

Motivation Factors for Adopting Building Information Modeling (BIM) in Iraq

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Abstract—Building information modeling (BIM) is an integrated and comprehensive system including whatever is related to a construction project and its stages. It represents a unified database for all project data through which project documents are available to all stakeholders. This paper evaluates the factors driving the adoption of BIM in Iraqi construction projects in different ministries and adopts quantitative approach to collect data by using a questionnaire survey specially prepared for this purpose which was distributed to experts in the ministries of the Iraqi construction sector. Returned data were subjected to proper statistical analysis. Results showed that the highest motivation for BIM application is to include it in the educational curricula, raise awareness through courses and workshops and contracting with international experts with experience in BIM field.

Keywords—construction project; building information modelling; BIM; Iraq; motivation factor

I. INTRODUCTION

Construction industry is witnessing a paradigm shift that tends to achieve higher productivity, efficiency, quality, sustainability and infrastructure value while reduces the life cycle costs and time [1, 2]. One of these techniques is building information modeling (BIM) which is a technological and procedural shift in the construction industry [3]. Actually, the evolution of computer science as well as information technology has caused a positive change in the processes of most industries [4]. BIM is an advanced process consisting of a combination of virtual aspects, systems and concepts facilitated within a unified environment [5]. It includes the application and keeping of integrated digital representation of different information across different project stages [6, 7]. There are many BIM applications [8] which can be used to support constructability, scheduling, analysis, cost estimating and sequencing [9]. BIM as a new paradigm has a great potential for integration into the life cycle of construction projects [10, 11]. One of the main benefits of BIM is the accurate geometrical representation of building parts within an integrated information environment [12]. Furthermore, BIM reduces the duration and cost of the project, improves maintenance management and increases the building value [7]. BIM also improves communication between the different

project parties [13]. On the other hand, BIM as a new phenomenon seeks to renew the practices of the construction industry, so it is subject to several challenges facing its application [14]. For the implementation of BIM, good planning and a coordinated approach with considerations for implementation and innovation management is required.

II. FACTORS MOTIVATING THE APPLICATION OF BIM

When authors in [15] investigated the factors that motivate the application of the BIM, he concluded that the two most important factors were leadership and a supportive environment. Author in [16] agreed on the importance of leadership as a key point in facilitating the application of BIM. The government should take the leadership role in the implementation of the BIM, but this is not enough. It should support and cooperate with other parties who have an impact on the development of Iraqi projects, such as specialists in the private sector, contractors or other specialists [16]. Making BIM mandatory was considered by specialists as an effective way to motivate institutions to move to BIM as this experience proved to be successful in the UK, USA, and Singapore [16]. In the context of mentioning cooperation, authors in [17] pointed out that one of the most important points to facilitate the task of implementing the BIM is the deployment of new cultures urging cooperation among stakeholders. Providing adequate training and upgrading knowledge of BIM will enhance its application [18, 19]. In the other hand, contracting with experienced BIM and professional trainees for BIM software is a step in facilitating the application and use of BIM [20]. Table I provides a summary of top BIM motivation factors according to previous researchers' studies.

III. RESEARCH METHODOLOGY

This paper studies the factors motivating the application of BIM in Iraq. The data were collected using the field survey method through the design of a special questionnaire for this purpose and its distribution to the engineers working in the Iraqi construction sector in both Ministry of Higher Education and Scientific Research and Ministry of Construction, Housing, Municipalities and Public Works (in Diyala Governorate as a case study).

TABLE I. SUMMARY OF BIM MOTIVATION FACTORS IN PREVIOUS STUDIES

Country and reference	Motivation factors for BIM adoption	Country and reference	Motivation factors for BIM adoption
USA [21]	<ul style="list-style-type: none"> Strategies to reduce strong resistance Improve cooperation skills Acceptance of stakeholders to BIM 	Australia [22]	<ul style="list-style-type: none"> Improvements in information technology (IT) infrastructure Improvements in computer hardware and software Government interest through the adoption of BIM for many demonstrator projects
USA [18]	<ul style="list-style-type: none"> Increase the level of knowledge of BIM Provide adequate training Coordination among stakeholders in the project Provide adequate support by senior management for BIM application. 	Australia [23]	<ul style="list-style-type: none"> Coordination among stakeholders in the project Provide adequate support by senior management for BIM application Contribution of different parties (education providers, specialists, supply chain Alliances) to develop broad lines towards application of BIM
UK [24]	<ul style="list-style-type: none"> Adopting collaborative methods and approaches within the design team Provide staff with experience in the field of BIM Provide contract forms that are suitable for use of BIM Development of standards for use of BIM 	Korea [25]	<ul style="list-style-type: none"> Organizational and individual confidence towards the use of new technology Provide adequate training Develop commitments to use BIM within the organizations and firms The government's obligation to use BIM in projects
China [26]	<ul style="list-style-type: none"> Prepare validation for BIM tools Pressure by government Coordination among stakeholders in the project 	Malaysia [27]	<ul style="list-style-type: none"> Compelling and supporting by the government Provide adequate training Provide adequate support by senior management for BIM application
Australia [28]	<ul style="list-style-type: none"> Provide adequate support by senior management for BIM application. Develop higher strategies that encourage cooperative work, conflict resolution and reduce the strong resistance to change towards new technologies Develop a plan for BIM adoption by the government. Not only training to expand knowledge of BIM, but dealing with external organizations of investors and experts with expertise in the field of BIM 	Nigeria [29]	<ul style="list-style-type: none"> Increase the level of knowledge of BIM Expanding the scope of research related to BIM Provide adequate support by senior management for BIM application. Provide adequate training Facilitate educational facilities for the purpose of supporting their use The government's obligation to use BIM in projects

