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Understanding BIM Adoption in the AEC Industry: The Case of Jordan

M Btoush[1]**, AT Haron**[1]

[1]Faculty of Civil Engineering & Earth Resources, University Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Pahang.
Corresponding author: wardbtoush2012@yahoo.com

Abstract. Building information modelling (BIM) is a new and powerful technology implemented by many countries. The construction industry in Jordan plays a vital role and contributes immensely to the economic growth and development. In order to boost the industry and the economy, many industry players including engineers and contractors have recommended the implementation of BIM in Jordan. However, research demonstrates that successful BIM implementation is possible through the awareness of the different levels of BIM, which is a basic precondition for BIM implementation. Without a clear understanding of BIM, many companies would be unable to fully achieve BIM potentials or implement BIM in their building lifecycle. The objective of this study is to assess the current awareness of BIM technology in the Jordanian construction industry. A field interviews were conducted and 15 responses were collected and. The findings indicate that a significant proportion of respondents have little or no understanding of the concept of BIM. Also, the usage was found to be very low. Based on the results, a holistic roadmap was developed to spread the BIM adoption through the Jordanian construction industry. It is expected that this roadmap would lead to a better understanding and enable the industry towards more extensive implementation of BIM.

1. Introduction

Building information modelling (BIM) is a new and powerful technology implemented by many countries [1–6]. The construction industry in Jordan plays a vital role and contributes immensely to the economic growth and development [7]. In order to boost the construction industry and the economy, many industry players including engineers and contractors have recommended BIM's adoption in Jordan. However, research demonstrates that successful BIM implementation is possible through the awareness of the different levels of BIM, which is a basic precondition for BIM implementation [3,8–10]. That is, the first step in BIM technology adoption is to understand what exactly BIM is about [11]. Without a clear understanding of BIM, many companies are unable to fully achieve BIM potentials or implement BIM in their building lifecycle [3,8]. Similarly, despite several attempts by companies to interpret and apply the BIM, many are still struggling with design quality issues, high design and execution costs, long lead times, and these are mostly attributed to the lack of clear understanding and the absence of a comprehensive implementation roadmap. Moreover, several studies have been conducted on BIM implementation issues in other countries [1–3], conversely, not much have been carried out on BIM implementation issues in Jordan.

The objective of this article is to assess the current state of the BIM awareness within the architecture, engineering, and construction (AEC) industry in Jordan.A field study was conducted and

15 survey responses were collected and analyzed. The findings indicate that a significant proportion of respondents have little or no understanding of the concept of BIM. Also, the usage was found to be very low. Based on the results, a holistic roadmap was developed to spread the BIM adoption through the Jordanian construction industry. It is expected that this roadmap would lead to a better understanding and enable the industry towards more extensive implementation of BIM.

2. Literature review

BIM is an IT enabled tool with integral digital representation (data repository) for different project lifecycle phases [11]. BIM technology is emerging as one of the most promising tools, both in construction management and practical sphere of building construction [4]. The use of BIM improves methods and tools to control risks, fragmentation and increase collaboration in construction projects. BIM is a framework designed to ensure sustainability, facilitate the integration of disjointed practices, reduce poor quality and act as a catalyst for changing business process [1,2,12].

Several studies have been conducted on BIM's adoption in several countries including Norway, Finland, Sweden, Germany, Malaysia, Singapore, France, USA, Australia, and UK [1–3,10,13–16], and BIM has demonstrated the capacities to improve information integration, business process flow, productivity, and reduce complexities, uncertainties, conflicts, fragmentations, among others [3]. Explicitly, BIM can save between 3% and 5% in costs, boost gross domestic product by 0.2 basis points, and present an accurate virtual model to digitally construct a building [5,11]. BIM is a promising recent development, an emerging procedural and technological shift within the AEC sector [12,17,18]. It is more reliable in streamlining the procurement of component parts or materials for production and in delivering projects within the shortest possible time [5,19]. BIM can be used for design, planning, construction and operation of a building facility. Generally, BIM can improve scheduling and minimize the mistakes and errors caused by modifications [20,21].

BIM is spreading widely and quickly, yet it is still relatively new in the Middle East [8], specifically Jordan. BIM has been adopted in Dubai, Kuwait, among others, however, the implementation rate is very low [8]. According to van Berlo L A H M and Papadonikolak [16] and [9], the adoption of BIM in the Middle East region is low. The study indicated that only 24% of companies used BIM, about 43% did not know how to utilize BIM, 41% were interested in using BIM but did not have the technical capabilities to start. Also, the study by Gerges *et al.* [8] indicated that only 20% of the AEC organizations are using or in the processing of adopting BIM in the Middle East. Moreover, it is confirmed that the Middle East has the most reduced BIM implementation rate due to lack of awareness and understanding as professionals only see BIM as a tool for 3D modeling of the building [9]. Thus, BIM is mainly used in the Middle East for design authoring, 3D coordination, and clash detection [9].

