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Research Paper

Framework for enhancing the application of building information modelling (BIM) in the Jordanian construction industry

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ABSTRACT

The construction sector in Jordan plays a major role in economic development. However, it suffers from numerous issues in most projects. Contractual problems are one such issue that needs to be addressed. Therefore, the current study aims to provide an effective framework for BIM adoption in Jordanian construction projects, as BIM is an effective approach to improving the performance of the construction sector. To achieve this, the researchers adopted a quantitative data collection approach using a questionnaire as the data collection tool. The collected data was analyzed using the Relative Importance Index (RII) to categorize the study variables. The results revealed that the critical issue in the Jordanian construction sector is discrepancies between specifications, drawings, and contract documents, with an RII of 0.74. The study also found several barriers to BIM adoption in Jordan, such as weak construction contracts, with an RII of 0.75. The framework presented in this study is important for stakeholders in the Jordanian construction sector to address the issues that hinder BIM adoption. The study recommends providing training courses on BIM software for engineers working in the construction sector to enhance their efficiency.

1. Introduction

The construction industry contributes to most countries of the world to sustainable development and effective economic growth, so it is considered one of the main and important sectors in any country. The construction industry in Jordan plays a major role in the development of human civilization and economic development, its significance is underscored by their contribution of more than 5.5% to Gross Domestic Product (GDP) of Jordan in 2023 (Jordanian Department of Statistics, 2023). Additionally, [1] indicated that the construction sector plays an essential role in struggling climate change and encouraging sustainable and green development. For the success and highlighting of the role of the construction industry, attention must be paid to the project's success factors, the most important of which are construction contracts. Due to the nature of construction contracts, vagueness or lack of clear terms in their content often guides to conflicts, change orders and cost overruns. Also, the Jordanian construction industry suffers from many challenges, the most important of which are weak construction contracts and lack of clarity in many of their clauses, which leads to exceeding the costs and time that were specified when the tender was awarded. The apparent weakness in many contract clauses in the Jordanian construction industry has led to many problems, the most prominent of which are poor communication between contracting parties, design errors, increased project implementation time, and cost overruns. According to [2], poor contract management is one of the most important factors affecting the time and cost of project implementation. In the view of [3], to resolve contractual issues, especially at the design stage, contract designs must contain the necessary flexibility that allows stakeholders to modify objectives and measurement procedures over time. Nowadays, projects in the construction industry have become more complex, which requires that contract the between the contracting parties be clearer and detailed, which leads to the smooth running of projects and thus reduces disputes and disagreements between stakeholders [4]. Furthermore, [5] stressed that there is an urgent need to review the documents and terms of contracts in the construction industry in Jordan periodically through continuous meetings with experts in the construction sectors in order to reduce the reasons for increasing costs and time for implementing projects. As construction projects suffer from the use of traditional contracts, which have created many contractual problems that often lead to disputes between stakeholders, it is imperative to turn to modern technologies to address these challenges. BIM creates a visual representation of the project that clarifies design intent, scope, and specifications. By using 3D models, stakeholders can visualize the project and better understand contractual obligations, reducing ambiguity. Building Information Modelling (BIM) is considered one of the most important technologies used in Project Implementation for reducing the negative effects of embracing traditional methods. According to the digital construction sector worldwide, [6] reported that as a result of the ability of BIM to improve the effective interaction between different stakeholders as well as developing the coordination principles, it becomes one of the digital tools that enhance construction projects to be completed easily, quickly and successfully [6]. In 2023, a study carried out by [7] showed that nowadays BIM became a common method for construction projects implementation that helps in giving all necessary information and data throughout the project life cycle and then enhancing stakeholders' effective communication. Most countries have adopted BIM as a way to deal with contracting parties and as a working method that makes the construction industry more efficient. In recent years, many countries have made BIM mandatory and contractual requirement in construction contracts and projects [8].

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Nomenclature

AW	Awareness of BIM in the Jordanian construction industry	*OB*	Obstacles in the Jordanian Construction Industry
BR	Barriers of BIM adoption in the Jordanian construction industry	*ST*	Strategies of BIM adoption in the Jordanian construction industry
BIM	Building Information Modelling	*SPSS*	Statistical Package for the Social Sciences
BM	The benefits of BIM in the construction industry	*RII*	Relative Importance Index
DR	Drivers of BIM in the construction industry	*Greek Symbols*	
DM	Project delivery method	$	The dollar sign
GDP	Gross Domestic Product	α	Cronbach's Alpha

In addition, [9] identified that if something reasonably foreseeable occurs in a project, the BIM collaborator is obliged to offer qualified services to avoid harm or loss to the client. This can be further reached by teams employed together in a cooperative atmosphere where everyone distinguishes what their tasks are. Therefore, all parties involved in the project at each stage should be attentive of what is going on in the project and the rightness of the model for each participant's aim, even if the service is not their direct responsibility. Except an identical process is recognized to isolated the contributions, rights, and obligations of the parties, there may be areas of vagueness in design responsibilities. Also, [10] added that BIM technology is an advanced digital tool as it includes many applications, and it has a vital role in the project implementation stages, as it provides correct planning and design, feasibility studies and maintenance. The Jordanian construction sector faces challenges due to ambiguous clauses in construction contracts. Contractual issues including disagreements, cost overruns, and project completion delays are sometimes brought on by these uncertainties. These problems have the potential to worsen and cause the project to fail. Establishing clear and regular channels of communication among stakeholders and making sure that everyone is aware of their duties and responsibilities are essential to reducing these difficulties. Project outcomes can be greatly improved, and these hazards can be decreased by putting into practice efficient project management techniques and utilizing contemporary construction technologies, such as Building Information Modeling (BIM).

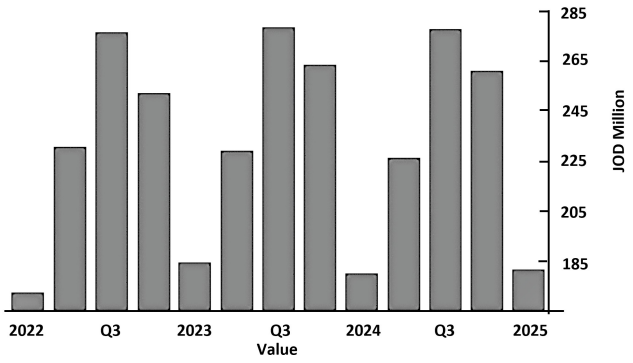

Figure 1. Jordan GDP from the construction sector (Jordanian Department of Statistics, (2023)).

1.1 Problem statement

Jordan's construction sector is essential to the nation's economic growth, yet it confronts several obstacles because of poor contract administration and execution. These flaws frequently result in disagreements, hold-ups, and inefficiencies that erode the sector's potential. The root causes and consequences of poor building contracts in Jordan are investigated in this study. By addressing the causes and consequences of poor construction contracts found in this study, it seeks to offer workable ways to enhance project performance. The shortcomings of building contracts have been the subject of numerous studies in industrialized nations, some of which may not be entirely relevant in developing nations like Jordan. By investigating the reasons behind poor construction contracts in the Jordanian construction sector specifically, this study seeks to close this knowledge gap. In addition to its capacity to improve the efficiency of construction projects and lower their cost and time—two of the biggest issues facing the Jordanian construction industry, BIM, is a sophisticated and widely used technology that also greatly improves contractual issues between parties. These problems show that urgently better contracting procedures, more robust labor and construction law enforcement, and the implementation of transparent and equitable dispute resolution procedures are needed. Addressing these gaps is essential to enhance confidence, improve project outcomes and ensure fair treatment of all stakeholders in the Jordanian construction sector. This study makes several key contributions to the literature and practice of BIM adoption in the construction industry. First, it addresses a significant research gap by focusing on the contractual and organizational challenges specific to the Jordanian construction sector an area largely overlooked in previous studies that have concentrated on developed economies. Second, the study integrates empirical evidence from a large-scale survey of 410 industry professionals, providing robust and context-specific insights into the barriers, drivers, and practical strategies for BIM adoption. Third, by developing a comprehensive framework that links BIM adoption directly with contractual reform and institutional readiness, the study offers actionable guidance for policymakers, industry stakeholders, and practitioners aiming to enhance project efficiency, minimize contractual disputes, and promote sustainable construction practices in developing economies. Finally, this research contributes to the broader international discourse on BIM implementation by offering a model that may be adapted to other developing countries facing similar contractual and institutional constraints, thus extending the global applicability of BIM research.