A total of 130 questionnaires were distributed, 65 in the Ministry of Higher Education and Scientific Research and 65 in the Ministry of Construction, Housing, Municipalities and Public Works. 114 were returned at a response rate of 87.7%. The questionnaire included two main parts: the first part is the personal information regarding the respondent: gender, age, academic qualification, specialization, group and work experience. The second part included 13 items representing the importance of motivation factors for the application of BIM designed in the five- Likert scale [30] from 1 to 5, 1 being not important and 5 being very important. After the collection of the questionnaires, they were arranged, unloaded and analyzed using the statistical packaging for social science (SPSS) software, Version 24. The statistical analysis represents the creation of some descriptive statistics such as frequency, percentage, mean and standard deviation and also calculated the value of the relative importance index (RII) in order to give ranks to the items.

IV. RESULTS AND DISCUSSION

A. General Information for Respondents

The demographic characteristics of target respondents are shown in Table II.

B. Statistical Validity and Reliability

Access to acceptable results within any research requires the use of accurate measurement instrument as one of the basic

requirements. Among the main objectives of the researcher is to design his research tool and make it characterized by three main qualities (be meaningful, be accurate, be efficient) [31]. Therefore, validity and reliability tests were conducted on the obtained data from the pilot survey which was conducted before the main study. Validity of instrument can be defined as the degree to which the instrument measures what it is supposed to measure [32, 33]. For the purpose of the test statistical questionnaire validity internal consistency was performed. Through internal consistency correlation coefficients between each element in a particular part are measured with the part as a whole [34]. Table III shows the values of the Spearman rho correlation and p-values for all items. Results showed that correlation coefficients ranged from 0.496 to 0.755 and all p-values were less than 0.05 which indicates that the items are consistent and valid to measure what has been set to measure. Reliability indicates the stability of the results when these are redistributed again for the same sample. One of the most common methods of calculating reliability and the value of the Cronbach's alpha constant from 0 to 1 and the closer to 1 indicates the high degree of reliability [35]. Table IV represents a classification for the degree of reliability according to the value of the Cronbach's alpha coefficient. When the Cronbach's alpha method was conducted for the questionnaire, the results were shown within the good limits with 0.899 value. This result confirms the reliability of the questionnaire.

TABLE II. RESPONDENTS PROFILE

Information about	Categories	Percentage (%)
Gender	Male	77.2
	Female	22.8
Age (years)	20-30	32.1
	31-40	24.7
	41-50	32.1
	More than 51	11.1
Academic qualification	Diploma	1.8
	Bachelor	75
	Master	11.6
	Ph.D.	10.6
	Other	1
Specialization	Architect	6.3
	Civil Engineer	64
	Electrical Engineer	9.9
	Mechanical Engineer	14.4
	Other	5.4
Group (Job)	Designer	14
	Consultant	9
	Project manager	10
	Site engineer	56
	Other	11
Practical experience (years)	Less than 5	19.5
	5-10	24.8
	11-15	15
	16-20	24.8
	More than 20	15.9

TABLE III. INTERNAL QUESTIONNAIRE CONSISTENCY

Motivation Factors	Correlation Coefficient	Sig. (2-tailed)
M1	0.644**	0.00
M2	0.751**	0.00
M3	0.691**	0.00
M4	0.773**	0.00
M5	0.662**	0.00
M6	0.683**	0.00
M7	0.670**	0.00
M8	0.679**	0.00
M9	0.702**	0.00
M10	0.714**	0.00
M11	0.679**	0.00
M12	0.625**	0.00
M13	0.500**	0.00

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

TABLE IV. RELIABILITY CLASSIFICATION [35]

Cronbach's alpha	Degree of reliability
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

C. Motivation Factors of BIM Adoption

This part consisted of 13 items that motivate the application of BIM. These items were taken from previous studies after their adaptation, modification and integration at certain points. These items were then subjected to the respondents' view and the results were then analyzed. One of the techniques used in the analysis of data is the relative importance index (RII). The

purpose of its use is to give a rank for each item in a particular part in the questionnaire [36]:

$$RII = \frac{\sum W}{(A * N)} \tag{1}$$

$$RII = \frac{5(n_5) + 4(n_4) + 3(n_3) + 2(n_2) + n_1}{5(n_5 + n_4 + n_3 + n_2 + n_1)} \tag{2}$$

where W is the weight given by respondents for each component (ranging from 1 to 5), A represents the highest weight (which equals to 5) and N represents the total number of respondents.