Although the use BIM in the Middle East is a recent phenomenon, its adoption in Jordan is very scarce [8–10]. Moreover, through the synthesis of literature, it has been recommended that more research to identify and analyze BIM definitions, changes, awareness, challenges and how the challenges should be addressed are needed to facilitate BIM adoption, especially in Jordan. Thus, the need for a quantitative analysis that is focused on Jordan. Considering the varying understandings of BIM from the literature review, the subsections below address BIM capability stages, BIM maturity levels, and BIM competencies. These are further evaluated and analyzed through a survey in Jordan.

2.1. BIM capability stages

BIM is an interactive set of processes, policies, and technologies producing an approach to manage essential building designs and project data in a digital format all through the building's life-cycle. However, according to Succar [22] in his "*Five Components of BIM Performance Measurement*," this definition delimits the BIM domain which continuously expands in connotation and coverage. To fully grasp the meaning of BIM, Succar suggested that professionals need to understand the BIM capability stages. The capability stages could be divided into three, which can further be subdivided into competency sets:

- **BIM Stage 1:** Object-Based Modelling of using virtually integrated design, construction and operation. For instance, the organizations considered at this stage should have employed an Object-Based Modelling software tool like Revit, ArchiCAD, Constructor or Tekla.
- **BIM Stage 2:** Model-Based Collaboration. For this stage, the organizations should have been part of a multidisciplinary Model-Based collaborative project.
- **BIM Stage 3:** Network-Based Integration. For this stage, the organizations should have deployed a Network-Based solution such as model servers to share Object-Based with not less than two other disciplines.

2.2. BIM maturity levels

The BIM maturity is repeatability, quality, and excellence with the BIM Capabilities. There are three main BIM maturity levels [3,23–25]. The maturity levels are characterized as 2D/3D, BIMs and iBIM. The BIM maturity level in an organization affects their understanding of BIM and its definition. Similarly, an organization's level of maturity can be assessed through their general objectives. For instance, organizations conducting pilot projects and testing to determine BIM's benefits may be at stage 1 (Object-Based Modelling) and within that stage they are at a defined or an ad-hoc maturity level, striving to be more optimized through continuous testing. Barlish and Sullivan [25] provides a detailed description of the maturity levels. Figure 1 presents the BIM maturity map, indicating the levels, capabilities, and descriptions.
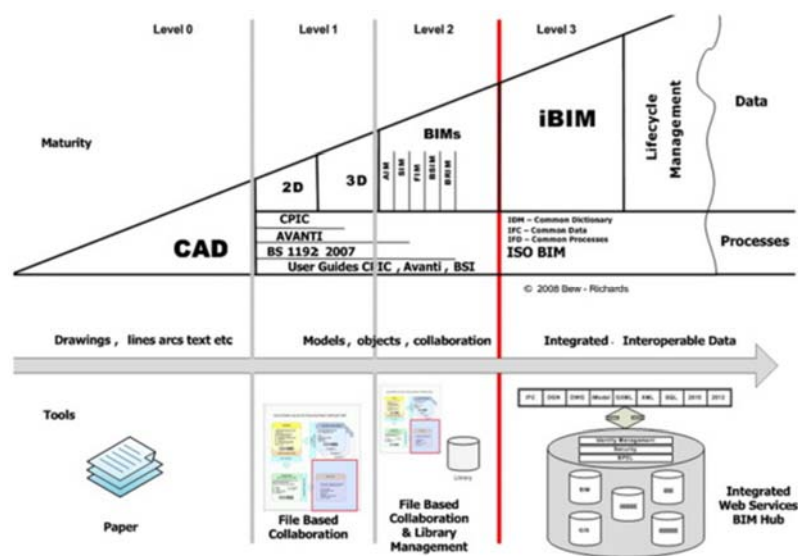

Figure 1. BIM Maturity Map [25].

2.3. BIM competencies

A set of BIM competency is a hierarchical pool of individual sets of competencies recognized for BIM assessment and implementation purposes [22]. There are three major sets of BIM competencies:

