minimizing time and cost in the AEC industry in Iraq.

2. LITERATURE REVIEW

2.1. COST AND TIME RELATED ISSUES

Abdul Rahman et al. (2013) aimed in their paper to recognize the highly influential causes for cost problems in large Malaysian building projects. Their designed questionnaire contains thirty-five of the main frequent factors couses cost problems, and these factors were classified into seven groups. The findings showed that the highest three signs of cost issues are the cash flow and financial problems tackled the contractors, the variation in the prices of the materials, and the inadequate management and supervision which goes under the group of contractor's site and financial management.

On the other hand, Doloi (2012) aimed to provide more understanding of the cost-related problems and different methods of management by conducting a survey study. The survey was designed to investigate the experiences of the contractors, the clients, and the consultants in the building industry. Also, to recognize the main acute factors that influence the performance of costs and expenses by ranking these factors reliant on the relative importance weight (RIW). They also used a multivariate regression assessment to investigate and analyze these influential factors considering the duties and responsibilities of the stakeholders. The gained regression analysis illustrates the impact of 5 key-factors on the expenses operations, and these factors are: accurate planning of the project and sufficient monitoring, as well as design adequacy along with the efficient site management, efficient communication, and the efficiency of contractor's performance.

Moreover, Enshassi et al. (2009) aimed to assess the factors that lead to issues related to costs (expenses overrun) and time problems (delays) in the AEC projects in Gaza Strip, Palestine. They selected around 110 factors/causes related to delays, and 42 cost-related factors classified into12 major groups. All these factors were based on previous studies, along with factors that arise in different circumstances occurring in the strip of Gaza. The importance level of all these factors was calculated and ranked according to their importance indexes based on the contractors, consultants, and owner's perspectives. The results indicate that there is a general agreement between the three major parties in construction (i.e., the owner, consultant, and contractor). The major delay factors appeared to be related to the general situation in the Gaza strip, materials availability, and procurement, etc. Furthermore, the major causes of cost-related issues were inflation, the fluctuations in the prices of materials, delays in delivering the material, and the equipment by the contractors.

Assaf and Al-Hejji (2006) investigated the roots of delays in megastructure projects. They also tested the importance degree of delay factors to analyze the differences based on the perceptions of the three major parties in the construction industry (i.e., the owners, the consultants, and the contractors). Based on a comprehensive literature review, they presented seventy-three causes of delays. A questionnaire form was made for data collection, and the results show that ‘‘change order’’ is the most significant cause of construction delays. Furthermore, around 76% and 56% of both of the contractors and the consultants respectively indicated that the percentage of time delays varies from (10 to 30)% of the project’s estimated duration. Finally, they concluded that around 70 % of the projects did not progress according to the planned schedule correctly for that they found that from the 76 selected projects in this study, 45 projects were considered as a delayed project.

2.1. THE BENEFITS OF BIM TECHNIQUE

It must be mentioned that there are many dedicated researchers who studied the benefits of the application the building information modeling in the AEC industry. One of these scholars is Azhar (2011). He determined eight different types of benefits: more effective and faster processes, improved designs, controlled overall expenses and data, improve the quality, better service for customers, accurate geometrical representation, and lifecycle data. He also presents four case studies to show the benefits of BIM technology by illustrating the cost and time savings, project planning, designing, pre-construction, and construction stages. By calculating the return on investment (ROI), the results show that the average ROI of BIM for the selected projects found to be around 634%, which illustrates the potential benefits of implementing BIM in terms of economy. On the other hand, Eastman et al. (2011) also discuss the benefits of applying BIM technique in the AEC industry at all of the stages of the main four construction phases, which are: the pre-construction phase, the design phase, construction, and building phase, and the post-construction phase. Moreover, some of these benefits were determined and discussed as expected benefits of BIM technique gained through the development of this technology in the future.

