

Adaption of Building Information Modelling (BIM) in Palestine's AEC Industry: Challenges, Benefits, and Future Directions

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Abstract

Building Information Modelling (BIM) is a rapidly evolving technology that has garnered considerable interest within the Architecture, Engineering, and Construction (AEC) sector. Understanding the current state of BIM adoption in Palestine is crucial, as it offers critical perspectives on the unique challenges and opportunities faced by the region, thereby guiding effective strategies for overcoming barriers and promoting the technology's widespread adoption. This study examines the adoption of BIM within Palestine's AEC industry, focusing on the associated challenges, benefits, and future directions. Despite the global recognition of BIM's potential to enhance collaboration, reduce costs, and improve project outcomes, its implementation in Palestine faces significant obstacles, including limited awareness, inadequate training, and a lack of regulatory support. Through a comprehensive literature review and analysis of secondary data, this paper identifies key barriers to BIM adoption in the Palestinian context and proposes strategies to overcome them. The findings underscore the need for targeted educational initiatives, policy reforms, and industry-wide collaboration to foster BIM integration. The study concludes by highlighting future directions, including the importance of integrating BIM into educational curricula, advancing professional development, and leveraging government incentives to promote widespread BIM adoption in Palestine's AEC industry. As this study highlights the challenges and benefits of adopting BIM in Palestine's AEC industry, it emphasizes the importance of addressing socio-economic and technological barriers. Key strategies include raising awareness, providing training, improving infrastructure, fostering openness to change, and offering financial support to facilitate BIM implementation and enhance project efficiency, outcomes, and sustainability.

Keywords: Building Information Modelling, BIM, Construction, Palestinian AEC, BIM Adoption

Introduction

Building Information Modelling (BIM) is an emerging technological approach that has gained significant attention in the Architecture, Engineering, and Construction (AEC) industry. This study focuses on the adaption of BIM in Palestine's AEC industry, aiming to explore the challenges, benefits, and future directions related to its implementation. By examining the current state of BIM adoption in Palestine, this research intends to provide valuable insights for industry professionals, policymakers, and researchers to facilitate a more efficient and effective integration of BIM in the construction sector.

BIM improves collaboration, saves time and cost, enhances quality, and allows for better decision-making throughout the entire project lifecycle (Wan Mohammad & Mohd Azmi, 2023). However, the adoption of BIM in Palestine's AEC industry faces several challenges (Enshassi & AbuHamra, 2017). These challenges include a lack of awareness about BIM among stakeholders, limited knowledge about BIM software, a lack of education and training on BIM usage, the absence of qualified staff to work with BIM software, and a shortage of resources for implementing BIM effectively (Saleh & Bakri, 2021). Additionally, there is a lack of demand for BIM from clients and a lack of governmental regulations or incentives to promote its use (Enshassi & AbuHamra, 2017). Despite these challenges, the potential benefits of BIM adoption in Palestine's AEC industry are significant (Al Daoor, 2018). By implementing BIM, professionals in Palestine's AEC industry can improve project coordination and communication, reduce errors and conflicts, enhance productivity and efficiency, optimize resource allocation, and improve overall project outcomes (Abuhamra, 2015). In order to overcome these challenges, several future directions can be pursued. Firstly, there needs to be a concerted effort to raise awareness about the benefits of BIM among stakeholders in the AEC industry in Palestine (Narlawar et al., 2019). This can be done through workshops, seminars, and education programs (Saleh & Bakri, 2021). Additionally, there should be a focus on providing education and training opportunities for professionals to develop the necessary skills in working with BIM software and tools (Enshassi & AbuHamra, 2017). Furthermore, collaborations between educational institutions and industry professionals can be established to facilitate knowledge exchange and skill development. Moreover, it is essential to establish governmental regulations and incentives that promote the adoption of BIM in Palestine's AEC industry. These regulations can include mandates for BIM usage on government projects, financial incentives for adopting BIM, and the establishment of a regulatory body to oversee the implementation and quality control of BIM in the industry (Saleh & Bakri, 2021). Furthermore, the development of a comprehensive BIM implementation framework specific to Palestine's AEC industry can provide guidance and standardization for organizations and professionals looking to adopt BIM. This framework can outline best practices, provide guidelines for BIM implementation, and include templates and resources to support organizations in their adoption journey.

