

Adoption Approaches for BIM Implementation in Construction Projects: Jordan as a case study

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Abstract. Despite of its contribution to the GDP, the construction industry is contemplated as one of the most challenging sectors. Poor performance due to poor communication and the exceptional disconnected environment to the construction sector have been identified as the main issue faced by the construction players. Although much studies related to BIM adoption has been investigated in most countries mainly those developed countries, little has been done in Jordan. The application of BIM is capable to integrate information and smoothen the process flow resulting in increase of productivity. Besides, it also reduces project complexity by minimizing the occurrence of conflicts and uncertainties. This study aimed to investigate the adoption strategies of BIM implementation which suit to the Jordanian construction environment. In order to achieve the objectives of the study, comprehensive review was conducted to identify the current scenario of construction practice and challenges. This study used the qualitative approach to conceptualize the selected theoretical adoption framework through semi structure interviews. The interview respondents are mainly from the major construction organizations in Jordan. The result revealed that, the adoption of BIM in Jordan is still at its infancy. The major barriers of BIM adoptions ranges from awareness, skills, expertise or specialist, government support, high initial cost and resistance to change. This study is expected to provide significant guideline to expedite the adoption process of BIM in the Jordanian construction industry. Furthermore, the newly proposed framework would be used as tool to benchmark the readiness of the industrial player in adopting BIM.

Keywords: BIM adoption, construction industry, semi structured interview.

INTRODUCTION

Construction industry with is dirty, dangerous and demanding is perceived as a challenging industry. Like other countries, construction is industry is vital to boost the economy of Jordan. However, the Jordanian construction

industry is challenged with low productivity that include delay and cost overrun [1]. Therefore, Hiyassat et al. argued that there is an urgency to uplift the level of awareness amongst the engineers and supervisors from the perspective of good quality management practices since to minimize the productivity issues in Jordan [2]. Besides that, there are critical communication issues due to erroneous drawings and documents which lead to confusion, delays and cost overrun [3]. As a consequence, BIM which is a good integrated system could possibly resolve the construction issues in Jordan [4].

BIM has proven to uplift the information integration which increases the productivity at the same time reducing the construction complexity, uncertainty, conflict and fragmentation [5]. From the perspective of cost, the adoption of BIM which have high precision reduces the cost approximately 3-5% [6]. Moreover, BIM is the latest development that is promising and evolving procedural and technological shift within the AEC sector [7-9]. It is more dependable when attaining parts or materials for production and delivering projects within the shortest possible time has been streamlined [10]. Numerous studies have been conducted on the adoption of building information modelling (BIM)'s in developed countries [5, 11-13]. While according to Jordan, Al Awad stated that the Public Works and Housing Ministry, jointly with the association of Jordanian Engineers, signed an agreement with Building SMART MENA to start a Building SMART forum in June 2011 to encourage BIM adoption in the construction sector; the target was to control the industry outputs. The result of the survey revealed that Jordanian contractors are not using BIM [14]. Based on social, cultural, financial, technological and legal factors, the use of BIM does not exist.

On the other hand, Al-Shammary and Ali mentioned a large gap in the Jordanian construction industry to benefit information technology in project's site management as the main engineering practice [15]. By moving beyond elementary applications like Microsoft Office, the construction sector can achieve the most of the Return on Investment (ROI) in information technology. Thus, this will give a clearer view of enabling IT to more competitively procure future construction products and processes [16]. BIM is becoming a popular tool not only in the project management but also for field supervision. It is mostly a collaborative set of processes, policies, and technologies that manage vital building designs and project data through the building's life cycle. Research has revealed that identifying barriers and challenges is a basic precondition for the transition of BIM in the Jordanian building sector. The issue of adopting BIM is the key management shift that encompasses diverse risk areas. In addition, research has revealed that identifying the setback that for successful BIM implementation possible in Jordan.

BUILDING INFORMATION MODELLING

The National Building Information Model Standard (NBIMS) Project Committee defines BIM as a digital representation of physical and functional characteristics of a facility. It is a shared knowledge resource for information about a facility establishing an unswerving basis for decisions in its lifecycle, from earliest conception to demolition. Moreover, Anderson et al. stated that locative data in a spreadsheet is considered data modelling like building an information model, especially if alphanumeric data is involved in simulating a real business progression [17]. On the other hand, BIM is a technology which is capable to assist architect in managing complex design and construction procedures.

