Minimizing delays in the Jordanian construction industry by adopting BIM technology

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Minimizing delays in the Jordanian construction industry by adopting BIM technology

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Abstract. The Jordanian construction industry plays a significant role and contributes immensely to the gross domestic product (GDP) of the economy. However, the Jordanian public work and housing ministry and most industry players including engineers and contractors have reported that most of the projects experience delays which lead time and cost overruns, and extra efforts. The main causes of delays identified by researchers include poor scheduling and planning, change orders, site conditions, weather, late deliveries, incompetent technical staff. To address these challenges, the implementation of building information modelling (BIM) is paramount. This paper presents BIM as a powerful tool for reducing delays in Jordan construction projects. The paper focuses on two main parts; the first part involves the identification of the major causes of delays, and the second part is to accurately outline the roles and responsibilities of BIM specialist in construction projects. Finally, the paper matches the roles and responsibilities of BIM specialist and the causes of delays, and how the delays are addressed through BIM specialist.

1. Introduction

The Jordanian construction industry plays a significant role and contributes immensely to the gross domestic product (GDP) of the economy [1]. However, the Jordanian public work and housing ministry and most industry players including engineers and contractors have reported that most of the projects experience delays which lead time and cost overruns, and extra efforts. The main causes of delays identified by researchers include poor scheduling and planning, frequent change orders, site conditions, late deliveries, poor designs, lack of competent technical staff, among others [1,2]. In order to address these challenges, the implementation of building information modelling (BIM) is paramount [3,4]. The use BIM in the Middle East is a recent phenomenon, especially, its implementation in Jordan is very scarce [5–7]. Nonetheless, BIM is emerging as a new tool, both in construction management and practical sphere of building construction. Researches have demonstrated that BIM has the capacity to improve methods and tools to control delays, fragmentation, risks and increase collaboration in construction projects. Likewise, the use of BIM facilitates the integration of disjointed practices, enhances sustainability, reduces poor quality and acts as a catalyst for changing construction process [8].

Several studies have shown potentials of BIM implementation to increase productivity, information integration, business process flow, and reduce uncertainties, complexities, fragmentations, conflicts, among others [3,4,9]. However, not much has carried out in Jordan to explore the effectiveness of

BIM to minimize the issues of delays in Jordan. This paper presents BIM as a powerful tool for reducing delays in Jordan construction projects. The paper focuses on two main parts; the first part involves the identification of the main causes of delays, and the second part is to accurately outline the roles and responsibilities of BIM specialist in construction projects. Finally, the paper matches the roles and responsibilities of BIM specialist and the causes of delays, and how the delays are addressed through BIM specialist. Thus, this will enable the industry towards more extensive BIM implementation to address delays and other wastes in the Jordanian building industry.

2. Related research

2.1. Delays in Jordan construction projects

Delays are common in most projects [8,10–21] and the Jordanian construction industry is not an exception. For instance, in the Middle East, several delays have been reported in Saudi Arabia [12,22,23], Egypt [24–26], UAE [14], Kuwait [27–29], Qatar [28,29], Bahrain [30], Oman [26,31], Yemen [32,33], among others.

In Jordan, there are major public and private infrastructure projects that have experienced delays. The factors causing delays in the Jordanian construction industry include frequent changes made by clients, climate, site and weather conditions, delays in deliveries, economic conditions, financial problems, lack of technical know-how, poor designs, poor planning and management, and others [1,2,34,35]. Based on a comprehensive literature review, the delay factors have been summarized in table 1. The table presents the factors causing delays from some relevant studies conducted about the delays in Jordan construction projects. The three most common delays from the available literature are *poor design, lack of communication between parties and poor scheduling and planning* [1,2,29,31,34–41].

Table 1. Major causes of delays in Jordan.