1.2 Construction industry in Jordan

The construction sector has been distinguished in recent years by its effective contribution to the economic development of the construction industry in Jordan through the implementation of many major projects. The sector has shown fluctuations in its contribution to the Gross Domestic Product (GDP). As shown in Fig. 1, in the second quarter of 2024, the GDP from construction increased to 224 million Jordanian Dinars (JOD) from 178 million JOD in the first quarter. Historically, from 2003 to 2024, the average GDP from construction was 180.19 million JOD, with a peak of 277 million JOD in the third quarter of 2022 (The Hashemite Kingdom of Jordan Department of Statistics, 2023). The New Abdali District project is a true example of the construction sector's contribution to the development of the Jordanian construction industry and its contribution to supporting the Jordanian economy. This project aims to create a new business center in Amman. The first phase, valued at more than 2.4 billion Jordanian dinars, includes seven towers and is expected to attract around 20 million visitors annually. In May 2024, plans for the second phase were announced, covering 1.2 million square meters and expected to generate more than 3,000 jobs annually. A multipurpose convention center, hotels, residential complexes, shopping centers, and state-of-the-art medical facilities are all part of this phase. Additionally, a $2.3 billion deal was reached in September 2024 between Jordan and the United Arab Emirates to construct railway lines that would connect the port of Aqaba to the mining regions of Eshidiya and Ghor Al-Safi. This program is a component of a larger investment package between the two nations totaling $5.5 billion. However, one of the most active industries in Jordan is construction, which offers employment opportunities to both qualified and unskilled individuals. According to an International Labour Organization [11] research, a significant percentage of the workforce is employed in the construction industry, particularly in metropolitan areas, and it provides a significant source of income for low-wage and migratory workers [11]. Additionally, the building sector is essential to the development of infrastructure, which is vital to Jordan's economic growth. The sector promotes the expansion of highways, bridges, and airports [12]. The need for housing and urban substructure has grown as a result of vital services that improve quality of life and stimulate economic activity, from schools, hospitals, and residential buildings population growth and urbanization. These demands are met by the construction sector, which helps to alleviate the housing scarcity and support population expansion. A significant portion of the sector's operations is related to residential development (Jordan Housing and Urban Development Corporation, 2022). One could argue that, despite regional difficulties, Jordan has become a center for development due to its advantageous location in the Middle East. Jordan's construction industry is robust and still contributes to cross-border projects and rehabilitation efforts despite the political and economic instability in neighboring countries (Middle East Economic Digest, 2020).

1.3 Obstacles to the Jordanian construction industry

Numerous obstacles prevent the Jordanian construction industry from growing and operating efficiently. There are many types of challenges, including eco-

nomic, technological, environmental, and others. Negative growth rates are considered one of the economic challenges that negatively affect the growth of the Jordanian construction sectors, as this was evident in the years 2015, 2017, and 2018, when it witnessed periods of stagnation, and its direct contribution to the GDP remained at about 3.0% to 3.5% (Jordan Strategy Forum, 2022). Financial limitations are also considered as significant economic problems for Jordan's building industry, since the high upfront costs of implementing contemporary technologies and the dearth of funds needed for research and development represent significant roadblocks [13]. Important examples of technological challenges facing Jordan's construction industry include a severe lack of qualified and skilled labor, high computing equipment requirements, and a lack of investment in digital construction technologies like Building Information Modeling (BIM) [13]. Furthermore, one actual illustration of the administrative difficulties confronting the Jordanian construction sector is the use of poor risk management techniques that lead to project delays and cost overruns [14]. However, the construction industry in Jordan has several project-specific issues, chief among them being the delays in government projects, which frequently occur as a result of ineffective procurement procedures and financial difficulties [15]. In addition to the refusal to apply modern technologies due to their high cost and the lack of professionals trained to adopt BIM [16]. External challenges also pose major obstacles to the development of the Jordanian construction industry. Regional instability leads to political crises in several neighboring countries, disrupting supply chains and increasing costs [17]. Rapid population growth and urbanization are also putting significant pressure on infrastructure and housing, driving up demand (Jordan Strategy Forum, 2022). The following Table 1 shows more examples of the obstacles facing the construction industry in Jordan.

Table 1. Obstacles in the Jordanian Construction Industry.

Obstacle Item	Author
Shortage of skilled labor.	[13]
Significant upfront costs associated with adopting digital technologies.	[18]
Limited investment in research and development by construction firms.	[19]
Financial limitations and constraints.	[20]
Lack of effective management support.	[21]
Flawed designs and delays in decision-making by project stakeholders.	[22], [23]
Inefficient coordination with subcontractors.	[14]
Corruption issues, including site-related bribery.	[14]
Financial instability among stakeholders.	[24]
Poor allocation of responsibilities and risks.	[25]
Unfavorable weather conditions impacting projects.	[26]
Employment of unauthorized foreign workers.	[27]
Difficulty in adopting flexible construction methodologies.	[21]
Challenges inherent in the structure and operations of construction companies.	[15]
Issues stemming from interactions among project stakeholders.	[24]
Limitations linked to systemic features of the construction industry.	[27]
Constraints tied to the characteristics of specific construction projects.	[28]
High computing requirements for digital construction processes.	[13]
Industry fragmentation impeding effective collaboration among stakeholders.	[29]
Concerns related to safety, delays, quality, and productivity deficiencies.	[25]
Inefficient communication between construction participants.	[30]
Elevated labor costs coupled with environmental concerns.	[31]
Technological limitations affecting project execution.	[32]
Barriers to implementing supply chain management strategies.	[31]

1.4 Contractual issues in the construction industry

Contractual issues facing the construction industry in general are a perennial challenge that hinders the development and effectiveness of the construction industry in many countries. In [33] view, the complexity of projects, the involvement of multiple stakeholders, and the large financial and time investments are the main causes of contractual disputes. Common contractual issues include ambiguity in contract terms, delays in project completion, cost overruns, scope changes, and general disputes. Poorly written contracts often lead to different interpretations and views of rights and responsibilities, which accelerates the escalation of disputes [33]. Additionally, [34] noted that demands for time extensions and monetary compensation arise from delays brought on by unanticipated events or subpar project management. From a different angle, [35] verified that scope changes, labor shortages, cost overruns, and changes in material prices all put more strain on contractual relationships and lead to legal disputes between stakeholders, which in turn affect the quality of materials and the execution of the project as a whole. Strategies that enhance the performance of the construction business must be used in order to decrease contractual issues, which frequently result in disputes between contracting parties. Along with defining deadlines, the scope of contracts, roles, and dispute resolution procedures, one of the most crucial approaches to minimize contractual issues is to create contracts clearly and thoroughly [33]. All partners stay in agreement on project goals thanks to open communication techniques, transparent reporting procedures, and regular meetings [36]. Following the principles of cooperation, such as stakeholder partnerships and alliances, is crucial to building confidence between contractual parties and lowering the likelihood of conflict between them. On the other hand, proactive risk management is a useful strategy for reducing contractual conflicts [37]. Many disagreements can be avoided by anticipating potential risks, such as design revisions, cost overruns, or project delays, and effectively resolving them within the contract. Important phrases in contracts, such as risk-sharing mechanisms like liquidated damages or force majeure clauses, are essential to this process. Additionally, technological innovations like Building Information Expedite modeling (BIM) and contract management software improve contract quality, lower the possibility of terms errors, and project planning, documentation, and supervision [6]. Researchers are looking into ways to solve the issue of contracting parties performing below expectations due to the fragmented structure of Jordan's construction industry. For projects to be completed successfully and goals to be met, contractual connections must be strengthened. To protect the interests of all parties involved and enhance their contractual interactions, new tools and legislation must be included in the legal frameworks governing collaboration within the construction sector [32]. Because of the fragmented structure of Jordan's construction industry, researchers are investigating strategies to address the problem of contracting parties delivering below expectations. Contractual relationships must be improved for projects to be finished successfully and objectives to be reached. The legal frameworks governing collaboration in the construction industry need to incorporate new instruments and legislation to safeguard the interests of all parties and improve their contractual interactions [32].