Jernigan (2007), in his practical approach to BIM technique, he illustrates that in the several case studies of construction projects he investigated, show that there were around 8 to15% cost savings on the new projects and up to 35% cost savings on reiterated projects that apply the technique of BIM. These recognized savings are the result of the proper use of information, improved decision making, and better assessments in the early phase of the project.

Hamada et al. (2016) investigated twenty potential BIM benefits as motivation factors to adopt BIM technique along with twelve factors that stand as barriers against implementing BIM in Iraq. They stated that the major benefit of BIM is minimizing the cost of the project. On the other hand, Hasan and Rasheed (2019) investigated the benefits of implementing 5D BIM in the construction industry. They determined that the significant benefits of adopting 5D BIM are that it increases the collaboration among the working teams, better estimation of cost and time, visual tracking and monitoring, Reduce change orders, and better quantity estimation.

According to global statistics in Britain, America, Finland, and Denmark, the most important business benefits for owners who are using BIM technology in construction projects

are: reduce rework by 36%, reduce errors in documenting, reduce omissions and oversight by 61%, reducing the cost of construction by 30%, reduce the duration of the project delivery by 22%, and reduce litigations and disputes by 17% (AUTODESK, 2014). Despite all other benefits, cost and time are related to all of them in a way or another. The previous researches illustrated that the application of the BIM technique endures the following benefits in terms of cost and time saving, see Table 1.

Table (1): Benefits of BIM According to Previous Studies

Organization or Researcher	Benefits
(Yan and Demian, 2008)	• reduce the cost and time by 25% of the UK's projects • USA projects reduce cost by 16% & time by 26% of USA projects
(Gilligan and Kunz, 2007)	• reducing costs and improving the accuracy and speed of cost estimates • reduction in projects' time by around 7%
(Azhar et al., 2008)	• Cost estimation accuracy within 3%. • Reduction in time up to 7%
(CIFE, 2007, Innovation, 2007, Azhar, 2011)	• A savings of up to 10% of the contract value through clash detections. • Up to 80% reduction in time taken to generate a cost estimate. • Up to 40% elimination of unbudgeted change. • Up to 10% reduction in project time.
(Azhar, 2011)	• Elimination of 40% of unbudgeted change • Accuracy cost estimation with 3% as compared to the traditional way • Reducing the time taken in cost estimation by 80% • Saving 10% of the contract value due to clash detection • reducing the project time by 7%
(Gerges et al., 2017)	• Increase the collaboration and coordination between stakeholders • The calculation of accurate estimates • Managing the sequence of the activities through the 4D model
(Ali, 2015, Osman, 2016)	• Increase design efficiency • Improve the construction process • Reduction and saving the cost of the project • Saving in cost and time due to clash detection
(Bryde et al., 2013)	• Control and reduce the cost & the time of the project • Risk reduction • Improve communication and coordination • Increase the quality of the project • Increase clients satisfactory • Improve the owner's experience and satisfaction • Increase the profit margin

3. METHODOLOGY

A questionnaire form is used as the main source of data in order to fulfill this paper's objective. This survey form was organized and created based on the academic study of the topic, including a comprehensive literature review of published scientific researches and articles related to the subject of this study as well as one-to-one interviews with experts involved and some academic personnel engrossed in the process of the AEC industry in Iraq.

As for the design of this survey, it was written with a clear English language supported by a good Arabic translation. It provided with a well-written cover letter that explains the objectives of the survey study, how to respond to the questions, and clarifies the security information security in order to encourage the respondents.

All of the needed information that supports to achieve the objectives of this paper were collected, assessed, and formalized to be appropriate for the survey and easy to understand by the respondents. Furthermore, after several phases of brainstorming, accessing, revising, and evaluating performed by the author, the questionnaire form was formed with two sections.

The first section of the questionnaire form is associated with the respondent's profile. This part is used to determine the experience, knowledge of respondents, etc. While the second part of this survey investigates the factors that influencing the project performance, and that might cause time & cost to overrun in AEC projects. It covers thirty factors categorized into different seven groups. The answers would be telling the importance of each factor based on three-point scale as recommended by experts. These three points are (3 = high), (2 = moderate) and (1 = low).