Researchers	Major causes of delay
[1,2,34–36,38,40]	Poor design
	Negligence of the owner
	Change orders
	Site condition
	Weather condition
	Late delivery
	Economic conditions
	Increase in quantities
[34,39–42]	Mistakes during construction
	Slow decision-making by clients
	Construction methods
	Improper planning
	Shortage of materials
	Documents
	Lack of communication between project parties
	Preparation and approval of drawings
[1,29,31,36–38]	Poor scheduling and planning of projects by contractors
	Frequent change orders by owners
	Shortage of manpower (skilled, semi-skilled, unskilled labor)
	Incompetent technical staff
	Financial difficulties faced by contractors

2.2. Building Information Modeling (BIM)

BIM is one of the most recent developments, an emerging procedural and technological shift within the architecture, engineering, and construction (AEC) sector [43–45]. Researches have shown that BIM, a three-dimensional (3D) parametric modelling software has the capacity to address a number of technical challenges in construction projects. For instance, BIM can reduce the costs of engineering and rework due to defects. It also enables uninterrupted flow of information, improves engineering productivity, improves customer services, reduces lead times and design errors. BIM is more reliable in delivering projects within the shortest possible time and in streamlining the procurement of component parts or materials for production [8,46]. Similarly, BIM can reduce the time, mistakes and errors caused by modifications [47,48]. Reports on BIM indicate that the adoption of BIM can save between 3% and 5% in costs, can boost GDP by 0.2 base point above the 'business as usual scenario' and has a remarkable effect design, construction and the economy [8,49].

BIM technology has increasingly been adopted by many AEC companies. These companies regularly seek to hire the most technically-skilled and creative design specialists available, especially with regard to BIM [50]. The motivation for these specialists is to address the issues of quality, schedule and cost overruns. According to Odeh and Battaineh [42], successful execution of construction projects and keeping them within the agreed schedule and estimated cost depend largely on the methodology which requires sound engineering judgment. In order to minimize delays through the use of BIM, the understanding of the roles and responsibilities of the BIM specialist is vital. Table 2 and table 3 presents the roles and responsibilities of BIM specialists [50–56]. The understanding of the roles and responsibilities could be used to gauge BIM potentials with regard to delay mitigation.

Table 2. Roles and responsibilities of BIM specialist.

BIM Specialist	Roles and Responsibilities
BIM Modeler	• The roles of the BIM Modeler are to develop, create and extract 2D documentations from BIM models.
	• May occupy the position of the Draftsperson
3D Modeler	• Develops the geometry in the BIM models, working in groups to create different parts of the model.
Cost Modeler	• Embeds information about the processes and resources required.
Detailing Modeler	• Designing, drawing, sizing, specifying, detailing, verifying and documenting the design process.
Sequencing Modeler	• Adds phases to the resources develops building phasing files used for planning by the general contractors.
BIM Analyst	• Performs simulations and analyses based on BIM models, e.g., security analysis, building performance analysis, etc.
Modelling Specialist	• Contributes along with specialists in various areas of the industry, to the standards, from the software product's requirements to the final characteristics.
BIM Application Developer	• Creates and customizes the software to bolster integration and BIM processes, from plug-ins to servers, data repositories, and integrated project management tools.
BIM Facilitator	• Assists other specialists. Generally, he works with those that physically construct the building, helping the engineers to communicate with contractors or foremen.
	• Extracts information from the BIM model for space planning, asset management, and maintenance schedule.
BIM Consultant	• Guides designers, builders and developers in BIM project implementation.
Functional	• Develops action plans according to strategies.
Operational	• Executes the process of implementation.
Strategic	• Develops strategies, typically, from medium to long-term based on a vision of accomplishment.
BIM Researcher	• BIM experts in research institutions, universities and government organizations who coordinate, teach or train and develop research on BIM.

Table 3. Roles and responsibilities of BIM specialist.