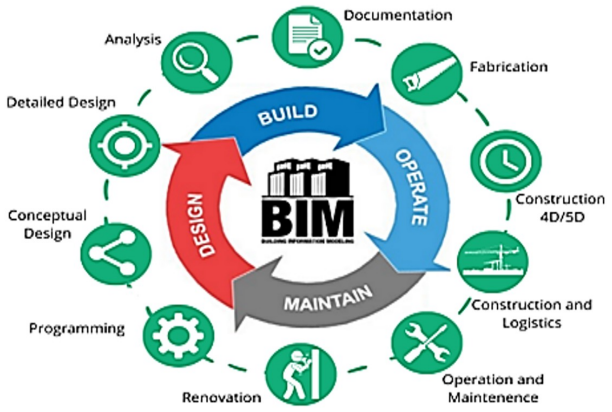

Figure 2. Roadmap Building Information Modeling (BIM) Indonesia.

2. Building Information Modelling

A digital tool called Building Information Modeling (BIM) generates and maintains data on a building from conception to demolition. To provide a collaborative environment for architects, engineers, contractors, and other stakeholders, BIM integrates 3D modeling with data-rich information. It goes beyond outdated design by including information about materials, energy performance, and spatial relationships within the model [38]. According to [39], BIM offers comprehensive three-dimensional models that permit interested party to imagine the entire structure before construction begins. Furthermore, a systematic review of architectural education challenges, including the integration of Building Information Modeling (BIM), stimulates and supports the dimensions of capacity building and professional education within an

integrated framework [40]. These features enable better understanding and communication among team members, leading to more informed decisions. As shown in Fig. 2, unlike conventional approaches, BIM mixes data connected to every aspect of the building, such as construction costs, material specifications, and maintenance schedules. This information is accessible to all stakeholders, ensuring transparency and accuracy [41]. Also, as mentioned by [42], collaboration is one of the core ideologies of BIM. By producing a shared platform, it permits architects, engineers, and contractors to work together more efficiently, this reduces conflicts, minimizes errors, and improves overall project efficiency. In the view of [43], BIM permits progressive simulations, such as structural and thermal performance analysis, allowing designers to optimize building efficiency. With BIM, project managers can order construction events, expect probable clashes, and monitor progress using a digital twin of the building [44]. In addition, post-construction BIM ropes facilities management by offering a detailed record of building components and maintenance requirements, warranting sustainability and long-term value [45]. Building Information Modeling (BIM) controls a construction project during its whole life cycle by integrating data and facilitating cooperation across several stages. These phases contain conceptual design, detailed design, construction, operation, and decommissioning. BIM models evolve, ensuring that every stage of the project is managed efficiently and effectively [38]. Also, BIM emerges among the enabling digital technologies shaping the project delivery and development process [46]. To clarify the rationale for referencing Indonesia's BIM roadmap Fig. 2, the following comparative analysis between Indonesia and Jordan is in Table 2.

Table 2. Comparison between Indonesia and Jordan toward BIM adoption [47,48].

Aspect	Indonesia	Jordan
Government Involvement	The government actively supports BIM through official policies, mandates, and a national roadmap	The government has limited involvement, and there is no national BIM strategy or roadmap.
BIM Awareness	Awareness is high, thanks to national campaigns and inclusion in education and training programs.	Awareness is moderate to low, and it varies between sectors with no coordinated efforts.
Level of Adoption	BIM is widely used, especially in public sector projects and large infrastructure works.	BIM is still in the pilot stage, used mostly in a few private sector projects.
Standards and Regulations	Indonesia uses BIM standards based on international (ISO) guidelines.	Jordan does not yet have any formal BIM standards or regulatory frameworks.
Main Barriers	The biggest challenges are the cost of implementation and upgrading old systems.	Jordan faces challenges like lack of training, weak government support, and unclear legal frameworks.

This comparison shows that while Indonesia has taken structured steps toward BIM adoption, Jordan still lacks coordination, official standards, and government support. Therefore, Indonesia provides a valuable model for Jordan to learn from. Throughout the early design stage, BIM eases the formation of initial models that contain spatial layouts and building massing. It permits architects and planners to visualize the project's feasibility and explore multiple design options. These models typically comprise schematic drawings such as site plans, massing diagrams, and initial floor plans [49]. For the duration of construction, BIM acts as an essential platform for sequencing construction activities, coordinating trades, and determining clashes before physical work starts. Tools like 4D BIM (time scheduling) and 5D BIM (cost estimation) help monitor progress and manage resources efficiently. Shop drawings and fabrication models are created to guide on-site assembly [50]. In addition, BIM technology is an intelligent building management and passive/active environmental control system, which is useful for integrating sustainability and intelligent facade modeling into the BIM framework [51,52]. Covering analytical methods in building materials and processes in research, including BIM technology, plays an important role in standardization and 4D/5D construction planning in infrastructure contexts [53]. It can be said, BIM is renovating the construction industry by posing a cooperative, data-driven method to building design, construction, and administration. Its capability to participate visualization, data, and collaboration makes it an invaluable tool for improving efficiency, reducing risks, and enhancing project outcomes. Furthermore, BIM obliges as a inclusive instrument for handling the project life cycle, from beginning to decommissioning. Its capability to adapt and integrate information at every stage improves project adeptness, sustainability, and collaboration among stakeholders.

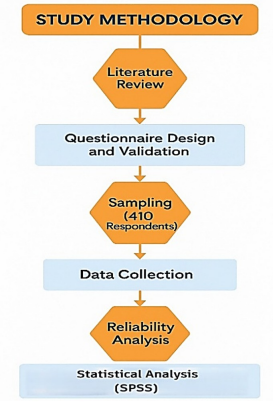

Figure 3. Methodology Flowchart.

2.1 Study methodology

To achieve the objectives of the current study, the researchers relied on the quantitative approach as a basic tool for collecting and analyzing data through the use of a closed-ended questionnaire. This approach was selected to obtain measurable and statistically analysable results from a large number of participants working in the Jordanian construction sector. The questionnaire was designed after a comprehensive review of previous studies that addressed the same topic of the current study. The initial version of the questionnaire was presented to a group of academic experts to ensure the validity of the questions and their compatibility with the objectives of the study before distributing it. The final version of the questionnaire includes three main parts obstacles in the construction industry, current contractual issues, and the status of BIM in the Jordanian construction sector. The third part is related to BIM adoption strategies, the organization's readiness to adopt BIM, the amendments required to the construction contract to adopt BIM, and the employer's information requirements. The research methodology followed the steps illustrated in Fig. 3 (Methodology Flowchart), which include.