- Technology sets in hardware, software, and networks. For instance, the readiness of BIM tools allows the transfer from drafting-based to Object-Based workflow (BIM Stage 1 requirement).
- Process sets in human resources, infrastructure, leadership and services/products. For instance, skills in database-sharing and collaboration processes are required to allow Model-Based Collaboration (BIM stage 2).
- Policy sets in regulations, contracts and education/research. For instance, contractual agreements are required for Network-Based Integration (BIM stage 3). Figure 2 presents the

structure of BIM competency sets, indicating the fields, stages, lenses, competency sets and their descriptions.
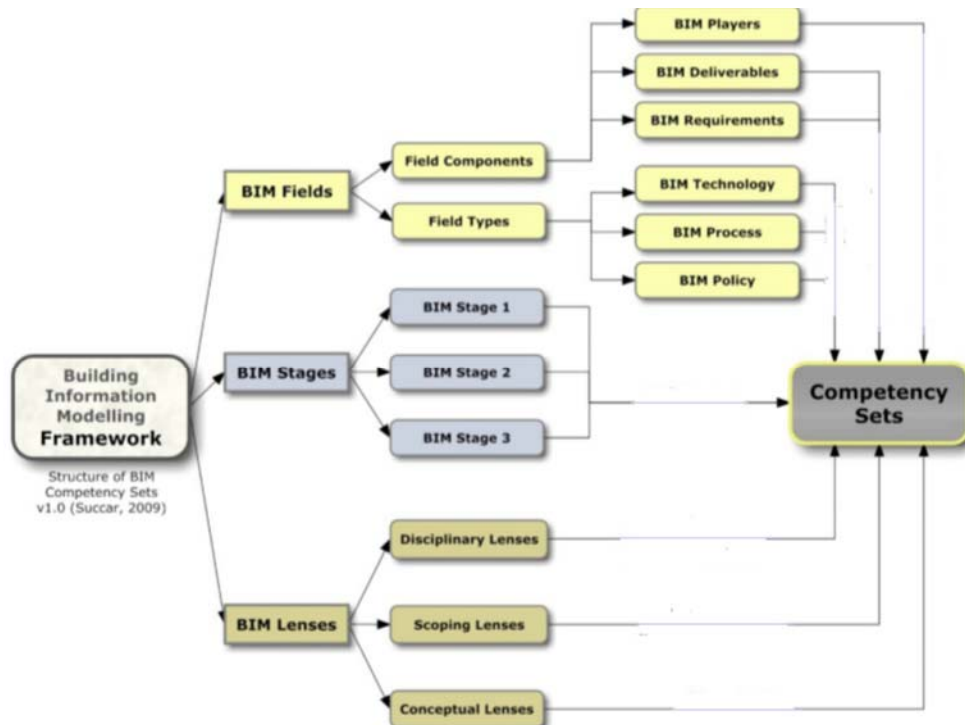

Figure 2. Structure of BIM Competency Sets [22].

3. Research methodology

The expert interview as a method of qualitative empirical research, designed to explore expert knowledge, has been developed considerably since the early 1990s. Furthermore, the expert interview has become very popular as a "streamlined" method [4]. The main focus of this article was to assess the current state of the BIM awareness within the architecture, engineering, and construction (AEC) industry in Jordan. Therefore, qualitative methods were applied in this research. Because it is a new phenomenon, the contextual analyses and qualitative methods seem appropriate as they better explain why and how [26]. The researcher demonstrated this by analyzing survey responses from the viewpoint of construction organizations representatives to measure the different levels of BIM awareness. First, an interview questionnaire structure was developed to assess the perceptions of the respondents of the relative awareness of BIM technology. The criteria for respondent's selection was based on the objectives of this study, and simplified as following: a) The respondent experience in the construction industry is more than 15 years b) The respondent work for a high-profile construction organization (Grade A based on the Jordanian Contractors Association) c) The respondent has excellent academic background (has published more than two papers in the Jordanian construction industry field).

Further, the responses were collected and analyzed. The analysis focused on measuring the different levels of BIM awareness. Table 1 illustrates the questions about BIM definition, BIM implementation, and BIM awareness responsibility.

**Table 1.** BIM Definition, BIM Implementation, and BIM Awareness.

		A	B	C	D	E
Q1	BIM Definition	Modelling Software	Model-Based Collaboration	Network-Based Integration	BIM is an interactive set of processes, policies, and technologies producing an approach to manage essential building designs and project data in a digital format all through the building's life-cycle.	I am not sure
Ans.		-	2	8	5	-
Q2	BIM Implementation	BIM is well-known in Jordan and many firms implement it	BIM is well-known in Jordan but a little number of firms implement it	Some construction firms in the industry know what BIM is but don't implement it	No single firm knows what BIM is nor implement it	I am not sure
Ans.		-	3	9	2	1
Q3	Awareness Responsibility	It is the government's responsibility	Private sector's responsibility	Construction associations' responsibility	Educational institutes' responsibility	All the mentioned
Ans.		9	2	1	1	2

4. Results and discussion

The categories of the analysis of the data are based on the personal experiences and background of the respondents, their understanding, and awareness of BIM. The responses reflected a variation in terms of BIM definition. While 2 (13.3) individuals characterized BIM as a Model-Based Collaboration, 5 (33.3%) defined BIM as "an interactive set of processes, policies, and technologies producing an approach to manage essential building designs and project data in a digital format all through the building's life-cycle." Likewise, 8 (53.3%) believed that BIM is a Network-Based Integration. In terms of BIM implementation, 6.7% (1 respondent) was not sure about BIM implementation in Jordan. 13.3% (2 respondents) believed no single firm knows what BIM is nor implement it, 20% (3 respondents) indicated that BIM is well-known in Jordan but a little number of firms implement it, and 60% (9 respondents) believed that some construction firms in the industry know what BIM is but don't implement it. In terms of BIM awareness responsibility, the majority of the respondents (60%) agreed that it is the responsibility of the government to promote BIM. However, 13.3% attributed the responsibility to the private sector, 13.3% to all the mentioned, 6.7% to educational institutes and 6.7% to construction association.

