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EXPLORING BARRIERS IN IMPLEMENTING BUILDING INFORMATION MODELING: A PRELIMINARY STUDY

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This study involves with Building Information Modeling (BIM) and exploring the reasons behind the slow speed of implementing this method in the construction industry in developing countries in general and Jordan in specific. The aim of the research was achieved through a survey which considered 15 barrier factors and 13 driving factors. The study revealed that the level of BIM implementation in construction projects is generally low. In addition, the significant barriers affecting the adoption of BIM are lack of qualified staff to operate the software, difficulty learning BIM, the existing system fulfils the need, resistance to change and uncertainties concerning return on investment of BIM. Also, the study pointed out the most important factors that could help implementing BIM in the Jordanian construction industry. These are providing BIM training program, introducing BIM in the university curriculum and providing the efforts by the government to push implementation of BIM in their projects. Finally, the paper presented some recommendations if followed the level of (BIM) implementation in this country may be improved.

Keywords: Building information management, Construction industry, Developing countries, Jordan.

1 INTRODUCTION

The construction industry in Jordan plays an important role in the economy of this country. It contributes to approximately 3 to 3.5 percent of the Gross Domestic Product (GDP) Annual Growth Rate (DOS 2014). The industry is facing large amount of deficiencies resulted due to cost overrun, time overrun, low productivity, low quality, using old technology, etc. (EBRD 2014).

In implementing construction project, the amount of information exchanged among parties is huge. These include documents, drawings and other information. The current procedures concerning exchanging information create mistakes because of the huge quantity of documents. These are resulted because these documents are in paper format and their management resulting miscommunication among the parties involved in the construction process.

If wrong information is distributed among parties, that could affect the efficiency of the project. This is mainly due to the fact that in a construction project, information might be the most effective item in the process. In this case, managing information is very desperate to ensure that all parties involved in the construction process receive the correct information. The employment of Building Information Modeling (BIM) is one of the schemes to accomplish these objectives (Kaner *et al.* 2008, Khandoz *et al*. 2008).

2 OBJECTIVE OF THE RESEARCH

The research aims to study the reasons behind the slow speed of implementation of this method in the construction industry in Jordan and the factors that could increase the level of adoption of this technique.

3 LITRATURE REVIEW

3.1 Definition and Concept of Building Information Modeling (BIM)

In general, BIM is a 3-dimensional illustration of a building project including its fundamental components. The BIM system is a combination of smart project components which consist of information attributes and parametric principles for each item (Hergunsel 2011).

BIM can be defined in many ways. The National Institution of Building Science defined BIM as the new concepts and practices that are so greatly improved by innovative information technologies and business structure that they will dramatically reduce the multiple forms of waste and inefficiency in the building industry (NIBS 2007). Rafael *et al.* (2010) considered BIM as conceptual path to the design of the different types of buildings.

Manning and Messer (2008) also mentioned that utilization of BIM system for the concept planning will enable the employees, in a short period, to develop the isometric and details of sections. All these can be developed prior to the contracting with the design and build contractors.

3.2 Benefits of BIM

The benefits of BIM can be recognized at the different phases of the project. It arises in the last few years as a promising and significant concept, and is seen as the future revolution of the Architectural Engineering and Construction (AEC) industry (Kassem *et al.* 2012).

3.3 Barriers Affecting the Adoption of BIM

There are many previous research works related to identifying barriers of BIM implementation. Kassem *et al.* (2012) developed a survey included contractors and consultants involved in UK construction process. The study revealed that the highest three barriers are: lack of benefits, lack of experience and lack of universal use within projects.

Arayici *et al.* (2011) attributed these barriers to many reasons including: resistance to change from parties, training required on BIM software, and current method (2D drafting) are adequate for their projects and BIM is an unnecessary investment. The technical matters include upgrading the system, interoperability, compatibility and complexity (Khanzode *et al*. 2008)

In Germany, Von Both and Kindsvater (2012) studied the barriers affecting the implementation of BIM in building industry. The study showed that 2-D planning is still preferable technique by the planning engineers in 60 % of their projects. The study categorized the barriers into four groups: technological, general, normative and educational.

In the Middle East, a survey carried out by Building Smart (2011) to find the capabilities and barriers related to adoption of BIM. The highest three barriers are: availability of skilled staff, cost of software and cost of implementation.

In Qatar, Ahmed *et al.* (2014) carried out a survey which identified and ranked 17 barriers to examine BIM/4d implementation in this country. The study revealed the three most effective barriers are: Knowledge about BIM, absence of contractual requirements and resistance to change.

In Malaysia, a study by Zahrizan *et al.* (2014) revealed that the parties involved are having difficulties to implement BIM because there is no national BIM standards and guidelines to follow. Another study at the same country carried out by Memon *et al.* (2014) revealed that the rate of BIM implementation in this country is very low. Major barriers are lack of competent staff to operate the software, unawareness of the technology and non-availability of parametric library.

Two studies were carried out in Iran. The first is by Hosseini *et al.* (2015) identified are almost entirely associated with the structure of the Iranian market, the nature of the construction industry and business environment and the lack of attention by policy makers and the government. The second is by Kiani *et al.* (2015) which concluded that the barriers were lack of legal backing from authority, lack of skilled BIM software operators and high price of software.