- Literature Review: To identify key BIM-related barriers, drivers, and strategies.
- Questionnaire Design: Based on literature findings and validated through expert review.
- Data Collection: A structured, closed-ended questionnaire using a 5-point Likert scale.
- Sampling: 535 questionnaires were distributed; 410 were received, yielding a 77% response rate.
- Statistical Analysis: Using SPSS to determine reliability (Cronbach's Alpha) and apply the Relative Importance Index (RII).
- Framework Development: A proposed framework was built based on RII results and expert interpretation.

In this study, the sample size of the population is determined based on the following formula provided by Dillman (2008) as shown in Eq. 1.

$$n = \frac{N \times P \times (1-P)}{(N-1) \times (B/C)^2 + P \times (1-P)} \quad (1)$$

Where n = estimated sample size required, N = size of population, p = percentage expected to answer a certain way, B = acceptable level of sampling error (0.05 = ±5%; 0.03 = ±3%), C = Z statistic associate with confidence interval (1.645 = 90% confidence level; 1.960 = 95% confidence level; 2.576 = 99% confidence level). Referring to the annual report of the Jordanian Engineers Association for the year 2018, the number of registered engineers reached 156,555, which represents the size of the population in this study. Therefore, according to Dillman's (2008) equation, the minimum estimated sample size for the questionnaire used in this study can be calculated as follows:

$$n = \frac{156555 \times 0.5 \times (1-0.5)}{(156555-1) \times (0.05/1.96)^2 + 0.5 \times (1-0.5)} \approx 383$$

Therefore, to guarantee a better response rate, the study sample is taken as 535, a sample size that is more than the calculated value. The RII was calculated using Eq. 2.

$$RII = \sum W/(A \times N) \quad (2)$$

Where W: Characterizes the weight given to every part by respondents and ranges from 1 to 5; A: Characterizes the highest weight (in this case = 5); N: Characterizes the total number of respondents, which equals 410.

2.2 Data collection

The main tool for data collection in this study is a questionnaire. The questionnaire targeted the engineers working in the construction industry in Jordan. To collect data, 535 copies of the questionnaire were distributed, while the number of questionnaires received was 410, with a high response rate of nearly 77%. The researchers focused on the study sample so that it would be representative of the construction sector in Jordan. The engineers who participated in the questionnaire had diverse experiences and specializations, which inevitably reflected in the results of the study.

3. Results and discussion

The data collected in this study were analyzed through SPSS, and the first test conducted on the data was the reliability test through Cronbach's alpha coefficient. The value of Cronbach's alpha coefficient for all items of the questionnaire are more than 0.70, which reveals the internal consistency of the questionnaire. Therefore, this means that the data collected for the study is reliable and acceptable with a high level of reliability.

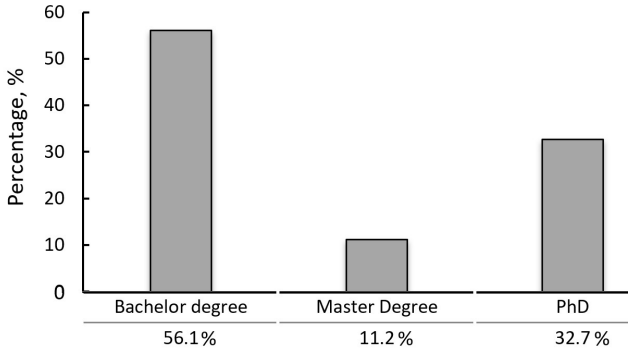

Figure 4. Respondents' level of education.

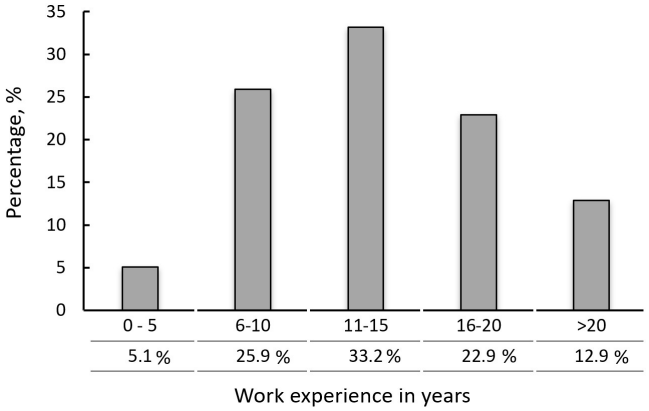

Figure 5. Respondents' work experience.

As illustrated in Fig. 4, the survey results revealed that the majority of respondents held a bachelor's degree, totalling 230 participants (56.1%). This was followed by PhD holders with 134 respondents (32.7%), and finally master's degree holders, who accounted for 11.2% of the responses. Furthermore, as depicted in Fig. 5, most respondents reported over 11 years of experience, accounting for more than 33% of the total. In contrast, only 5.1% had fewer than five years of experience. Also, Fig. 6 highlights the three key stakeholders in Jordan's construction projects: clients, contractors, and consultants. Survey results show that consultants and contractors represent the largest respondent groups at 35.6% and 35.4% respectively, while clients account for 29% of responses. On the other hand, the Relative Important Index (RII) was used in the current study to rank the items included in the questionnaire such as contractual problems, obstacles facing the construction industry in Jordan, potential BIM benefits, BIM barriers, BIM drivers, and others. Each group ranked separately based on the value of the RII for its sub-items involved in each group. The results in Table 3 summarize the values of RII for the contractual problems in the Jordanian construction industry (PR). The results revealed that the critical problem is PR1 (conflicts between specifications, drawings, and contract documents) with a high value of RII of approximately 0.74.

Figure 6. Respondents' organization role.

Table 3. The critical contractual problems in the Jordanian construction industry.

Items	Mean	RII	Rank
PR1	3.70	0.740	01
PR2	3.64	0.728	02
PR3	3.46	0.692	07
PR4	3.21	0.642	12
PR5	3.52	0.704	04
PR6	3.33	0.666	11
PR7	3.47	0.694	06
PR8	3.36	0.672	10
PR9	3.47	0.694	05
PR10	3.37	0.674	09
P11	3.62	0.724	03
P12	3.43	0.686	08

Table 4. The critical obstacles in the Jordanian Construction Industry.

Items	Mean	RII	Rank
OB1	3.75	0.750	01
OB2	3.49	0.698	03
OB3	3.34	0.668	04
OB4	3.27	0.645	05
OB5	3.53	0.706	02
OB6	3.16	0.632	06
OB7	3.02	0.604	07

This problem resulted in changes to the design, drawings, and specifications in the contract documents, which required additional time and cost for the project [54]. On the other hand, the other critical problem is PR2 (handing over the project site with obstacles). The Jordanian construction industry has faced many obstacles (OB), some of which have been presented in the questionnaire to identify the main obstacles according to the respondents. The results in Table 4 revealed that the major obstacle is OB1 (weakness of the construction contract) with a value of RII equal to 0.75, which is indicated as high. On the other hand, the least important obstacle is OB7 (the unclear roles and responsibilities between parties). All items in Table are indicated as high RII as obtained by [55]. Furthermore, the researchers investigated the project implementation methods used in the Jordanian construction industry. The results in Table 5 show that the common delivery method (DM) in Jordan is DM1 (Design Bid Build) with a high value of RII equal to 0.802. On the other hand, the other methods have low values of RII, which reveals that Design Bid Build is the common method. This result is consistent with the findings of [56] who reported that the most common and preferred procurement method in the public sector is the Design Bid Build. The analysis of the BIM awareness (AW) among the respondents, the results revealed that the high value for RII is 0.634 related to the AW3 (BIM system facilitates the collaboration between project stakeholders), while (AW2), BIMAW2 (BIM is adopted in the construction sectors in Jordan) is the

lowest one. Based on the results summarized in Table 6, 56.6% of respondents stated that they are aware of BIM, which indicates a relatively low awareness of BIM in the Jordanian construction industry. These findings are consistent with the findings of another study by [57], which reported that there is insufficient awareness of BIM and its benefits in the construction industry in South Australia. Furthermore, the results shown in Table 7 classify BIM barriers (BR) based on RII values. The major barrier found in the Jordanian construction industry is BR1 (lack of training BIM centers) with a 0.736 value of RII followed by BR2 (lack of support from the government) with a 0.724 value of RII. Lack of awareness of BIM seems to be a result of these challenges, so the concerned parties in the construction industry must address these challenges which will inevitably improve awareness of BIM. It is worth noting that all the barriers referred to in the current study were classified as very important levels based on the RII values. In addition, the present study investigated the benefits of BIM. The results listed in Table 8 indicate that the important benefit of BIM in the construction industry is BM4 with a high RII value of 0.852, which indicates that the respondents are aware of the great benefits of BIM, (BM).