With such a varying understanding, these definitions were evaluated to reflect the maturity levels of understanding and awareness. The general overview of the results was dominated by more respondents on the individual questions. Thus, the survey results were able to reflect the understanding of BIM across the Jordan construction industry. Furthermore, the results indicated that professionals have an understanding of BIM yet lack the capacity to implements it. Perhaps clear guidance, training, and financial and technical support would boost extensive BIM implementation across Jordan. Based on the results, a holistic roadmap has been developed to spread the BIM adoption through the

Jordanian construction industry. This is illustrated in figure 3 indicating the overall model for BIM awareness.
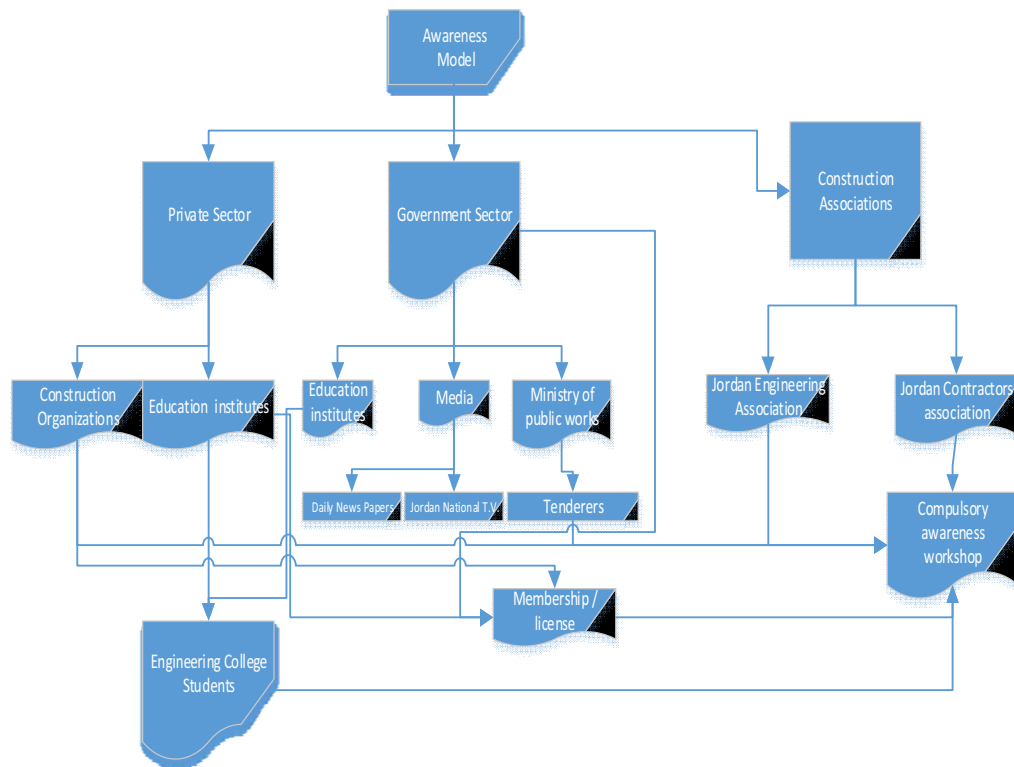
Figure 3. Model for BIM Awareness.

5. Conclusion

BIM adoption is increasingly becoming a must for the AEC industry to integrate the construction process and address challenges in the building lifecycles. In using BIM maturity gauge, the results demonstrated that professionals have a better understanding and are aware of BIM (53.3% and 60% respectively), but lack the capacity to implement it. This may be due to the lack of training staff on new process and workflow, new software and technology, the lack of familiarity with BIM use, client expectations, lack of the capital to invest, resistance to culture change, among others. Perhaps clear guidance, training, and financial and technical support would boost extensive BIM implementation across Jordan. More also, the government, the private sector, construction association and educational institutes are called upon to promote BIM adoption in the Jordanian construction industry. Based on the results, a comprehensive roadmap has been developed to spread the BIM adoption throughout the Jordanian construction industry. It is expected that this roadmap would lead to a better understanding and enable the industry towards more extensive implementation of BIM.

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