BIM Specialist	Roles and Responsibilities
BIM Manager (General)	• Oversees people in the implementation as well as maintenance of BIM processes. • Coordinates the team, production, and implementation of the model. • Inspects and evaluates the objectives of the BIM process and afterward designs a plan to meet the desires and demands of clients. • Performs other functions including coordinating entity model's integration, setting design templates, etc. • Guides the decision-making of the team.
Project Model Manager	• Concentrates on the production model, interacts with other project actors and the system. • Coordinates information from various construction stakeholders, which guarantees non-dilution of the responsibilities between the contractor and the design team. • Plans the mechanisms of maintenance and exchange of data • Determines the necessary conventions for the management and reviewing of model versions. • Holds meetings or calls with the modelers and the client to determine the required models, owners of the models and the responsibilities. • Divides projects into teams of modelers. • Verifies interference and keep the models accurate and updated. • Ensures the alteration of models when there is a request for changes. • transfers, access rights control, and information compilation from smaller models of different members. • Avails model files to general contractors. • Identifies communication errors, improves communication and information technologies and facilitates communication protocols. • Manages and supports detailing teams for the implementation and establishment of BIM standards. • Specifies detailing budgets for cost estimations.
BIM Manager (Design Firm)	• Responsible for BIM implementation • Coordinates project teams and establishes connections for correspondence between various offices. • Attends developmental plan meetings for BIM project implementation. • Arranges training for workers to keep them updated about the trends and versions of BIM software. • Attends and participates in industrial conferences. • Designs materials to educate clients of the company's BIM capabilities, evaluates new products and verifies technical problems and deficiencies in the software, hardware and the net. • Ensures teams' commitment by developing an effective procurement system so that every agent performs its responsibilities.
BIM Manager (Contractor)	• Assists in the estimation of time and cost for implementation • Uses BIM software. • Designs a plan for small teams that after training perform works with BIM. • Responsible for resources management (people, software, and hardware) involved in model development. • Select the right individuals for every project activity. • Promotes credibility and confidence in the project team including clients, subcontractors and internal team members.

3. Discussion

It has been indicated that delays have become an integral part of project's construction lifecycle. Even with project management understanding and modern advanced technology, construction projects still experience delays [57]. The question which arises is, "is BIM capable of resolving the delay issues?" To address this question, the major delays in the Jordanian construction projects are matched to the responsibilities of the BIM specialists in table 4 to explore BIM's potentials for minimizing delays.

Table 4. Delay cause and the required strategies.

Delay Cause	Strategy to adopt by organization's top management
Poor design	Hiring BIM specialist to divide the phase into intervals (designing, drawing, verifying) which demand technological infrastructure (ex. 3D modelling software, valid account with Autodesk., well trained staff to deal with software).
Lack of communication between project parties	In this case, BIM specialist will act as a communication cycle between the projects partners by modelling the project and make it available to all the parts, update using integrated communication web site so any correction on the model will be available to all partners. The specialist' duty is to identify communication errors, improve communication and information technology and facility communication protocol. Also, he coordinates project teams and establishes connections for correspondence between various offices.
Poor scheduling and planning	To address this issue, the BIM specialist will develop the geometry in the BIM models, working in groups to create different parts of the model, embeds information about the processes and resources required, add phases to the resources develops building phasing files used for planning by the general contractors, extracts information from the BIM model for space planning, asset management, and maintenance scheduling, develops strategies, typically, from medium to long-term based on a vision of accomplishment.

4. Conclusion

BIM implementation can lead to a successful construction of projects. BIM application can increase productivity, business process flow, and reduce wastes, uncertainties, complexities, fragmentations, conflicts, thus leading to quality construction projects. It also benefits construction projects by minimizing construction cost and improving information and communication between project parties, leading to delay mitigation. The use of BIM facilitates the integration of disjointed practices, enhances sustainability, reduces poor quality and acts as a catalyst for changing construction process. From the discussion, it was seen that BIM can resolve the major delay issues including poor design, lack of communication between project parties, and poor scheduling and planning in the Jordanian construction industry. With training, client and government support, it is expected that BIM technology would be used more widely in the Jordanian construction projects. This study opens the door for more realistic research's about adopting BIM as powerful tool to address delay issues in the Jordan construction industry.

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