Sign test is equivalent to “One sample t test” and it is execute based on dealing with the value of a medium for a single sample that is not complying with the parametric test conditions and its idea is based on the assumption of the medium value for the distribution of the sample and then give “sign” for all the values of sample depending on the value of whether it is greater or less than the hypothesis medium and thus gives a binomial probability for the observed pattern of sample values [37]. The sign test of BIM motivation factors was performed with a cut off value of 4 and 61% percentage. For the Likert five point scale the assumption is that 61% for answer is equal or more than 4. Table V illustrates the values of the descriptive statistics sign test results, the value of the relative importance index RII and the rank of the items according to (RII, mean and standard deviation).

Figure 1 shows the values of the relative importance index of the thirteen items. Results showed that M7 (establish an educational base for BIM by making it part of the curriculum education in universities) represented the highest rank. This result may have taken the top rank because Iraqi universities lack a curriculum related to BIM, especially in the early stages of the study. M1 (promote local awareness of BIM benefits through workshops and courses as well as specialized conferences) took second rank, probably because the Iraqi construction sector suffers from poor knowledge regarding BIM. The third rank is for M13 (contracting with international specialists with experience in BIM filed), because many countries have previous experience in the application of BIM and the use of their experts has a positive impact on the application of BIM in Iraq. Since all p-values in sign test results are less than 0.05, and by the ratios shown in the Table, it is found that more than 0.61% of the respondents evaluated the BIM motivation factors as “Important” and “Very important”.

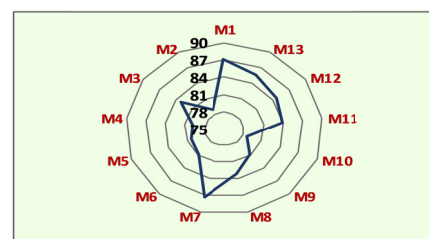


Fig. 1. Relative Importance Index (RII) for Motivations Factors

TABLE V. RESULTS OF BIM MOTIVATION FACTORS STATISTICAL ANALYSIS

NO	Items	Sign Test					Mean	SD	RII %	Rank
		N		Observed Prop.		Sig. 1-tailed				
		≥4	<4	≥4	<4					
M1	Promote local awareness of BIM benefits through workshops and courses as well as specialized conferences	100	14	0.88	0.12	0.000	4.36	.82	87.19	2
M2	Government policy is to make use of BIM mandatory through developing special laws	83	31	0.73	0.27	0.006	3.93	.97	78.77	12
M3	Provide government support for the implementation of BIM in companies and firms	93	21	0.82	0.18	0.000	4.15	.86	83.16	7
M4	Detailed analysis of project life cycle costs to convince the clients of financial returns from using BIM	91	23	0.80	0.20	0.000	3.99	.92	79.82	11
M5	Disseminate positive views to reduce strong resistance to change resulting from adhering to traditional practices and programs	92	22	0.81	0.19	0.000	4.01	.89	80.35	10
M6	Raise the level of public-private partnerships	86	28	0.75	0.25	0.001	4.04	.85	80.88	9
M7	Establish an educational base for BIM by making it part of the curriculum education in universities	101	13	0.89	0.11	0.000	4.36	.77	87.19	1
M8	Allocation of financial funding to support the costs of BIM adoption	93	21	0.82	0.18	0.000	4.16	.83	83.16	6
M9	Raise awareness of cooperation culture importance between different stockholders	88	26	0.77	0.13	0.000	4.05	.87	81.05	8
M10	Development of contracts and legal rules governing the use of BIM	83	31	0.73	0.27	0.005	3.93	.84	78.60	13
M11	Raise the employment rate for fast-learning ages of engineers	95	19	0.83	0.17	0.000	4.20	.89	83.86	5
M12	Develop skills of inexperienced engineers through Specialized systematic programs	99	15	0.87	0.13	0.000	4.22	.94	84.56	4
M13	Contracting with international specialists with experience in BIM filed	94	20	0.82	0.18	0.000	4.28	.93	85.61	3

V. CONCLUSION AND RECOMMENDATIONS

This paper studied the factors that motivate the application of BIM in Iraq. This was discussed through a theoretical study that included a comprehensive survey of previous studies followed by analysis of the results of the survey that was prepared for this purpose and results showed that the highest three factors are “BIM is to include it in the educational curricula”, “Raise awareness through courses and workshops”, and “Contracting with international experts with experience in BIM”. A set of recommendations are needed to be considered including the need to update the curricula of civil engineering and architecture and these curricula should be working on student development in both modelling skills using BIM tools as well as working skills within the BIM collaborative environment. Also, the need to raise the level of knowledge in BIM by providing courses, conferences and training workshops about it, provide material and moral support by various organizations and finally the importance of attracting internationally individuals competent with extensive experience in the field of BIM.

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