Regarding the questionnaire distributed, it has been distributed to 50 members of the top and middle management in different construction companies, site engineers, consultants, and other experts in the field of the AEC industry. The researchers were dedicated to make a one on one interview with respondents discussing and explaining each factor in the questionnaire to gain the most accurate response. The valid received and analyzed questionnaires were only 42.

In terms of data analysis, the statistical package for the Social Science (SPSS 25) software is used, and Microsoft Excel for the data manipulating and analysis. The relativity importance index (RII) will be adopted to rank (R) each factor in the questionnaire. The relative importance index will be calculated for the data collected based on the formula used by Saleh (2015) below:

$$\boldsymbol{RII = \frac{\Sigma W}{A * N}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{1})$$

Where $\boldsymbol{W}$ represents the weight assumed by the respondents for each question, ranging from one to three; while $\boldsymbol{A}$ stand for the maximum weight which is three in this case; and $\boldsymbol{N}$ correspond to the number of the respondents.

4. RESULTS AND DISCUSSION

In order to assist the reader to have a clear understanding of the data, it has been discussed and presented within three sections where the first section deals with the profile of the respondents while the second section is dedicated to discussing the statistical reliability of the questionnaire survey. Finally, the third part is devoted to review the core of the research where it shows the responses of the participants on the questionnaire, the calculations as well as the comparison of the results with previous researches.

4.1. RESPONDENTS' PROFILE

The characteristics of respondents are presented in Table 2 gives the percentage of each category, while Figure 1 shows the percentage of respondents who know BIM and who don't.

Table 2 describes the participants in this study. The obtained results show that 59.5% of respondents working in the public sector, 16.7% work in the private sector while the rest of them work in both industries. Males represent 81% of the respondents, 44.7% of the participants were aged (31 – 40) years old, 78.6% have a bachelor's degree, 69% were civil engineers while the around 21.4% were Architects, 26.2% were consultants, and 52.4% have a (6 – 15) years of experience. The survey showed that about 10% of participants use BIM technology; in other words, only a few parts of the BIM technique like cost estimation and clash detection. Only 6% used REVIT architecture, 3.6% used REVIT structural, and 7% used ARCHICAD, which are software for BIM.

Table (2): Respondent Profile

Information	Categories	Percentage (%)	Information	Categories	Percentage (%)
Sector	Public	59.5	Group (Job)	Designer	19.0
	Private	16.7		Consultant	26.2
	both sectors	23.8		Project manager	7.1
Gender	Male	71.4		Site engineer	42.9
	Female	28.6		Other	4.8
Age (years)	21 – 30	9.5	Use of BIM	yes	9.5
	31 – 40	47.6		no	90.5
	41 – 50	19.0	Use of CAD	Don't use the CAD	9.5
	More than 51	23.8		Use only 2D CAD	69.0
Academic qualification	Diploma	2.4		Use only 3D CAD	2.4
	Bachelor	78.6		Use both 2D & 3D	19.0
	Master	4.8	Software	Autodesk AutoCAD	44.0
	Ph.D.	11.9		SKETCH UP	10.7
	Other	2.4		MS EXCEL	23.8
Specialization	Architect	21.4		MS PROJECT	3.6
	Civil	69.0		PRIMAVERA	1.2
	Electrical	2.4		REVIT structural	3.6
	Mechanical	7.1		REVIT architecture	6.0
Practical experience	≤ 5	7.1		ARCHICAD	0
	6 – 15	52.4			
	16 – 25	23.8		3D MAX	7.1
	More than 26	16.7			

By asking the respondent, “have you ever heard of the applications and solutions of BIM?” the results showed that only 29% of them know about BIM, see Figure 1. How respondents got their knowledge about BIM and their Suggestions to promote BIM in Erbil are shown in Table 3.