The rapid evolvement of the construction industries had led to many issues, such as huge and complicated construction technology, massive investment, determining the construction period, and the relationship between multiagent stakeholders [18]. Generally, the results of these issues reflected in the cost and time of the project. Therefore, Building Information Modeling contributes to realizing multiple benefits for the construction industry, such as short time of the completion, less waste of material, great efficiency during the project life cycle, complete the project in high quality, and improved communication between the project parties.

Besides, from planning, design, construction, maintenance, and destruction, BIM is a powerful tool to govern construction information, organization, roles and procedures required [3]. Therefore, most countries particularly developed countries have adopted BIM for a more productive construction industry. Sutter Medical Centre (USA), Crussel Bridge (Finland), One Island East Office Tower (Hong Kong (HK)), National Cancer Institute (NCI) (Malaysia) and Sultan Ibrahim Hall (Malaysia) are the few fine examples of projects which has successfully adopted BIM in their construction [10, 19]. Furthermore, the aim of BIM implementation in construction projects varies depending on the phases of the project [19,20]. As a result, various organizations have developed computer programs different ICT system to address various issues through the project lifecycle. The evolution of BIM definitions produced using computer tools from 1975 to 2013 is summarized in Figure 1 as adopted by Latiffi et al. [3].

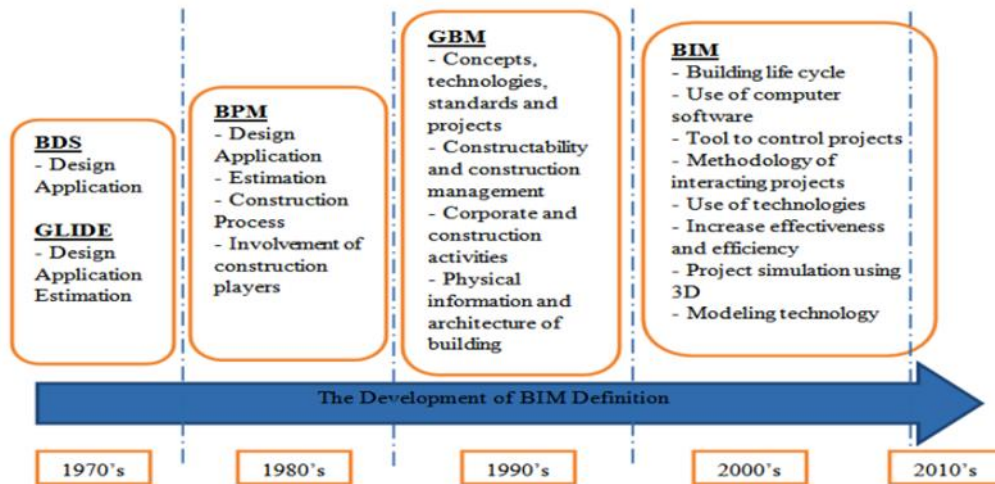


FIGURE 1. The Development of BIM Definition
Source: Adopted by Latiffi et al. (2014)

To examine influencing factors for a successful BIM adoption, Ahuja et al. built a model based on the technology-organization-environment framework [21]. To examine the factors that stymie BIM adoption in the construction industry, Qin et al. suggested an integrated TAM (technology acceptance model) and TOE (technology-organization-environment) framework [22]. The TOE framework identifies three contextual elements for organizations to accept innovations: technology, organization, and environment [23]. Also, Songer et al. have recommended incorporating economic elements into the adoption framework [24].

BIM adoption has progressed through three stages at the organizational level: the first is the multidisciplinary object-based modelling process, the second is the synergy based on the existing model, and the third is the network-based synergy [25]. In the United States, Australia, and other industrialized countries, this three-stage BIM adoption approach has been employed. They want to see BIM become more extensively used [26-27]. Nonetheless, in developing nations, BIM adoption is at a standstill. In most developing nations, BIM has not been used throughout the entire construction cycle [28]. Especially in Jordan, the adoption of BIM in Jordan is still in a very primitive phase, and it faces a number of critical barriers such as, but not limited to, the absence of government incentives, the lack of BIM standards, lack of BIM awareness, lack of BIM need, cost and resistance to change. Also, the majority of studies examine the influencing elements from the standpoint of a specific adoption model. For example, the BIM adoption level is not very high in China [29]. In India, BIM adoption maturity is estimated to be quite low [30]. Due to the high costs of applying Building Information Modeling, its application in most developing countries is limited.

