BIM Impact on Construction Project Time

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Building Information Modeling (BIM), a complete process that can improve every aspect of a project, is crucial in the building sector. BIM makes it feasible for design, construction, and engineering teams to employ digital technologies. It typically produces better results overall.

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1. Introduction

The construction sector in Saudi Arabia is growing swiftly to meet the increasing demand for projects under Vision 2030. For instance, Saudi Arabia has seen an unparalleled increase in building over the past 20 years, resulting in the fast expansion of the country’s infrastructure, including the emergence of new cities, transportation infrastructure, airports, highways, and other types of infrastructure. This expansion, in turn, has led to construction experts worldwide becoming involved in investment and sector development. However, project delay is still a significant challenge hindering the Saudi construction industry. Such a prevalent occurrence of delays, from the point of view of experts and academics, has negatively affected the construction industry. For example, Saudi University Campus construction projects (UCP) experienced delays ranging from 50% to 150%, with 99% overrunning anticipated costs in 2016.

Moreover, in 2019, 40% of Saudi public buildings were delayed, and in the following year, 355 reported that educational projects were delayed. Furthermore, the Saudi Contractors Authority announced that construction firms were the businesses that most frequently claimed bankruptcy. These delays result in various issues, including increasing costs, litigation, conflicts, and project discontinuation. The adverse effects of the delays motivated the researchers to explore the root causes of the delays and the potential solutions. Since 1991, Saudi researchers have narrowed their focus to exploring the factors causing delays and the percentage of delays. Interestingly, within the traditional construction process, the literature revealed consistency in the construction project delay factors between the Saudi context and those of other countries.

As a result of the current high delay occurrence, there is a need to use the new technology advantages in the construction industry. Globally, there is an increase in interest in fourth-generation technologies, the most significant of which is Building Information Modeling (BIM) in construction. BIM, a complete process that can improve every aspect of a project, is crucial in the building sector. BIM makes it feasible for design, construction, and engineering teams to employ digital technologies. It typically produces better results overall. In addition, BIM has enormous prospects concerning reducing the scheduled time. BIM boosts technological work during the planning phase by developing 3D models that cover every structural perspective and characterize the framework’s requirements competently. Planning assignments may also improve the models. Honnappa and Padala utilized BIM in examining delay when considering a change in management.

Notably, even with the wide diffusion of BIM technology and its benefits to project success, there is still a need for project owners, consultants, and contractors to understand how BIM will affect their projects. The lack of trust is one of the biggest obstacles to adopting BIM; the lack of trust extends to methods for project management, communication, and data sharing among team members. Farouk et al. stated that management, readiness, ability, cooperation, cognition, education, and administration establish confidence in BIM-based construction projects. Several studies examined the influences on BIM capabilities, which improved the utilization of BIM. For example, Rajabi et al. investigated crucial factors for evaluating organizational BIM capabilities in Malaysia and Iran. He stated that knowledge of BIM capabilities is needed for the construction industry to recognize the benefits of executing BIM. Rani et al., through an examination of government strategies, discussed the challenges that prevent the use of BIM in the Indonesian construction industry and presented several proposals.
One of BIM’s features in improving construction practice is dealing with the Common Data Environment (CDE). Reasonable and operative BIM and Historic Building Information Modeling (HBIM) projects are shared and managed through a CDE. A CDE is a digital medium or software that promotes project stakeholders’ cooperation, data sharing, and version control. Within a CDE, various BIM models, data, and documents related to the project are stored, collected, and made accessible to authorized users. This centralized repository ensures all project participants can access the most up-to-date information, reducing errors and enhancing coordination. Therefore, sharing data for BIM stimulates its use more in Saudi Arabia.