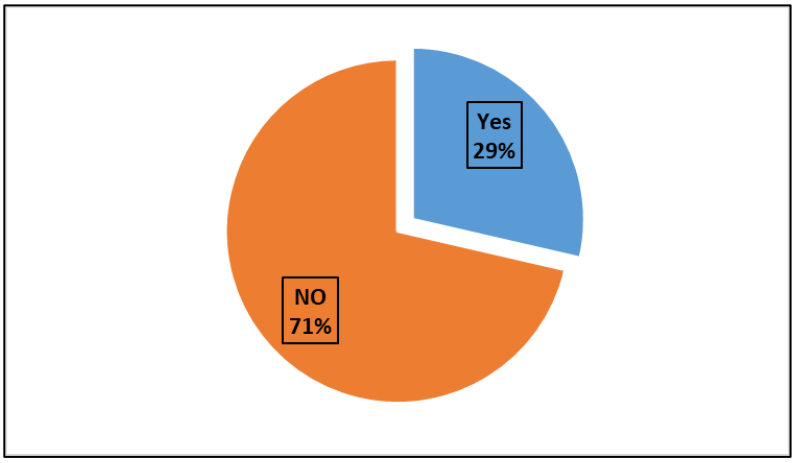

Figure (1): Do Respondents Have Knowledge About BIM?

Table (3): Respondents' source of knowledge about BIM and suggestions to promote BIM

How Respondents' get their information about BIM	Read researches related to BIM	50.00%
	participated in conferences or meetings related to BIM	16.70%
	part dealt with in my university	11.10%
	I am training on the use of the BIM programs individually	16.70%
	Other	5.60%
Respondents' Suggestions to promote BIM	Promote local awareness of BIM benefits through workshops and courses.	35.60%
	Improving the role of the local Engineers Union.	28.80%
	To be included in the curriculum	33.90%
	Other	1.70%

4.2. STATISTICAL RELIABILITY

One of the basic requirements in any research paper is maintaining accurate measurements and acceptable results. So, a 25 sized pilot survey was performed to check the questionnaire's validity and reliability before starting the main survey study. The researcher performed an internal consistency with the aim of testing the statistical validity. The questionnaire's internal consistency giving the values of the Spearman's Rho correlation and the p-values as shown in table 6. The correlation coefficients for Part (II) of the survey varied from 0.311 to 0.750 and the p-value for all of the questions were below 0.05, which means that all of the questions are valid to start the survey. For measuring internal consistency, the researcher used Cronbach's alpha as it is an effective important common method for testing reliability (Yockey, 2017). Table 4 shows the classifications of reliability, according to Cronbach's alpha value. By conducting this method to test the questionnaire reliability, the result showed that the Cronbach's alpha is on the Excellent scale, as shown in Table 5 and Table 6 below, which confirm the questionnaires' reliability.

Table (4): Cronbach's alpha Reliability Classifications (Yockey, 2017)

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 (Moderate)
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Table (5): Case Processing Summary of Cronbach's alpha Reliability Test

Case Processing Summary

		N	%
Cases	Valid	42	100.0
	Excluded[a]	0	.0
	Total	42	100.0

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

Table 6: Cronbach's alpha Reliability

Reliability Statistics

Cronbach's Alpha	N of Items
.912	30

Table (7): Questionnaire's Internal Consistency

Factor	Correlation Coefficient	Sig. (2-tailed)	Factor	Correlation Coefficient	Sig. (2-tailed)
Q1	.547**	0.00	Q16	.494**	0.00
Q2	.492**	0.00	Q17	.443**	0.00
Q3	.520**	0.00	Q18	.560**	0.00
Q4	.517**	0.00	Q19	.462**	0.00
Q5	.548**	0.00	Q20	.494**	0.00
Q6	.618**	0.00	Q21	.333*	0.04
Q7	.412**	0.01	Q22	.348*	0.03
Q8	.426**	0.00	Q23	.494**	0.00
Q9	.750**	0.00	Q24	.590**	0.00
Q10	.700**	0.00	Q25	.382*	0.03
Q11	.664**	0.00	Q26	.697**	0.00
Q12	.679**	0.00	Q27	.482**	0.00
Q13	.468**	0.00	Q28	.515**	0.00
Q14	.509**	0.00	Q29	.595**	0.00
Q15	.311*	0.04	Q30	.567**	0.00