Table 5. The project-delivering methods.

Items	Mean	RII	Rank
DM1	4.01	0.802	01
DM2	2.17	0.434	02
DM3	2.15	0.430	03
DM4	2.00	0.400	04

Table 6. Awareness of BIM in the Jordanian construction industry.

Items	Mean	RII	Rank
AW1	3.04	0.608	03
AW2	1.97	0.394	07
AW3	3.17	0.634	01
AW4	2.95	0.590	04
AW5	3.15	0.630	02
AW6	1.99	0.398	05
AW7	1.98	0.396	06

Table 7. Barriers of BIM adoption in the Jordanian construction industry.

Items	Mean	RII	Rank
BR1	3.68	0.736	01
BR2	3.62	0.724	02
BR3	3.44	0.688	06
BR4	3.19	0.638	09
BR5	3.50	0.700	03
BR6	3.31	0.662	08
BR7	3.45	0.690	05
BR8	3.34	0.668	07
BR9	3.45	0.690	04

Table 8. The benefits of BIM in the construction industry.

Items	Mean	RII	Rank
BM1	4.14	0.828	04
BM2	3.83	0.766	08
BM3	4.15	0.830	03
BM4	4.26	0.852	01
BM5	4.06	0.812	06
BM6	3.80	0.760	09
BM7	4.12	0.824	05
BM8	3.78	0.756	10
BM9	3.95	0.790	07
BM0	3.78	0.756	11
BM11	4.23	0.846	02

Table 9. Drivers of BIM in the construction industry.

Items	Mean	RII	Rank
DR1	3.30	0.660	01
DR2	2.31	0.462	03
DR3	2.02	0.404	05
DR4	2.21	0.442	04
DR5	2.53	0.506	02

Table 10. Strategies of BIM adoption in the Jordanian construction industry.

Items	Mean	RII	Rank
ST1	3.36	0.672	02
ST2	2.93	0.586	03
ST3	3.58	0.716	01
ST4	2.76	0.552	04

It is also clear that the RII values of all items are greater than 0.75, indicating that all items are important levels. The top important benefits of BIM are 3D visualization, executing the project successfully, improving decision-making, the as-built drawing model, and reducing conflicts. These results are similar to those reported by [58], where 85% of participants believe that BIM can improve visualization in Jordanian construction projects. On the other hand, researchers have investigated BIM drivers (DR) by calculating RII to indicate their importance. The results in Table 9 state that the main BIM driver in the construction industry is DR1 (the government efforts) with a 0.66 value of RII., which reveals that it is an important driver. This result agreed with another study by [59], which stated that the government should make efforts to bring about the necessary changes and amendments to adopt BIM. The second driver as shown in Table 9 is DR5 (cooperation between all the parts) followed by DR2 (construction associations' effort). Several factors influence the adoption of BIM in the construction industry in Jordan. Therefore, the current study pointed out that the (ST) strategies of BIM adoption in the construction industry are important. The results in Table 10 reveal that ST3 (develop the contract by making BIM technology in government projects obligatory) has the highest value of RII followed by ST1 (develop standards and guides through the national BIM program). These results in the current study support the study conducted by [43], which indicated the importance of these strategies for adopting BIM in the Jordanian construction industry.Based on the results indicated in this study, the necessary framework for adopting the BIM in the Jordanian construction sector was developed, as seen in Fig. 7.

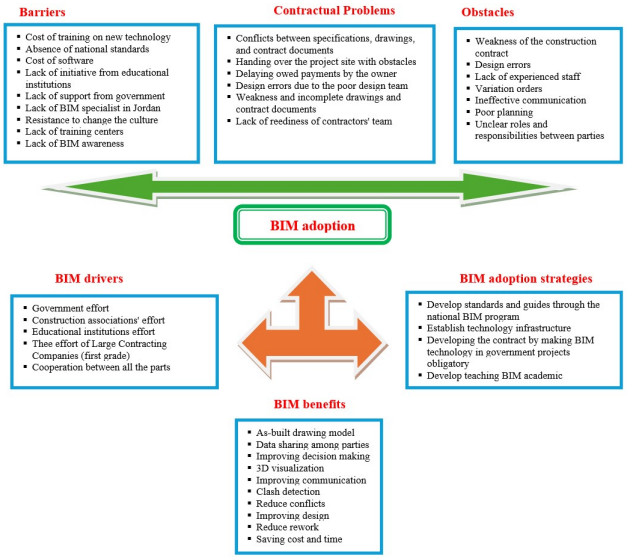

Figure 7. Framework of BIM adoption in the Jordanian construction industry.

4. Conclusion and limitations

This study provides a practical framework for enhancing the adoption of Building Information Modelling (BIM) in the Jordanian construction industry. The results revealed that the most significant contractual issue is inconsistency

between project documents. Barriers to BIM implementation include the lack of training centers and government support. These findings point to an urgent need for policy reforms, training programs, and awareness initiatives. The study also provides specific clauses that must be included in contracts to mandate the use of BIM, suggested curricula for BIM training programs, and addressing potential resistance from stakeholders (such as contractors reluctant to invest in BIM) and how to mitigate it. The results align with the study's objectives to diagnose existing barriers and develop a strategic roadmap for BIM integration. The proposed framework, built on evidence-based priorities, can serve as a reference for policymakers and stakeholders. Study limitations include the reliance on a single data collection tool (questionnaire) and the lack of field application of the framework. Future studies are encouraged to implement and test this framework in actual projects and expand the demographic scope to other developing countries. Overall, the study supports the integration of BIM with legal and institutional reforms to drive digital transformation in construction.

A. Appendix

Part 1: Demographic profile (Background Information of the Respondents).
Please mark (✓) on the one that is appropriate for your background.

1. Level of your education is:
[– – –] Bachelor degree [– – –] Master Degree [– – –] PhD

2. Your working experience in (Years) in the construction industry is :
[– – –] 0-5 [– – –] 6-10 [– – –] 11-15 [– – –] 6-20 [– – –] >20

3. Kindly indicate your engineering competency:
[– – –] Civil engineer [– – –] Architecture engineer
[– – –] Electrical engineer [– – –] Mechanical engineer
[– – –] Other (Please specify.....)

4. Your position or title at your organization is :
[– – –] Top Management [– – –] Project Manager
[– – –] Site Engineer

5. Please indicate the type of organization you work in:
[– – –] Government [– – –] Association (JEA, JCCA, etc)
[– – –] Educational (Universities, Colleges, etc)
[– – –] Engineer private office (Architect, Civil, Mechanical, Electrical)

6. Please indicate your organization role in the construction industry:
[– – –] Client] [– – –] Consultant
[– – –] Contractor [– – –] Other (please specify.....)