Background

BIM is emerging as a critical tool in the AEC industry globally, including in the Palestinian context. Recent academic research has focused on understanding its adoption, application, and challenges, mainly in the Gaza Strip, offering insights into the current state and potential future of BIM in Palestinian universities and the broader construction industry. This article discusses BIM, a method increasingly adopted by companies for efficient project management and control. Globally, developed nations have widely embraced BIM, with

Australia leading (18-75% adoption), followed by the United States (31%), Europe (16%), the Middle East (11%), and India (9%). Reflecting this global trend, construction firms in Palestine are beginning to recognize and adopt BIM for their projects, spurred by an increasing understanding of its numerous advantages.

Research indicates a low level of BIM awareness and application in the Palestinian AEC industry (Saleh & Bakri, 2021), particularly among engineering students in Gaza Strip universities (Enshassi1a & AbUHamra2b, 2017). Despite BIM being a relatively recent concept in the region's architecture and construction sectors, there is a growing recognition of its importance. Studies suggest that Palestinian universities are beginning to adopt BIM in their engineering curriculum, addressing the existing knowledge gap and preparing future professionals for advanced construction practices. Studies emphasize the significant potential benefits of BIM, such as enhanced data management, visualized design, and improved construction operations. However, the adoption is hindered by several barriers, including limited industry awareness, resistance to change, and economic challenges. These obstacles underscore the need for targeted efforts to foster BIM integration in the Palestinian AEC industry.

The role of the Palestinian government is crucial in promoting BIM adoption. Academic research suggests that government-led initiatives, including demonstration of BIM's value in public procurement and support in overcoming identified barriers, could significantly advance BIM application. The potential impact of BIM on improving knowledge areas within the AEC industry highlights the importance of collaborative efforts among educational institutions, industry professionals, and government entities to fully harness the benefits of BIM in Palestine's construction sector.

Review of Literature

BIM Definition

To effectively discuss BIM within the construction industry, it's essential to first establish its definition, particularly for evaluating its recognition in the Jordanian construction sector. BIM, a concept that surfaced in 2003 (Saxon, 2013), has been variously defined by researchers. The National BIM Standard (2010) describes it as a digital model that encapsulates both the physical and functional attributes of a facility, serving as a vital informational resource throughout its lifecycle, from initial conception to demolition. Latest study by (Borkowski, 2023) argued that BIM is variously defined as a modelling technology and set of processes, a process-oriented approach for designing, constructing, and operating facilities using electronic information (UK Task Group, BS 8536-1:2015), and an IT-based approach for managing building information throughout a project's lifecycle (Gu, London, 2010). Beyond these, BIM is also seen as a broader organizational tool, enhancing collaboration, communication, and efficiency in construction projects (Goulding, Rahimian, Wang, 2014; Munir, Kiviniemi, Jones, 2019). This multifaceted nature of BIM reflects its role in lifecycle management, offering value as an activity, product, or system in various construction stages (Lin, Hsu, Hu, 2022; Preidel, Borrmann, 2018; Salehi, Yitmen, 2018)

BIM Tools

In the adaption of BIM in AEC, a wide array of tools are utilized globally, each designed to cater to various aspects of construction project management. These tools, ranging from

software for 3D modelling to advanced analytics for project tracking, have revolutionized how construction projects are planned, executed, and monitored. Internationally, popular BIM tools include Autodesk Revit, Bentley Systems, and ArchiCAD, known for their comprehensive features in design visualization, collaboration, and project lifecycle management. These tools have facilitated a more integrated and efficient approach to construction, aiding in aspects like clash detection, cost estimation, and timeline management.

In the context of Palestine, the adoption and effectiveness of these BIM tools are influenced by several local factors. The technological infrastructure in Palestine, while developing, poses challenges in terms of access to the latest software and hardware required for the optimal use of BIM. Moreover, the availability of skilled professionals trained in BIM technology is crucial. As the construction industry in Palestine evolves, there is an increasing need for training and development programs to equip local professionals with the necessary skills to effectively utilize BIM tools. Collaboration with international partners and educational institutions can play a significant role in bridging this skills gap, thereby enhancing the adoption and impact of BIM in Palestine's construction sector.