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

4.3. FACTORS THAT CAUSE DELAY AND COST TO OVERRUN IN THE AEC PROJECTS

The mean and the standard deviation values for all of the 29 factors are shown in Table 8, as well as their rankings, which is based on the values of the relative importance index (RII) along with the RII values for each group of factors. The top five factors in this survey are Q2, Q19, Q26, Q7, and Q18, with RII of 0.98, 0.87, 0.85, 0.83, and 0.82, respectively. These factors are inadequate planning and scheduling; selection of inefficient contractors in administrative and financial terms; selection of contractors with limited technical competence; frequent changes in design (change orders); the selection of a project team that is inefficient in administrative and financial terms, and errors and mistakes in the preparation of bill of quantities and materials (BOQ/BOM) are the most influential factors on the cost and time-related problems in the construction projects. This is related to the bad practices, lack of experience and the poor technique used in the construction industry, as well as the corruption in most governmental departments, which strongly stand against the development of the AEC industry in Iraq. This corruption caused several projects to be delayed, implemented with poor quality and high costs, which dramatically reduce the value as well as the economic feasibility of the project.

In terms of the values of the mean and standard deviation, the mean values were ranged from 1.81 to 2.93; the highest value of mean is for Q2, obviously as it ranked first. The values of standard deviation were all below one, which indicates a good relationship between the collected data.

Similar findings were obtained by Frimpong et al. (2003), Assaf and Al-Hejji (2006), Le-Hoai et al. (2008), Alinaitwe et al. (2013), and Btoush and Harun (2017).

Table (8): Factors Affecting cost and Time overrun in Construction Projects

Group	RII	No.	Items	Mean	SD	RII	Rank
Contractor's site management factors	*0.79*	*Q1*	Poor site management and supervision	2.38	0.764	0.79	9
		Q2	Inadequate planning and scheduling	2.93	0.707	0.98	1
		Q3	Inaccurate time and cost estimation	2.33	0.721	0.78	11
		Q4	Delay in providing instructions/responding to contractor's requests for information	2.07	0.712	0.69	22
		Q5	Lack of follow up by the contractor's home	2.17	0.794	0.72	17

			office				
Design related factors	0.78	*Q6*	Mistakes and errors in design	2.26	0.734	0.75	14
		Q7	Frequent changes in design (change orders)	2.5	0.595	0.83	4
		Q8	Bad preparing of shop drawings	2.29	0.636	0.76	13
Information and communication related factors	*0.69*	*Q9*	Lack of coordination between parties	2.12	0.803	0.71	19
		Q10	Slow information flow between parties	1.98	0.78	0.66	27
		Q11	weak communications and misunderstanding between parties	2.07	0.808	0.69	23
		Q12	Low harmony between the contractor team and the owner team which may lead to a controversy between both of them	2.12	0.772	0.71	20
Project management related factors	0.69	*Q13*	Poor project management	2.24	0.692	0.75	15
		Q14	Delays in decision making	1.95	0.764	0.65	28
		Q15	Major disputes and negotiations	2.05	0.697	0.68	24
		Q16	The absence of continuous tracking for the project time schedule	2	0.796	0.67	26
		Q17	Weak Definition of the roles and responsibilities that fit the organization's structure according to the project and its characteristics	2.14	0.647	0.71	18
Administration related factors	*0.84*	*Q18*	The selection of a project team that is inefficient in administrative and financial terms	2.45	0.705	0.82	5
		Q19	Selection of inefficient contractors in administrative and financial terms	2.6	0.701	0.87	2
Legislative problems and errors	*0.70*	*Q20*	The contracts are not well drafted, due to the lack of experience in contracting.	2.12	0.861	0.71	21
		Q21	The duration of the project must be in the years and months, not the number of days that are explained by working days	1.81	0.862	0.60	30
		Q22	There is no legislation on the use of modern technologies in building projects, according to international standards	2.33	0.65	0.78	12
Technical related factors	*0.78*	*Q23*	Method of transferring project data and information such as (soil examination report, site maps, and survey works)	2.05	0.764	0.68	25
		Q24	Preparation of architectural, structural, mechanical and electrical designs without a general coordinator for the design team, causing frequent conflicts.	2.43	0.668	0.81	8
		Q25	The difficulty of conducting electronic checks of designs because they are placed in hundreds of files for each department.	2.24	0.726	0.75	16
		Q26	Selection of contractors with limited technical competence	2.55	0.739	0.85	3
		Q27	Errors and mistakes in the preparation of bill of quantities and materials (BOQ/BOM)	2.45	0.633	0.82	6
		Q28	Change orders and their consequences	2.38	0.623	0.79	10
		Q29	Wrong implementation methods due to the lack of design and working schemes	2.45	0.633	0.82	7