RESEARCH METHODOLOGY

This study aims to retrieve genuine information and opinions on BIM implementation in the Jordanian construction industry, providing support developments in the Jordanian construction industry practice by producing a BIM adoption framework. To achieve the study objective, the researcher adopted a qualitative method for data collection and analysis. To get the experience and perceptions about BIM adoption, direct interviews will be conducted with top management and project managers. Therefore, the best suitable technique for collecting data is 'interviews. During the interviews, the researcher used open-ended questions to explore BIM adoption issues in Jordanian construction institutions based on the participants' experience. The questions covered the main topics related to BIM in the Jordanian construction industry, such as barriers and challenges facing BIM adoption, the awareness of BIM technology, and the drivers to adopt BIM.

Semi-structured interviews are proposed to collect current study data to understand the respondents' views and opinions. There is provision for opportunity through the semi-structured and in-depth interview for further investigation of the responses given. The opportunity for a better understanding of these senses will add wisdom and obligation to the data gained. In addition, there is an avenue for participants to use words or ideas in different ways. This technique may lead to better understanding since interviewees guide debates into zones not well-thought-out earlier but matching the research inquiry. Moreover, Saunders advises that the investigator should consider that the mode of communication in the interviewees will influence the quality of data gathered [31]. The flow chart of research methodology is summarized as shown in Figure 2.

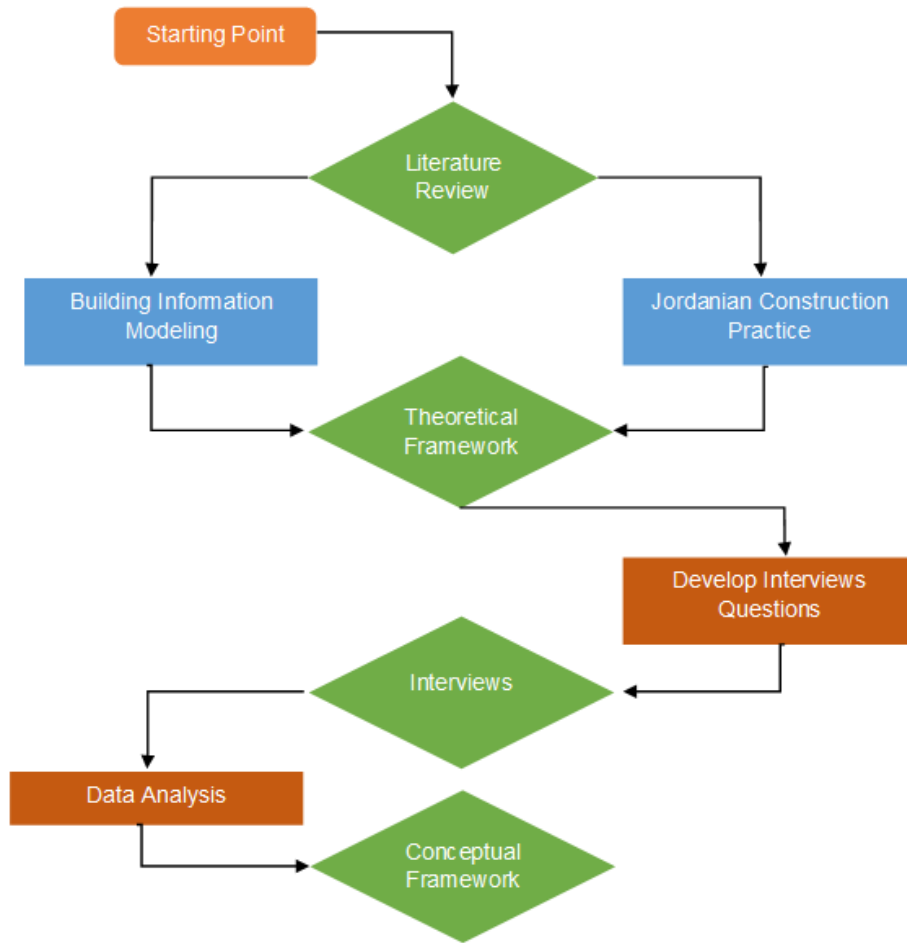


FIGURE 2. Flow chart of research methodology

RESULTS AND DISCUSSION

This study aims to discover and analyze the current status of Building Information Modelling (BIM) adoption among construction organizations in Jordan. To achieve this, the study adopted the qualitative approach through create semi-structured interviews to collect study data. Accordingly, interviews were held with 15 engineers working in the Jordanian construction sector, where they were senior management and managers. Because most BIM activities that occur at this scale are administration collaboration, data and information distribution and communication.