The integration of BIM tools in construction project management has been extensively studied, highlighting their transformative impact on the industry. (Srimathi & Uma, 2017) research provides a comprehensive overview of various BIM tools, including Autodesk Revit Architecture, ArchiCAD, and Bentley Architecture, emphasizing their widespread adoption in the AEC industry for tasks such as design, modeling, energy analysis, clash detection, and cost estimating. The study particularly focuses on the capabilities of these tools in construction scheduling and cost estimation, illustrating the multifaceted applications of BIM in enhancing project efficiency and accuracy (Srimathi & Uma, 2017). In a practical application context, a study on time and resource management using BIM in residential apartment construction demonstrates the use of Autodesk Revit 2019 for 3D modeling, incorporating time (4D) and cost (5D) dimensions. This research highlights the effectiveness of BIM tools like Autodesk Navisworks Manage 2019 in providing graphical presentations of construction schedules and cost estimations, showcasing their role in optimizing project delivery, reducing costs, and improving overall project management (Narlawar et al., 2019). While, another study conducted in Bangladesh explores the benefits of using BIM for project time and cost control, employing Autodesk Revit MEP (2021) as a methodological tool. The findings reveal that BIM functions effectively in reducing costs, optimizing schedules, and benefiting all project participants, demonstrating its superiority over conventional modeling methods (Khan & Muhib, 2022). Lastly, Anaïs Tur Carbó's project on the construction of a building using BIM technology, specifically Autodesk Revit, compares BIM with traditional methodologies in terms of information management. This study underscores the advantages of BIM in detecting inconsistencies and managing a single database for project information, further elevating the quality of project execution plans (Cheng et al., 2023; Olugboyega et al., 2023; Spisakova et al., 2021). Collectively, these studies affirm the critical role of BIM tools in revolutionizing construction project management, enhancing design visualization, collaboration, scheduling, cost estimation, and overall project lifecycle management.

Research Methodology

This segment outlines the methodology employed in conducting this research. Data acquisition can be approached through various methods. Essentially, data is sourced from two

main categories. Primary data involves direct gathering and processing of information by the researcher, which includes methods like observations, surveys, interviews, and focus groups. On the other hand, secondary data involves sourcing information from already existing materials, such as academic papers, online resources, or library investigations. As depicted in Figure 1, this study primarily utilized secondary data sources for its data collection process.

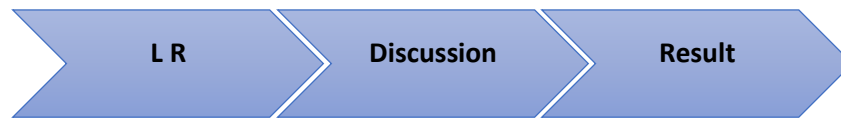


Figure 1 The process of data collection

A comprehensive literature review was conducted to assess the existing knowledge about the adoption of BIM in the Palestinian AEC industry. This review aimed to achieve three key objectives: 1) to accurately define and understand the concept of BIM as it applies to the Palestinian construction sector; 2) to identify the unique challenges faced by local industry players in adopting BIM; and 3) to offer insights and guidance for professionals in Palestine's construction industry on the effective implementation of BIM. In order to fulfil the objectives of this review, academic literature related to BIM was sourced from an online repository. The primary data sources selected for retrieving scholarly articles were the Web of Science (WOS) database, Scopus, and Google Scholar. To systematically manage the search process and ensure comprehensive coverage of interconnected articles, well-defined boundaries were established within the domain of study. The research employed a systematic methodology and a scientific mapping approach to conduct both bibliometric and systematic review analyses. Consequently, Figure 1 visually outlines the methodological framework employed in this study. From an initial pool of over 4303 sources, including journal articles, conference papers, case studies, press releases, professional presentations, and online content, the focus was narrowed down to 18 pertinent sources published within the last ten years. These sources primarily explore the definition, benefits, challenges, and strategic approaches to BIM adoption in the Palestinian construction context. This comprehensive approach to source selection was deemed necessary due to the limited existing research on BIM in Palestine. Given the scarcity of studies in this specific context, the review was not confined to a single database, such as the WOS. Instead, an exhaustive effort was made to collect publications from all available sources, with a primary focus on the WOS database, Scopus, ProQuest and Google Scholar, check screenshots in Appendix A. This inclusive strategy aimed to ensure that a thorough and representative examination of the existing literature related to BIM adoption in Palestine was conducted. On August 13, 2025, a research query was conducted using the following final search string: (("Building Information Modeling" OR "Building Information Modelling" OR "BIM") AND ("Construction" OR "construction industry" OR "AEC industry") AND "Palestine" OR "Palestinian" OR "Gaza" OR "West Bank")) and English (Languages), Date (2015-2025). The purpose was to filter the results to focus on the relevant field of BIM adaption research related to Palestine. Then, the titles and abstracts of the collected documents were subjected to a meticulous manual review and assessment to identify the ones relevant to the field of interest. Through a rigorous filtering process, a final dataset of 28 documents was curated, comprising a diverse range of publications, including journals, review articles, and conference papers. These carefully selected documents now form the pertinent literature that will be further analysed and considered in the course of the research.