		Q20	Frequent conflicts with other projects implemented in advance due to not having the documents of these projects for not giving documents the proper attention.	1.9	0.79	0.63	29

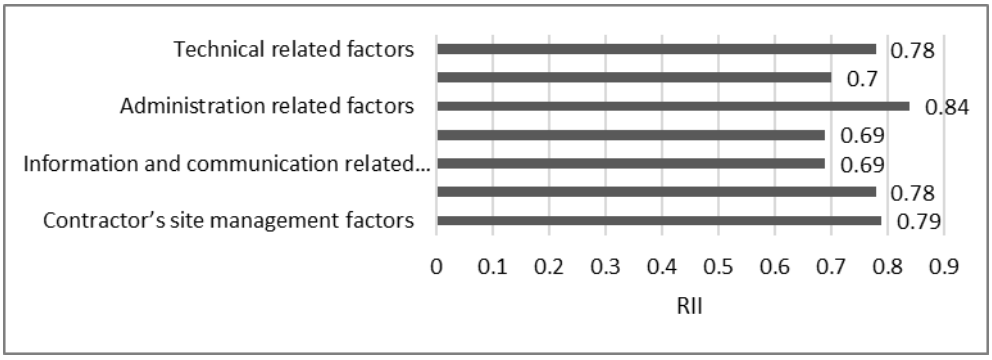

Figure (2): Relative Importance Index (RII) for Factor Groups

Figure 2 shows the values of RII for each group factor, which ranged from 0.69 to 0.84. These values are based on the results shown in Table 8 as they represent the average of factors of each group. The group of administration-related factors is in the first position among all groups with an RII of 0.84. The second position is for contractor's site management related factors is with RII of 0.79 then closely followed by the technical-related group and design-related group with RII of 0.78 each. The group factors of the information and communication and the group of project management come at the last position with RII of 0.69 each.

Similar findings were obtained by Assaf and Al-Hejji (2006), While Le-Hoai et al. (2008), and Alinaitwe et al. (2013) regarding the contractor related factors for coming in the first position. While Btoush and Harun (2017) revealed that technical related issues along with the information and communication-related influences are the essential factors in terms of time delays in the AEC projects.

5. CONCLUSION AND RECOMMENDATIONS

This paper investigates the cost and time-related problems in the AEC industry of Iraq as well as reviewing the benefits of BIM technology in solving these issues through a deep literature review. The results of the survey prepared for the purpose of the study were analyzed, and it concluded that inadequate planning and scheduling, choosing an inefficient contractor, change orders, the mistakes and errors occurring during the preparation of the bill of quantities and the bill of materials (BOQ/BOM) are the most influential factors on the cost and time overrun. It is concluded that poor experience, as well as poor practices and techniques used in the AEC industry, along with the corruption in most governmental departments, plays a vital role in the rising of these issues. It's been concluded that the Administration, contractors, design, and technical related factors are the most influential factor groups with RII of 0.84, 0.79, and 0.78, respectively. This indicates the low technology and the poor management practices used in the AEC industry in Iraq.