Part 2- (Section A): contractual problems in the Jordanian construction industry.
Please indicate your agreement to the following statements regarding the contractual problems in the Jordanian construction industry.

1:Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

No.	Contractual problems	Please tick one				
		1	2	3	4	5
1	Conflicts between specification, drawings and contract documents					
2	Handing over the project site with obstacles					
3	Not selecting (Dispute Resolution Board) from the beginning of the project					
4	Weakness of trained human resources with the skills required by the project					
5	Delayed owed payments by the owner					
6	Adoption of awarding the bid to the lowest price					
7	Design errors due to poor design team					
8	Traditional favouring methods					
9	Weakness and incomplete of drawings and contract documents					
10	Problems resulting from variation orders					
11	Lack reediness of contractors' team					
12	The high cost of purchasing technology and training staff on it					

Part- Section (B): Obstacles in the Jordanian construction sector.
Please indicate which of these obstacles in the construction industry in Jordan most significant according to your experience.

1:Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

No.	Obstacles in the construction sector	Please tick one				
		1	2	3	4	5
1	Weaknesses of the construction contract					
2	Design errors					
3	Lack of experienced staff					
4	Variation orders					
5	Ineffective communication					
6	poor planning					
7	Unclear roles and responsibilities between parties					
8	please specify any others obstacles in the Jordanian construction sector					

Part 2- Section (C): project-delivering methods using in the Jordanian construction industry.
Please indicate which of these project-delivering methods using in the construction industry in Jordan is the most popular according to your experience.

1:Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

No.	Project-delivering methods	Please tick one				
		1	2	3	4	5
1	Design-Bid-Build (DBB)					
2	Design-Build (DB)					
3	Construction Management (CM)					
4	Integrated Project Delivery (IPD)					

Part 2- Section (D): BIM Status in the Jordanian construction industry.
Please indicate your agreement to the following statements regarding BIM status in Jordanian construction industry.

1:Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

No.	BIM Awareness	Please tick one				
		1	2	3	4	5
1	Am aware of BIM					
2	Am currently using BIM					
3	BIM is a digital approach that has many benefits					
4	BIM system is facilitating the collaboration between project stakeholders.					
5	BIM is the integration of several multidisciplinary models.					
6	BIM is adopted in my organization					
7	BIM is adopted in the construction sectors in Jordan					

Part 2- Section (E): Barriers facing BIM implementation in the Jordanian construction industry.
Please indicate your agreement to the following statements regarding barriers to adopting BIM in the construction industry in Jordan.

1:Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

No.	BIM Barriers	Please tick one				
		1	2	3	4	5
1	Lack of BIM awareness					
2	Lack of training centers					
3	Resistance to change culture					
4	Lack of BIM specialist in Jordan					
5	Lack support from government					
6	Lack of initiative from educational institutions					
7	Cost of software					
8	Absence of national standards					
9	Cost of training in new technology					
10	Please specify any others barriers					

Part 2- Section (F): BIM Benefits.
Please indicate your agreement to the following statements regarding perceived BIM benefits.

1:Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

No.	BIM Benefits	Please tick one				
		1	2	3	4	5
1	As-built drawing model					
2	Data sharing among parties					
3	Improving decision making					
4	3D visualization					
5	Improving communication					
6	Clash detection					
7	Reduce conflicts					
8	Improving design					
9	Reduce rework					
10	Saving cost and time					
11	Executing the project successfully					
12	please specify any others benefits					

Part 2- Section (G): BIM Drivers.
Please indicate your agreement to the following statements regarding drivers to adopting BIM in the construction industry in Jordan.

1:Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

No.	BIM Drivers: Who should drive the BIM adoption in Jordan?	Please tick one				
		1	2	3	4	5
1	Government effort					
2	Construction associations' effort					
3	Educational institutions effort					
4	Effort of large contracting companies (first grade)					
5	Cooperation between all the parts					

Part 3- Section (A): BIM adoption in the Jordanian construction industry.
Please indicate your agreement to the following statements regarding BIM adoption strategies in the construction industry in Jordan.

1:Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

No.	BIM adoption strategies	Please tick one				
		1	2	3	4	5
1	Develop standards and guides through the national BIM program					
2	Establish technology infrastructure					
3	Develop the contract by making BIM technology in government projects obligatory					
4	Develop teaching BIM academic					

Authors' contribution

Ibrahim Saraireh contributes to conceptualization, methodology, and data collection. Faten Albtoush contributes to analysis, project administration, and funding acquisition. Nawzat Al Jbour data collection, draft preparation, manuscript editing.

Declaration of competing interest

The authors declare no conflicts of interest.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

[1] R. Alawneh, F. E. M. Ghazali, H. Ali, and M. Asif, "Assessing the contribution of water and energy efficiency in green buildings to achieve united nations sustainable development goals in jordan," *Building and Environment*, vol. 146, p. 119–132, 2018. [Online]. Available: https://doi.org/10.1016/j.buildenv.2018.09.043

[2] M. N. Assafi, M. I. Hoque, and M. M. Hossain, "Investigating the causes of construction delay on the perspective of organization-sectors involved in the construction industry of bangladesh," *International Journal of Building Pathology and Adaptation*, vol. 42, no. 4, p. 788–817, 2024. [Online]. Available: https://doi.org/10.1108/IJBPA-10-2021-0137

[3] J. C. F. de Oliveira and F. J. C. de Melo, "Barriers and drivers of sustainable construction: a systematic literature review," *International Journal of Services and Operations Management*, vol. 47, no. 3, p. 277–313, 2024. [Online]. Available: https://doi.org/10.1504/IJSOM.2024.137313

[4] I. El-adaway, I. Abotaleb, and S. Eteifa, "Framework for multiparty relational contracting," *Journal of legal affairs and dispute resolution in engineering and construction*, vol. 9, no. 3, p. 04517018, 2017. [Online]. Available: https://doi.org/10.1061/(ASCE)LA.1943-4170.0000238

[5] N. J. Sweis, R. J. Sweis, G. Kassab, A. Elfar, D. Athammneh, and G. J. Sweis, "Demotivating factors influencing productivity in jordanian residential construction projects," *International Journal of Productivity and Quality Management*, vol. 20, no. 2, pp. 154–168, 2017. [Online]. Available: https://doi.org/10.1504/IJPQM.2017.081479

[6] S. N. A. S. Alwee, U. K. Zolkafli, and H. Salleh, "Contract administration practices on building information modelling (bim)-based construction project–an exploratory study," *Facilities*, vol. 41, no. 11/12, p. 742–766, 2023. [Online]. Available: https://doi.org/10.1108/F-10-2021-0094

[7] D. Stellmacher, M. Kaufhold, H. A. Meins-Becker, and M. Helmus, "the suitability of existing construction contracts forms for bim construction projects," *Proceedings of International Structural Engineering and Construction*, vol. 10, no. 1, 2023. [Online]. Available: https://doi.org/10.14455/ISEC.2023.10(1).AAE-17

[8] F. Kaya, A. A. Güngör, and M. T. Birgönül, "An investigation of legal aspects of bim in construction contracts," *Trabzon, Türkiye,International Civil Engineering and Architecture Conference*, p. 214, 2019. [Online]. Available: https://hdl.handle.net/11511/83407

[9] A. Alwash, P. E. Love, and O. Olatunji, "Impact and remedy of legal uncertainties in building information modeling," *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction,*, vol. 9, no. 3, p. 04517005, 2017. [Online]. Available: http://doi.org/10.1061/(ASCE)LA.1943-4170.0000219

[10] A. Rashidi, D. W. Chan, M. Ravanshadnia, H. Sarvari, and A. Tajaddini, "Applying building information modelling (bim) technology in pre-tender cost estimation of construction projects: A case study in iran," *Buildings*, vol. 14, no. 5, p. 1260, 2024. [Online]. Available: https://doi.org/10.3390/buildings14051260

[11] J. Gordon, "The international governance of refugee work: reflections on the jordan compact," *Global Public Policy and Governance*, vol. 1, no. 3, p. 239–255, 2021. [Online]. Available: https://doi.org/10.1007/s43508-021-00019-6

[12] M. East and N. Africa, "Jordan," 2022:jordan economic update april 2022," 2022.