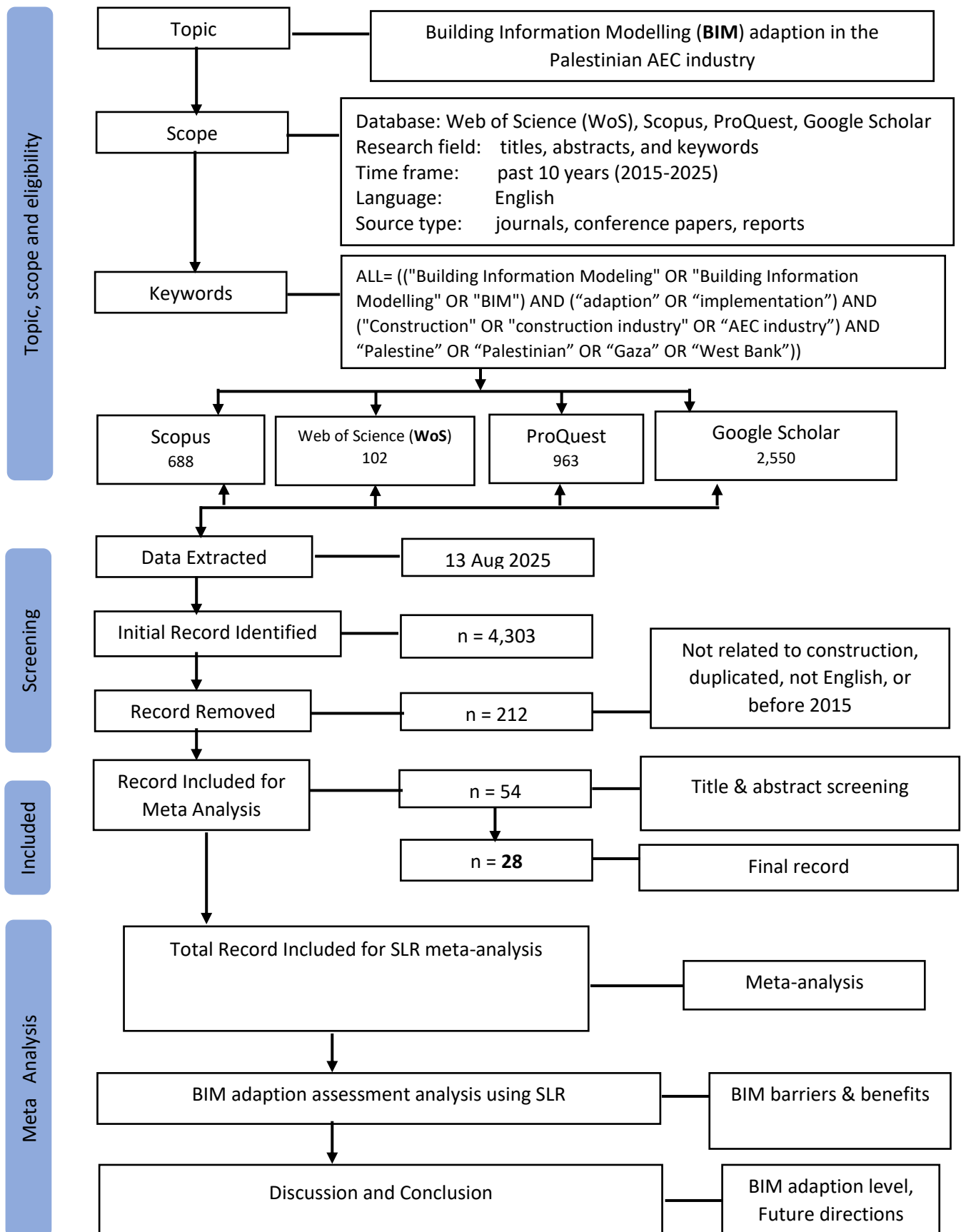


Figure 2 Flow diagram of the PRISMA search

Results and Discussion

Benefits of BIM adoption in the AEC industry Globally

BIM offers numerous benefits that are applicable globally, including in regions like Palestine. Many recent BIM studies demonstrate substantial quantifiable benefits in construction project efficiency through predominantly mixed-methods research approaches. The evidence reveals significant cost reductions ranging from 3% to 40%, with notable findings including project cost reductions of 16-20% reported by 41% of respondents Hosny et al., 2023, elimination of unbudgeted changes by up to 40% and contract value savings of up to 10% Bensalah et al., 2019, and cost overrun reductions of 12% alongside 18% improvements in cost estimation accuracy Saputra et al., 2025. Time savings prove equally substantial, with overall project delay reductions of 14.55% and payment delay reductions reaching 25.34% Alnaser et al., 2023, whilst cost estimation processes demonstrate remarkable efficiency gains of up to 80% and project time reductions of up to 7% Bensalah et al., 2019. Furthermore, project duration reductions vary considerably by facility type, achieving 15% improvements for airports and stadia and up to 40% for emergency facilities Saputra et al., 2025.

The research consistently identifies enhanced collaboration, design optimisation, and clash detection as fundamental process improvements underpinning these quantitative benefits, with all included studies reporting improved collaboration and communication through centralised data environments and integrated workflows. Design phase improvements feature prominently across nearly all studies, with BIM's capacity to simulate, visualise, and test design alternatives before construction leading to substantial waste and error reductions, including design error reductions of 21-25% reported by 46% of respondents and rework reductions of 21-25% noted by 51% of respondents Hosny et al., 2023, alongside design conflict reductions exceeding 60% in specific cases Saputra et al., 2025. The evidence base, whilst heterogeneous in study design and measurement