In Turkey, a study by Ezcan *et al.* (2013) was carried out to address the BIM gap between Turkey and United Kingdom in terms of awareness and use. The findings identify significant differences in BIM adoption between these two countries.

4 METHODOLOGY

The literature review revealed a survey which targeted parties involved in the construction process. The main aim of the survey was to discover and identify the relative importance of the barriers and driving factors affecting the Building Information Modelling in the construction industry in Jordan. The survey questionnaire consists of four sections. The first was to recognize the respondent's characteristics. The second part was set to discover the level of implementation of BIM in the Jordanian industry. The respondents were asked to select the level of this implementation (very high, high, medium, low or none). The third section concentrated on the barriers factors affecting the adoption of BIM in construction projects in Jordan. A defined fifteen factors revealed out of the literature review. The respondents were asked to rate their level of agreement on the importance of each factor on a five-point Likert scale. The fourth section of the questionnaire is related to the factors, if considered, will push the adoption of BIM in the construction projects. A defined thirteen factors were considered. The same five-point Likert scale was adopted.

Due to the fact that little amount of database for BIM is available in Jordan, it was not easy to predict, in accurate, the population size. The rule of thumb suggested by Olejnik (1984) was followed. The data collection approach was to get as much as respondents as possible.

5 DATA ANALYSIS

5.1 Reliability Test

Testing the reliability of the questionnaire was carried out using Cronach's alpha testing tool. Cronbac's alpha is 0.78 which is greater than 0.70 bench mark which means good level of consistency and reliability of the collected data.

5.2 Ranking of Barriers

The factors were ranked according to their relative importance index (RII). The RII is determined using Eq. (1):

$$RII = \frac{\sum WX_i}{AN} \quad (1)$$

where W is the selected weighting to each factor – according to participant's answer. This is ranges from one to five where one is "strongly disagree" and five is "strongly agree", X is the frequency of each answer, A is the highest possible weight for that response is five in this particular case, N is the number of respondents. In addition, the significant factors for the results of each party involved in the survey were identified. The significant factors are those with RII above the average RII's of the group.

6 RESULTS AND DISCUSSIONS

6.1 Number and Characteristics of Respondents

The questionnaire was delivered and collected in person. These were distributed to 150 participants in Jordan out of which 58 responded. The respondents have different level of experience in the private and public sectors clients, consultants and contractors. They were involved in different types of projects.

6.2 Level of BIM Implementation

The survey revealed that the majority of the respondents (about 79%) declared that the level of the organization's implementation of BIM was between "Low" and "very low".

6.3 Barriers Ranking

Table 1 shows the most significant barriers according to clients, consultants, and contractors and the overall results. The significant factors are those with RII above the average RII's for each group and the overall factors.

Table 1. The significant factors revealed by for each group.

Client related factors	**Consultant related factors**
• Difficulty learning BIM • Resistance to change • The existing system fulfils the requirements • Lack of qualified staff • Uncertainties – return on investment • Contractual requirements • Lack of training and education	• Lack of qualified staff • Difficulty learning BIM • Resistance to change • Uncertainties – return on investment • The existing system fulfils the requirements • Lack of procedures and standards • Lack of knowledge about BIM
Contractor related factors	**Overall factors**
• Lack of procedures and standards • Lack of qualified staff • Contractual requirements • The existing system fulfils the requirements • Uncertainties – return on investment • Contractual requirements • Lack of procedures and standards	• Lack of qualified staff • Difficulty learning BIM • The existing system fulfils the requirements • Resistance to change • Uncertainties – return on investment • Lack of procedures and standards • Lack of knowledge about BIM

6.4 Driving Factors in Implementing BIM

The survey showed that the variables that could most increase the opportunity of adopting this technology in the Jordanian construction industry are the following:

- Providing adequate training for construction staff.
- Introduction of BIM in University Curriculum.
- Providing, by the government, all the efforts in the direction of pushing the implementation of BIM
- Provision of legislations on the usage of BIM in construction projects.
- The Engineering and Contracting bodies have to take responsibility to introduce BIM in the industry.
- The Engineering and Contracting bodies are to set standards and guidelines for BIM implementation.

7 CONCLUSIONS

The study presented in this paper revealed the following:

- Low level of BIM adoption and shortage of interest.
- The five most significant barriers affecting the adoption of BIM are: lack of qualified staff, difficulty learning BIM, the existing system fulfils the need, resistance to change, uncertainties concerning return on investment of BIM.
- The most important factors that could help implementing BIM are: providing BIM training program, introducing BIM in the university curriculum and providing the efforts by the government to push implementation of BIM in their projects.

8 RECOMMENDATIONS

Based on conclusions presented in above, the following matters can be recommended:

- The training centres, universities and engineering firms could introduce the BIM technology among students and engineers.
- The government ministries should play their roles through enforcing adoption of BIM in the university curriculum and their projects.
- The government departments should produce legislation on the usage of BIM and giving some incentives for adopting this technology.
- The Engineers and Contractors Unions should introduce BIM in the industry.

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