[13] Z. Alwashah, G. J. Sweis, H. A. Hajar, W. Abu-Khader, and R. J. Sweis, "Challenges to adopt digital construction technologies in the jordanian construction industry," *Construction Innovation*, 2024. [Online]. Available: https://doi.org/10.1108/CI-03-2023-0056

[14] M. T. Hatamleh, A. Alzarrad, A. Alghossoon, M. Alhusban, and O. Ogunrinde, "Strategies for improving project risk management via communication and integration: the case of jordn," *Engineering, Construction and Architectural Managemen*, 2024. [Online]. Available: https://doi.org/10.1108/ECAM-05-2024-0536

[15] F. Amireh and I. Tlemsani, "Delays in governmental construction projects in jordan," *in Achieving Sustainable Business through AI, Technology Education and Computer Science Springer,*, vol. 158, p. 463–471, nov 2024. [Online]. Available: https://doi.org/10.1007/978-3-031-70855-8_40

[16] A. Suleiman and S. Asaad, "Bim implementation in the middle east construction: Evaluating the prospects and challenges," *presented at the E3S Web of Conferences, EDP Sciences*, vol. 579, p. 03004(13 pages), 2024. [Online]. Available: https://doi.org/10.1051/e3sconf/202457903004

[17] J. A. Husseini and R. A. Tal, "Youth unemployment in jordan ,arab renaissance for democracy and development (ardd)," *halshs*, vol. 16, no. 1, p. 50, 2023. [Online]. Available: https://shs.hal.science/halshs-04362170

[18] A. E. Oke, J. Aliu, and S. A. Onajite, "Barriers to the adoption of digital technologies for sustainable construction in a

developing economy," *Architectural Engineering and Design Management*, vol. 20, no. 3, p. 431–447, 2024. [Online]. Available: https://doi.org/10.1080/17452007.2023.2187754

[19] Z. F. Zeadat, "Implementing sustainable construction practices in the jordanian housing industry," *Journal of Sustainable Real Estate*, vol. 16, no. 1, p. 2298554, 2024. [Online]. Available: https://doi.org/10.1080/19498276.2023.2298554

[20] L. Abu-Reishah and M. A. Hiyassat, "The severity of design-construction interface risks in jordanian construction industry," *International journal of construction management*, vol. 23, no. 9, p. 1540–1548, January 2023. [Online]. Available: https://doi.org/10.1080/15623599.2021.1983930

[21] W. A. Balkhy, R. Sweis, and Z. Lafhaj, "Barriers to adopting lean construction in the construction industry—the case of jordan," *Buildings*, vol. 11, no. 6, p. 222, 2021. [Online]. Available: https://doi.org/10.3390/buildings11060222

[22] Z. T. A. Salem and A. Suleiman, "Risk factors causing time delay in the jordanian construction sector ," *International Journal of Engineering Research and Technology*, vol. 13, no. 2, p. 307–315, September 2020. [Online]. Available: https://doi.org/10.37624/IJERT/13.2.2020.307-315

[23] B. M. Sabir and F. A. Mustafa, "Performance-based building design: Evaluation of the functional performance of the emergency department in erbil city hospitals using patient feedback," *Al-Qadisiyah Journal for Engineering Sciences*, vol. 15, no. 4, p. 255–261, 2022. [Online]. Available: https://doi.org/10.30772/qjes.v15i4.887

[24] M. T. Hatamleh, G. P. Moynihan, R. G. Batson, A. Alzarrad, and O. Ogunrinde., "Risk assessment and ranking in the developing countries' construction industry: the case of jordan," *Engineering, Construction and Architectural Management,*, vol. 30, no. 4, p. 1344–1364, 2023. [Online]. Available: https://doi.org/10.1108/ECAM-06-2021-0489

[25] R. A. et al., "Development of a new method for assessing project risks in sustainable building construction projects in developing countries: The case of jordan," *Buildings*, vol. 14, no. 6, p. 1573, 2024. [Online]. Available: https://doi.org/10.3390/buildings14061573

[26] S. J. Schuldt, M. R. Nicholson, Y. A. Adams, and J. D. Delorit, "Weather-related construction delays in a changing climate: a systematic state-of-the-art review," *Sustainability*, vol. 13, no. 5, p. 2861, 2021. [Online]. Available: https://doi.org/10.3390/su13052861

[27] S. A. Hussein and D. Hashem, "Syrian refugees in jordan: consequences for egyptian migrant workers," *in Public Policy in the Arab World, Edward Elgar Publishing*, p. 23–44, 2024. [Online]. Available: https://doi.org/10.4337/9781035312696.00011

[28] R. A. Qalbin, H. Rabayah, M. Darwish, and R. Abendeh, "Assessment of construction risks in projects funded by external sources in jordan during the covid-19 pandemic," *Buildings*, vol. 13, no. 8, p. 1885, 2023. [Online]. Available: https://doi.org/10.3390/buildings13081885

[29] S. Alkilani and M. Loosemore, "An investigation of how stakeholders influence construction project performance: a small and medium sized contractor's perspective in the jordanian construction industry," *Engineering, Construction and Architectural Management*, vol. 31, no. 3, p. 1272–1297, 2022. [Online]. Available: https://doi.org/10.1108/ECAM-06-2022-0539

[30] A. Suleiman, H. Almasaeid, N. Hussein, and J. Abahre, "Addressing the causes and effects of poor communication in the jordanian construction industry: a study on improving project performance," *Civil and Environmental Engineering*, vol. 19, no. 1, p. 156–166, 2023. [Online]. Available: https://doi.org/10.2478/cee-2023-0014

[31] A. Al-Refaie, D. Al-Momani, and R. Al-Tarawneh, "Modelling the barriers of green supply chain practices in jordanian firms," *International journal of productivity and quality management*, vol. 29, no. 3, p. 397–417, 2020. [Online]. Available: https://doi.org/10.1504/IJPQM.2020.105991

[32] H. Jaradat, O. A. M. Alshboul, I. M. Obeidat, and M. K. Zoubi, "Green building, carbon emission, and environmental sustainability of construction industry in jordan: Awareness, actions and barriers," *Ain Shams Engineering Journal*, vol. 15, no. 2, p. 102441, 2024. [Online]. Available: https://doi.org/10.1016/j.asej.2023.102441

[33] S. A. El-Hamid, S. Farag, and A. Abdelalim, "Construction contracts' pricing according to contractual provisions and risk allocation," *International Journal of Civil and Structural Engineering Research ISSN*, vol. 11, no. 1, p. 8–31, 2023. [Online]. Available: https://doi.org/10.5281/zenodo.7876040

[34] J. Eliasson, "Cost overruns of infrastructure projects–distributions, causes and remedies," *Transportation Research Part A: Policy and Practice*, vol. 198, p. 104532, 2025. [Online]. Available: https://doi.org/10.1016/j.tra.2025.104532

[35] N. M. Huynh, A. T. Le, L. Le-Hoai, and H. T. Nguyen, "Factors causing cost overruns in public hospital construction in developing countries: a case from vietnam," *Journal of Asian Architecture and Building Engineering*, vol. 24, no. 3, p. 1716–1730, 2024. [Online]. Available: https://doi.org/10.1080/13467581.2024.2357196