methodologies—encompassing surveys, case studies, system dynamics, and structural equation modelling—consistently demonstrates that enhanced visualisation and decision support capabilities contribute to improved project management and stakeholder satisfaction, establishing BIM as a transformative technology for construction project efficiency across diverse geographical and sectoral contexts.

One of the primary advantages of BIM is its ability to significantly reduce both costs and time in construction projects.

Benefits of BIM adoption in the Palestinian AEC Industry

As is evident from the global discourse, numerous scholarly investigations have underscored a multitude of benefits associated with the adaptation of BIM within the Palestinian AEC industry. The study of (Saleh & Bakri, 2021) highlights several benefits of BIM adoption in the Palestinian AEC industry. A key advantage is the significant time savings across various stages of the BIM process. BIM models lead to accurate outputs in both drawings and quantities, assuming the model's accuracy, which is essential for effective planning and execution in construction projects. Furthermore, BIM facilitates documentation by creating an efficient archiving system that reduces the time required to access related files, effectively converting building mass into a comprehensive data mass. Besides that, BIM aids in updating cost estimations, a critical aspect of budget management in construction. This is particularly crucial for large projects, where BIM enhances project management and coordination. The complexity and size of these projects necessitate a more effective approach to problem-

solving and data interpretation, areas where BIM offers significant improvements over traditional methods. Another notable application of BIM is in operational and maintenance phases. Some firms provide their clients with 3D BIM models for these purposes, showcasing the model's versatility and long-term utility beyond just the construction phase. Additionally, the ability to obtain accurate and updated quantities from BIM models is a significant advantage, assisting in material management and cost estimation.