The best solution to overcome time and cost issues in the AEC industry is building information modeling technique. It is essential to improve the AEC industry by putting more effort into taking BIM into implementation. The application of BIM technology will contribute to reduce the expenses and the time required to deliver the projects and therefore, it has a significant impact on the economy and resources (i.e., the application of BIM technology is significant and it will cooperate in developing the sustainability of Iraqi AEC industry).

Based on those 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:

- Developing systems and laws to meet the highest international standards in order to develop the level of services and optimal use of modern technology.
- Instructing all governmental departments in the country that have construction projects to use this technology and obligate them to make designs according to BIM technology for its benefits in solving all of projects problems.
- Imposing rules on implementing BIM in large projects.
- Giving more attention to the sustainability of the construction projects.
- The use of (employ) experts and consultants to assist ministries and government departments in preparing the appropriate plan for the implementation of BIM technology.
- Participation and Organizing events, conferences, and exhibitions that promote this technology locally and improving the role of the local Engineers Union.
- Including this technology in the curriculum of engineering colleges.
- Conducting visits and working meetings with the organizations working with BIM technology in USA, UK, UAE, and Qatar as they are among the leading countries in this field.

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References

ABDUL RAHMAN, I., MEMON, A. H., KARIM, A. & TARMIZI, A. 2013. Significant factors causing cost overruns in large construction projects in Malaysia. Journal of Applied Science, 13, 286-293.

ABDULLAH, M., AZIS, A. A. & RAHMAN, I. A. 2009. Potential effects on large mara construction projects due to construction delay. International Journal of Integrated Engineering, 1.

AGC, A. 2005. The contractors guide to BIM. URL: http://iweb. agc. org/iweb/Purchase/ProductDetail. aspx.

ALI, H. B. M. 2015. Benefits of building Information Modeling for Construction in Sudan. Sudan University of Science and Technology.

ALINAITWE, H., APOLOT, R. & TINDIWENSI, D. 2013. Investigation into the causes of delays and cost overruns in Uganda's public sector construction projects. Journal of Construction in Developing Countries, 18, 33.

ARAYICI, Y., KHOSROWSHAHI, F., PONTING, A. M. & MIHINDU, S. Towards implementation of building information modelling in the construction industry. Proceedings of The Fifth International Conference on Construction in the 21st Century (CITC-V) "Collaboration and Integration in Engineering, Management and Technology", May 20-22, 2009, Istanbul, Turkey., 2009. 1342-1351.ASSAF, S. A. & AL-HEJJI, S. 2006. Causes of delay in large construction projects. International journal of project management, 24, 349-357.

AUTODESK. 2014. The Value of BIM for Owners: Save Time and Money During the Building Lifecycle [Online]. Available: http://damassets.autodesk.net/content/dam/autodesk/www/solutions/bim/BIM_for_Owners.pdf. [Accessed 23-Dec 2018].

AZHAR, S. 2011. Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. Leadership and management in engineering, 11, 241-252.

AZHAR, S., NADEEM, A., MOK, J. Y. & LEUNG, B. H. Building Information Modeling (BIM): A new paradigm for visual interactive modeling and simulation for construction projects. Proc., First International Conference on Construction in Developing Countries (ICCIDC–I), Karachi, Pakistan; 08/2008, 2008. 435-446.

BRYDE, D., BROQUETAS, M. & VOLM, J. M. 2013. The project benefits of building information modelling (BIM). International journal of project management, 31, 971-980.

CANTARELLI, C. C. Cost overruns in Dutch transportation infrastructure projects. Delft University of Technology. Conference Presentation, 2009. Citeseer, 19-20.

CIFE. 2007. CIFE Technical Reports [Online]. Available: https://cife.stanford.edu/Publications/index.html [Accessed 23-Dec 2018].

DOLOI, H. 2012. Cost overruns and failure in project management: Understanding the roles of key stakeholders in construction projects. Journal of construction engineering and management, 139, 267-279.