The participants' analysis revealed that all the participants have experience in the construction industry of more than 10 years. In addition, most of them have bachelor degree with 73.3%. At the same time, 53.3% of the participants are contractors, followed by 26.6% consultants and 20% owners. According to the job position of the participants, most of them are project managers with 60%, and the other 40% are top managers. Participants' background shows that they are qualified to provide the necessary data for the study, based on their experiences in the Jordanian construction industry.

The researcher kept a set of questions to ask every respondent, which allows the study to path any adjustment in the data collected. The researcher documented the interviews by recording tapes. Firstly, the data was transliterated and then analyzed using a content analysis technique to identify the major themes. A coding scheme was settled to check the data for a more comprehensive analysis. The main themes recognized from the analysis of the content besides the literature inspection serve to develop the coding scheme used for data analysis. These major themes were classified under the following categories: BIM understanding, Challenges/Barriers, Drivers to adopting BIM, and the organization's readiness to adopt BIM.

Construction industry challenges

Relatively, as a result of the findings of the interviews, the majority of the respondents believe that the Jordan construction industry is faced with serious challenges; 90% of the respondent believe that these challenges led to delay and cost overruns and these challenges include: poor scheduling and planning, poor design, ineffective communications, lack of competent technical staff and change orders among other challenges facing the construction industry as shown in Figure 3.

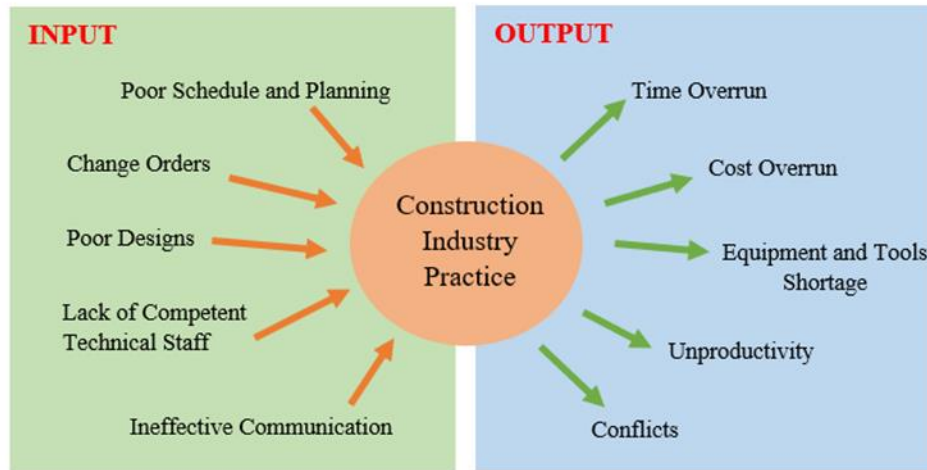


FIGURE 3. Construction industry challenges

BIM Understanding

Through literature review, it is found that Jordan is ranked the least in BIM implementation on projects, as stated by [32]. Also, Al Awad (2015) study shows that BIM does not exist in Jordan [14]. Therefore, interviews conducted by the researcher begin by the lookout for the assurance of that information or its denial. Based on the findings of the interviews, there is a low-level implementation of BIM in Jordan as no single construction organization in the sample uses it. All the respondents emphasized that BIM is implemented by a small number of organizations in their project constructing process. 53% of the respondent are aware of BIM in the surface context of the concept, and they have no

deep information about it. For example, they have the knowledge of BIM as a method and approaches for integration data sharing and networking. In comparison, 47% of the respondent do not know what BIM is. Therefore, the responses of the participants confirm that construction organizations in Jordan do not widely implement BIM. More details of the BIM Understanding summarize in Figure 4.