On the other hand, the interdependencies of the factors that impact the BIM capabilities were examined using a Partial Least Square Structural Equation Model (PLS-SEM) and System Dynamics (SD). At the same time, Tu et al. evaluated the status of BIM performance in the building phase by studying the interactions among the factors that impact the BIM system using SD. Moreover, most BIM studies have focused on the challenges that hinder BIM performance in such sectors. Moreover, some researchers found that these challenges included delay risk factors that hindered the BIM construction projects, such as ineffective planning and scheduling. This finding, in turn, led to the question: What is the association between the BIM implementation and the construction project delay factors? According to BIM studies, e.g., Al-Gahtani et al., it is generally known that BIM implementation contributes to a reduction in construction project delays. Some studies revealed that the delay reduction rate percentages reached savings of 5% to 10%. Nur Sholeh et al. stated that BIM led to a reduction in planning time of 50%, and in some studies, it reached up to 50%.

### 2. Delay-Related Issues in Saudi Building Projects

The Saudi building sector is expected to experience exponential growth in the coming years as it prepares for the post-oil era when new major cities will be planned and built. Given the importance of the Saudi construction sector since 1991, several local researchers have shed light on improving the sector by narrowing their focus to exploring the causes of delays to create improvement. For instance, Assaf and Hejji stated that the average delay ranged between 10% and 30% of the scheduled duration. They pointed out that the most significant delay factor involved change orders. Al-Gahtani et al. utilized the most commonly caused delay factors to forecast the project duration using two techniques (DEMATEL and SD).

Along with the abovementioned studies, Al-Emad et al. conducted a survey study on the Makkah building projects. The research samples included 100 contractors, consultants, and project management firm professionals. The quantitative approach disclosed the top ten factors out of 37 common delay factors in construction projects, including contractor financial issues, insufficient coordination between project parties, lack of labor, delays in producing design documents, inefficient planning and scheduling, expenditure delays, low labor productivity levels, insufficient communication between stakeholders, an inexperienced workforce, and deficiency of contract management.

To examine the main reasons why industrial and manufacturing projects in Saudi Arabia are delayed, Abdellatif and Alshibani conducted a survey study. A thorough literature review revealed 22 delay factors, which were examined by surveying 106 professionals working in the Saudi construction industry. The findings showed that the five leading causes of delays were, in order, complications for the contractor or manufacturer in funding the project, delayed material procurement, slowed material delivery, delayed progress expenses, and delayed approval of design documentation.

Interestingly, it is noted that the elements that contribute to construction building project delays are also present in the Riyadh railway and metro construction projects. For instance, a survey study was conducted by Gopang et al. with 105 participants (i.e., clients, consultants, and contractors) to identify the top five significant delay factors. Across 36 delay factors examined through a review of the literature, the top five delay factors discovered were the decision-making processes by clients and differences in the management processes, layout mistakes, a lack of skilled labor, change orders from clients/consultants, and issues with stakeholder approval and permission, respectively. Similarly, to identify the client-related causes of delays, a survey study was conducted by Alenazi et al. across 37 projects within three key public ministries. Alenazi et al. concluded that there were eight significant causes of delays, including change orders and postponements in their endorsement; poor coordination between the project parties; ineffective time management and planning; lack of finance; varied and defective designs; delays in approving the amended bill of quantities; problems on the job site; and client financial issues. A vital link was found between the delays—variations, design flaws, and payment delays—and the project cost. In examining the problem of delays experienced by building projects and organizations, and vice versa, a work based on a literature review study by Alajmi and Memon noted several delays causes and effects, such as inadequate contract management, incorrect planning, a lack of skilled employees, a delay in decision making, and financial difficulties.
Recently, qualitative research was conducted by Alshihri et al. [23] to investigate and rank the risk factors connected to delays and cost overruns in the Saudi construction sector. Accordingly, 83 risk factors were explored and examined by the questionnaire. The findings revealed that the top ten factors associated with the construction building project delays and cost overruns were the contractor’s financial difficulties, the client’s uncertainty in making progress expenditures for finished works, contracts being granted to the lowest bidder, change orders throughout the building process; the contractor’s inadequate site management and supervision; insufficient contractor experience; delays in the subcontractors’ work or by suppliers; and unqualified or inexperienced workers, respectively. The findings have shown problems with the client/contractor relationship and the distribution of tenders, which may allow companies and governmental organizations to develop plans to reduce the risks found in this study. The subject of additional studies might be the force majeure risks and how they affect the relationships between the stakeholders and supply chain systems in the Saudi construction sector.