[36] S. Laryea, O. K. Kwasafo, and S. Mensah, "Bibliometric review of social value in construction literature," *Conference: WABER SuDBE 2024 Conference ProceedingsAt: Wits University, Johannnesburg,*, no. 1, 2024. [Online]. Available: https://www.academia.edu/122667801/Bibliometric_review_of_social_value_in_construction_literature

[37] M. S. H. S. M. A. Alshehhi, R. Sidik and E. A. Rozali, "The impact of risk management on the performance of construction projects," *Educational Administration: Theory and Practice*, vol. 30, no. 5, 2024. [Online]. Available: https://doi.org/10.53555/kuey.v30i5.3708

[38] N. S. Zainuddin, A. H. Alias, N. A. Bakar, and N. A. Haron, "Unlocking the potential of bim and vr integration to address construction challenges in malaysia's building industry: a literature review," *Journal of Sustainable Civil Engineering Technology (JSCET)*, vol. 3, no. 1, p. 10–38, 2024. [Online]. Available: http://doi.org/10.24191/jscet.v3i1.10-38

[39] D. H. Lauritzen and P. N. Gade, "Transformative potentials of data visualization in digital building design-a literature review," *presented at the International Conference on Cooperative Design, Visualization and Engineering, Springer*, vol. 15158, no. 5, p. 322–331, 2024. [Online]. Available: https://link.springer.com/chapter/10.1007/978-3-031-71315-6_33

[40] A. B. Hammadamin and J. Nordin, "Learning challenges of architectural education in early twenty-first century: A systematic literature review," *Al-Qadisiyah Journal for Engineering Sciences*, vol. 17, no. 4, p. 339–351, 2024. [Online]. Available: https://doi.org/10.30772/qjes.2024.149312.1220

[41] N. Rane, "Integrating building information modelling (bim) and artificial intelligence (ai) for smart construction schedule, cost, quality, and safety management: Challenges and opportunities," *Cost, Quality, and Safety Management: Challenges and Opportunities (September 16)*, p. 20, 2023. [Online]. Available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4616055

[42] K. Wang, C. Zhang, F. Guo, , and S. Guo, "Toward an efficient construction process: what drives bim professionals to collaborate in bim-enabled projects," *Journal of Management in Engineering*, vol. 38, no. 4, 2022. [Online]. Available: https://doi.org/10.1061/(ASCE)ME.1943-5479.0001056

[43] A. B. Mohammed, "Applying bim to achieve sustainability throughout a building life cycle towards a sustainable bim model," *International journal of construction management*, vol. 22, no. 2, p. 148–165, 2022. [Online]. Available: https://doi.org/10.1080/15623599.2019.1615755

[44] Y. Celik, I. Petri, , and Y. Rezgui, "Leveraging bim and blockchain for digital twins," *IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC), IEEE*, no. 5, pp. 1–10, 2021. [Online]. Available: :https://doi.org/10.1109/ICE/ITMC52061.2021.9570246

[45] M. M. Rahman, "Bim enabled sustainable facility management," *International Journal of Integrated Engineering*, vol. 13, no. 7, p. 101–107, 2021. [Online]. Available: https://doi.org/10.30880/ijie.2021.13.07.013

[46] K. Tochaiwat, A. Budda, and P. Seniwong, "Forecasting technologies impacting real estate business during the transition to 2030s," *Al-Qadisiyah Journal for Engineering Sciences*, vol. 18, no. 1, p. 92–98, 2025. [Online]. Available: https://doi.org/10.30772/qjes.2025.155895.1450

[47] E. Hyarat, T. Hyarat, and M. Al Kuisi, "Barriers to the implementation of building information modeling among jordanian aec companies," *Buildings*, vol. 12, no. 2, p. 150, 2022. [Online]. Available: https://doi.org/10.3390/buildings12020150

[48] Latupeirissa, J. E., and H. Arrang, "Sustainability factors of building information modeling (bim) implementing for successful construction project managemet life cycle in indonesia." *Journal of Building Pathology and Rehabilitation*, vol. 9, no. 26, 2024. [Online]. Available: https://doi.org/10.1007/s41024-023-00376-1

[49] S. Gaur and A. Tawalare, "Investigating the role of bim in stakeholder management: Evidence from a metro-rail project," *Journal of management in engineering*, vol. 38, no. 1, p. 05021013, 2022. [Online]. Available: https://doi.org/10.1061/(ASCE)ME.1943-5479.0000979

[50] T. S. Bacheva and J. F. R. Grau, "Building information modeling (bim) for visual representation of embodied impacts

of buildings: Current methods and future prospects," *presented at the Congreso Internacional de Expresión Gráfica Arquitectónica, Springer*, vol. 43, p. 351–358, 2024. [Online]. Available: :https://link.springer.com/chapter/10.1007/978-3-031-57575-4_41

[51] A. Waqar, I. Othman, and H. e. a. Almujibah, "Implementing building information modeling (bim) for the success of geotechnical offshore construction projects: malaysian construction industry," *Quality Quantity*, vol. 58, p. 1945–1970, 2024. [Online]. Available: https://doi.org/10.1007/s11135-023-01730-8

[52] H. A. Jasim, A. S. Ramadan, and A. I. Mahmood, "The formation of invisible architecture according to environmental tendencies techniques," *Al-Qadisiyah Journal for Engineering Sciences*, vol. 14, no. 3, p. 179–192, 2021. [Online]. Available: e:https://doi.org/10.30772/qjes.v14i3.790

[53] R. I. Al-Nawasir and B. H. Al-Humeidawi, "A scientometric study and a bibliometric review of the literature on the design and construction of semi-flexible pavement," *Al-Qadisiyah Journal for Engineering Sciences,*, vol. 16, no. 2, p. 82–91, 2023. [Online]. Available: https://doi.org/10.30772/qjes.v16i2.921

[54] R. Saki and C. Yeom, "Causes of variation orders in road construction projects in tanzania," *The Open Transportation Journal*, vol. 16, no. 1, 2022. [Online]. Available: https://doi.org/10.2174/18744478-v16-e2208182

[55] O. Akinradewo, M. Hafez, J. Aliu, A. Oke, C. Aigbavboa, and S. Adekunle, "Barriers to the adoption of augmented reality technologies for education and training in the built environment: A developing country context," *Technologies*, vol. 13, no. 2, p. 62, 2025. [Online]. Available: https://doi.org/10.3390/technologies13020062

[56] P. Lahdenpera, "Design-build with a development phase: An initiation and the first trials," *Construction Economics and Building*, vol. 24, no. 4/5, p. 18–42, 2024. [Online]. Available: https://doi.org/10.5130/AJCEB.v24i4/5.8471

[57] A. M. Saad, H. D. Badran, S. Ajayi, and S. Sarhan, "Have we reached a technological plateau? a situational awareness approach to overcome the barriers limiting the development of bim-based plugins," 2024:https://www.emerald.com/insight/content/doi/10.1108/ci-08-2023-0196/full/html," *Construction Innovation*, no. 5, 2024. [Online]. Available: https://doi.org/10.1108/CI-08-2023-0196

[58] R. Matarneh and S. Hamed, "Barriers to the adoption of building information modeling in the jordanian building industry," *Open journal of civil engineering,*, vol. 7, no. 3, p. 325–335, 2017. [Online]. Available: https://doi.org/10.4236/ojce.2017.73022

[59] M. Hamma-adama, T. Kouider, and H. Salman, "Analysis of barriers and drivers for bim adoption," *International journal of BIM and engineering science*, vol. 3, no. 1, pp. 18–41, 2020. [Online]. Available: https://rgu-repository.worktribe.com/output/941282

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