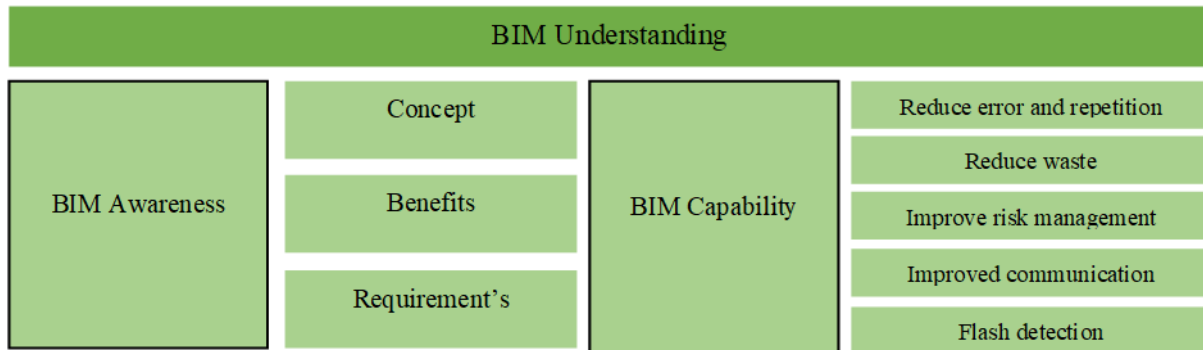


FIGURE 4. BIM Understanding

BIM adoption challenges & Barriers

The researcher asked the participants who are aware of the benefits of BIM about the confrontations and obstacles that hinder the adoption of BIM. In the first place, the wakefulness of BIM, as stated by 12 respondents. The project managers think the organization top management will not invest their money in an unfamiliar technology. A respondent from one of the biggest construction organizations said there is no BIM training Centre and BIM specialist in Jordanian construction until this time. According to 12 respondents, the necessary training centre is not available”, was in the next place of challenges and obstacles. At the same time, “no previous experience nor BIM specialist is available” was in the third place of challenges and barriers against BIM adoption. More details of the BIM adoption challenges & Barriers are illustrated in Figure 5.

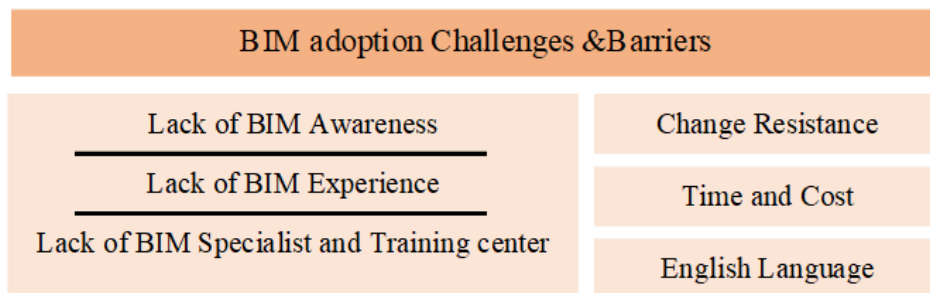


FIGURE 5. The BIM adoption challenges & Barriers

BIM Drivers

About 20% of the respondents feel that in driving BIM to Jordan, all parts of the construction industry are responsible for this, i.e., public and private sectors altogether. This includes the key stakeholders in the construction projects as the owners, the consultants, and contractors. Three driver categories were identified as a baseline summary of respondents' opinions regarding BIM accreditation facilitators. These include government actions, construction industry associations, firm responsibility, and collaboration between all the parts, as shown in Figure 6.

Government action

About 40% of the respondents believe that this could push BIM adoption into the Jordanian construction industry if the government starts implementing BIM models. Another respondent assumed that importing a specialist in BIM and obligating contractors to join the training Centre is the government's responsibility, provided it wants to participate in government tenders, especially those of the Ministry of Public Works and Housing, to implement BIM. Additionally, respondents assume that the government can develop a strategic plan for adopting BIM models within the next five years.

Construction associations

about 23% of the respondents do not trust the government's action as they believe more in construction associations. For example, for contractors who wish to be a member of JCCA, an aptitude exam has been designated for them, and in addition, an awareness course could be added to the exam while the same valid for JEA. Moreover, one of the respondents mentioned that this would be the only means to adopt BIM in Jordan.