3. BIM Impacts on Project Delay

BIM offers features like 3D visualization, clash detection, time and cost estimation, facility management, and synchronization, which provide significant advantages to the construction industry [20]. Several studies, such as [22], have shown that implementing BIM reduces wasted time, project costs, and schedule changes. BIM also positively impacts project time, cost, and quality, leading to quicker decision-making, clash detection, and data loss prevention.

In addition, to determine a link between BIM adoptions and the causes of construction project delays and cost overruns, Muhammad et al. [22] administered a survey study to 69 contractors in the Malaysian construction sector. The results demonstrated a relationship between the causes of delays and cost overruns. However, this study did not address the risk factors contributing to construction project delays and cost overruns. The findings also revealed a negative relationship between BIM adoption and the causes of delays and cost overruns. The study suggested that the increasing usage of BIM led to a substantial reduction in the cost and duration of construction projects. This finding is consistent with studies such as that of Egwim et al. [23], who conducted a systematic review, confirming the positive impact of BIM on construction project delays.

Similarly, survey research by Sarvari et al. [24] sought to identify and investigate factors that might impact the duration, cost, and quality of mass housing construction projects. The data analysis of 50 respondents from the construction industry showed a high cost and time reduction in the construction phase compared to the pre-construction phase, with a higher reduction in time and cost in the post-construction phase. In line with the residential development sector, there was an attempt to investigate the effects of BIM on the construction of two-story homes in Jeddah city. Thus, quantitative research was carried out by Almujibah [25] to look at the success factors for time and money savings in construction projects. Consequently, the results showed that BIM considerably improved home construction projects’ cost, time, quality, safety, efficiency, and environmental impact.

Alongside the studies mentioned above, there is an attempt to improve the performance of BIM abilities in managing construction delays. For example, Ali et al. [26] study claimed that BIM technology could not deal with construction delays due to a lack of associated features in such technology. As a result, a prototype called BIM-based Construction Delays Recorder (BIM-CDR) is developed for storing and visualizing information related to construction delays. Several BIM-CDR prototype benefits were identified, such as delay management, easy-to-identify delay locations, visualization of the delay’s impact, managing contracts, resolving disputes, and lessons learned. Furthermore, the same study suggested that several potential challenges linked with the implementation of BIM-CDR are, namely, a lack of BIM expertise, financial and educational needs, resistance to change, and legal constraints [27].

Regarding the impact of BIM in causes delay factors, such as inadequate planning and scheduling, in this context, construction planning and scheduling include sequencing activities over time and space considering procurement, the resources available, spatial constraints, and other process elements [30]. For example, a quantitative analysis was carried out by Nawaz et al. [31] to examine how BIM affected project planning and scheduling. The survey indicated a connection between efficient project planning, scheduling, and BIM usage.

The traditional scheduling techniques are limited in terms of detailed plans and cannot deal with strategic issues such as BIM. In addition, BIM can be applied to accelerate the project schedule, and it is not easy to demonstrate that impact with traditional scheduling techniques. This BIM impact requires a more holistic approach to quantifying, such as SD [41]. It is necessary to comprehend the strategic problems of the BIM impact to reduce project delays; this can only be accomplished through a more standard systematic analysis such as SD.
SD is a computer-aided methodology for formulating strategies and policies. The fundamental objective is to assist researchers in making better decisions when challenged with complexity. Many fields of research and engineering have used SD in various ways. SD can be used to consider the correlations between system factors and their variance with simulation time. Al-Gahtani et al. [31] developed an SD model that assumed design and implementation errors during construction. The model considered the most time-delaying factors identified by Alshihri et al. and their interdependencies with the project delay.

References