EASTMAN, C., TEICHOLZ, P., SACKS, R. & LISTON, K. 2011. BIM handbook: A guide to building information modeling for owners, managers,

designers, engineers and contractors, John Wiley & Sons.

ENSHASSI, A., AL-NAJJAR, J. & KUMARASWAMY, M. 2009. Delays and cost overruns in the construction projects in the Gaza Strip. Journal of Financial Management of Property and Construction, 14, 126-151.

FLYVBJERG, B., SKAMRIS HOLM, M. K. & BUHL, S. L. 2003. How common and how large are cost overruns in transport infrastructure projects? Transport reviews, 23, 71-88.

FRIMPONG, Y., OLUWOYE, J. & CRAWFORD, L. 2003. Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. International Journal of project management, 21, 321-326.

GERGES, M., AUSTIN, S., MAYOUF, M., AHIAKWO, O., JAEGER, M., SAAD, A. & GOHARY, T.-E. 2017. An investigation into the implementation of Building Information Modeling in the Middle East. Journal of Information Technology in Construction (ITcon), 22, 1-15.

GILLIGAN, B. & KUNZ, J. 2007. VDC use in 2007: significant value, dramatic growth, and apparent business opportunity. TR171, 36.

HAMADA, H., HARON, A., ZAKIRIA, Z. & HUMADA, A. 2016. Benefits and Barriers of BIM Adoption in the Iraqi Construction Firms. International Journal of Innovative Research in Advanced Engineering, 3, 76-84.

HARDIN, B. & MCCOOL, D. 2015. BIM and construction management: proven tools, methods, and workflows, John Wiley & Sons.

HASAN, A. N. & RASHEED, S. M. 2019. The Benefits of and Challenges to Implement 5D BIM in Construction Industry. Civil Engineering Journal, 5, 412-421.

INNOVATION, C. C. 2007. Adopting BIM for facilities management: Solutions for managing the Sydney Opera House. Cooperative Research Center for Construction Innovation, Brisbane, Australia.

JERNIGAN, F. 2007. BIG BIM little bim: The practical approach to building information modeling, edn. 4Site Press, Salisbury, Maryland, United Sates.

LE-HOAI, L., DAI LEE, Y. & LEE, J. Y. 2008. Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries. KSCE journal of civil engineering, 12, 367-377.

MAHDI, M. M. & ALI, N. S. 2019. Reducing Waste of Construction Materials in Civil Engineering Projects In Iraq. J ZANCO Journal of Pure Applied Sciences, 31, 257-263.

OLAWALE, Y. A. & SUN, M. 2010. Cost and time control of construction projects: inhibiting factors and mitigating measures in practice. Construction management and economics, 28, 509-526.

OSMAN, M. K. 2016. Implementation and potential benefits of building information modeling (BIM) in Sudan construction industry. Sudan University of Science and Technology.

RAZAK BIN IBRAHIM, A., ROY, M. H., AHMED, Z. & IMTIAZ, G. 2010. An investigation of the status of the Malaysian construction industry. Benchmarking: An International Journal, 17, 294-308.

SALEH, M. A. D. 2015. Barriers and Driving Factors for Implementing Building Information Modelling (BIM) in Libya. Eastern Mediterranean University (EMU)-Doğu Akdeniz Üniversitesi (DAÜ).

SAMBASIVAN, M. & SOON, Y. W. 2007. Causes and effects of delays in Malaysian construction industry. International Journal of project management, 25, 517-526.

WALI, K. I. & OTHMAN, S. A. 2019. Schedule Risk Analysis Using Monte Carlo Simulation for Residential Projects. J ZANCO Journal of Pure Applied Sciences, 31, 90-103.

YAN, H. & DEMIAN, P. 2008. Benefits and barriers of building information modelling.

YOCKEY, R. D., (2017). SPSS Demystified: A Simple Guide and Reference, 2nd ed. 2017, United Kingdom: Taylor & Francis, (2017). https://books.google.iq/books?id=m6Q5DwAAQBAJ