Firm responsibility

About 17% of the respondents believed the initiation should begin from within the firm itself as they become the main beneficiary in the long run. The problem is that clients do not demand BIM technology. Generally, BIM can increase the firm's capital by reducing waste and drawing a product procedure with a perfect job description for all staff. They believe that BIM can be better driven by the private sector better than the public sector. About 67% of the respondents (10 respondents) believed that the organization readiness is the most important factor in the adoption process, where more than 50% of the respondents believe that the organization readiness in terms of technology infrastructure (hardware, software and communication networking) is a must condition to adopt BIM.

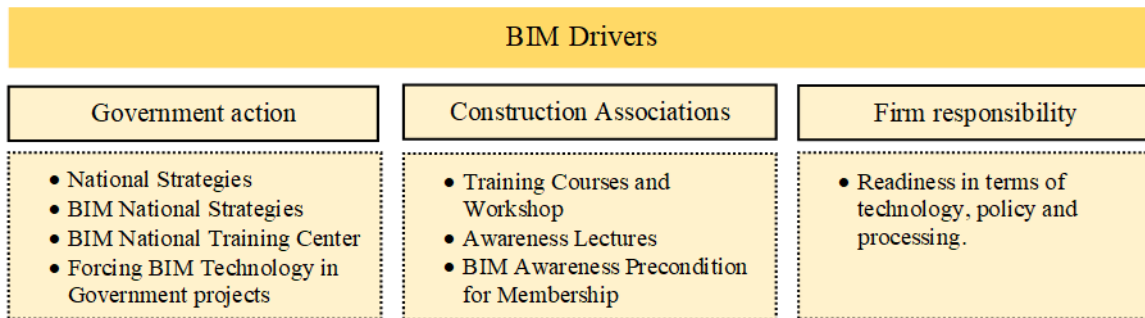


FIGURE 6. The BIM Drivers

BIM adoption strategies

The best strategy for BIM adoption as proposed by the majority of the respondents (13) is by beginning with the drawing of a national BIM program that could be released by JEA and adopted by JCCA. on the other hand, about 12 of the respondents suppose the adoption should set off by putting down the BIM principles like the Jordanian building code. In contrast, 12 respondents assume that MPWH can set a strong strategy by making BIM technology in government projects compulsory. More details are shown in Figure 7.

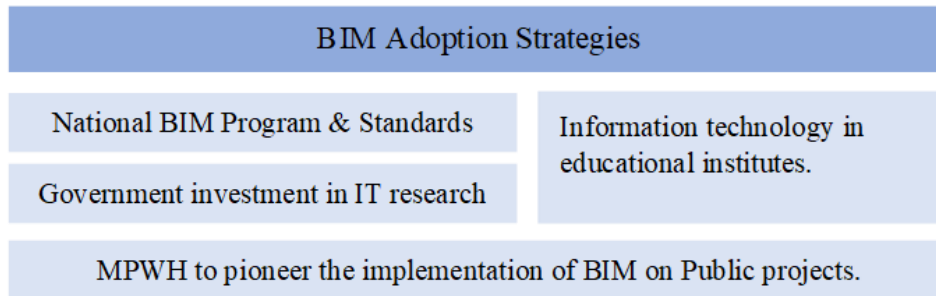


FIGURE 7. The BIM Adoption Strategies

CONCLUSION

The construction in Jordan is presently in a difficult loop where the absence of understanding and awareness about BIM end in the absence of assurance and drivers to adopt BIM-based cooperation. On the other hand, the knowledge about BIM technology still lows. Consequently, there is reticence to implement and use BIM until this time. Therefore, most organizations in the construction industry are still ongoing on the use of AutoCAD. Amongst all participants, it was observable that the main theme was “Absence of awareness” of BIM, establishing the fact that there is a gap amid education. Besides the associations of construction, the government should work together to create awareness of the benefits of BIM to have its way amongst construction organizations. Also, the provision of national strategies and the release of laws to adopt BIM will play an important role in pushing adopting BIM.

This study focuses on the adoption of BIM in Jordanian construction projects, which helps in assessing and exploring the challenges and obstacles facing the adoption of in developing strategies to pave the way for the adoption of, which will contribute to reducing many of the problems faced by stakeholders during the implementation of construction projects. Therefore, this study provides a database to conduct other studies regarding BIM adoption in Jordanian construction projects.

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