In the study of (A. Enshassi et al., 2016) examining the implementation of BIM in the Palestinian AEC industry, the identification of key barriers provides insights into the potential benefits of BIM adoption. Overcoming a prevalent lack of interest and resistance to changing existing workflows indicates that BIM could revolutionize construction project management by fostering more efficient and integrated workflows. Additionally, the barrier of insufficient BIM knowledge among professionals' points to an opportunity for significant skill enhancement and the development of expertise in modern construction technologies. The challenges associated with the cost of implementation and cultural resistance to adopting new technologies suggest that, once these hurdles are overcome, BIM could emerge as a cost-effective and culturally accepted innovation within the industry. Furthermore, the study's emphasis on the need for proactive government involvement in promoting BIM underscores its potential to greatly enhance the value of government-procured construction projects. This enhancement could manifest in more efficient, transparent, and well-managed construction processes. Hence, BIM adoption in the Palestinian AEC industry promises a transformative impact, marked by improved workflow integration, advanced skill development, economic viability, cultural adaptability to technological advancements, and an overall increase in the value and efficiency of construction projects, especially those involving governmental entities.

The study of Enshassi et al. (2018) identifies several key benefits of BIM, organized into four main components. These components are: (i) life cycle cost control and environmental issues, (ii) effective construction processes, (iii) design and quality improvement, and (iv) decision-making support. The most significant individual benefits within these components include improving management and operation of buildings, controlling the entire life cycle cost, reducing change orders, increasing coordination between contracting parties, enhancing communication, boosting safety, enhancing quality, and improving the decision-making process. The adoption of BIM in designing and constructing buildings and infrastructure projects in the Gaza Strip is seen as a way to significantly improve the effectiveness, efficiency, productivity, and quality of construction projects. This study highlights the benefits of using BIM in the construction industry in the Gaza Strip, contributing to the body of knowledge advocating for BIM among construction organizations in developing countries, a field with limited existing research. While these benefits underscore the potential of BIM in the Palestinian AEC industry, the study also notes that the full understanding and adoption of BIM are still not widespread in the region, indicating a need for broader implementation and awareness of its capabilities.

The study of (Enshassi et al., 2016) focused on the challenges and barriers hindering BIM implementation, such as organizational resistance, lack of knowledge, and cost considerations. The emphasis was on overcoming these obstacles to facilitate smoother adoption of BIM technologies, suggesting that once these barriers are addressed, the benefits

could include improved workflows, skill development, and cost-effectiveness, especially in government-related projects. In contrast, the other study of (Enshassi et al., 2018) presents a more direct and positive perspective on the advantages of BIM adoption. It outlines four key benefit areas: life cycle cost control and environmental issues, effective construction processes, design and quality improvement, and decision-making support. The highlighted benefits include enhanced management and operation of buildings, better control over life cycle costs, reduced change orders, improved coordination, communication, safety, and quality, as well as superior decision-making processes. This study underscores the practical advantages of BIM in improving effectiveness, efficiency, productivity, and quality of construction projects in the Gaza Strip, emphasizing its value in developing countries with limited research in this area.

Overall, while the first study identifies barriers to BIM adoption, the second study reveals the positive impacts once these barriers are overcome, illustrating a progression from recognizing challenges to realizing the comprehensive benefits of BIM in the Palestinian AEC industry. Table 2 provides an overview of the benefits of utilizing BIM, as indicated by various authors. The mutual benefits illustrate the significant impact BIM can have on the efficiency, quality, and overall success of construction projects in the Palestinian AEC industry

Table 2

The benefits of BIM adaption in the Palestinian AEC industry

No.	Benefits	Author
1	Improving management and operation of buildings:	Enshassi et al., 2018
2	Controlling the whole life cycle cost	Enshassi et al., 2018 Maliha, 2019 Saleh & Bakri, 2021
3	Reducing change orders:	Enshassi et al., 2018 Maliha, 2019
4	Improved Coordination and Communication	Enshassi et al., 2018 Saleh & Bakri, 2021 Maliha, 2019 Enshassi et al., 2016
5	Improving safety	Enshassi et al., 2018 Saleh & Bakri, 2021
6	Improving quality	Enshassi et al., 2018 Maliha, 2019
7	Improving decision-making process	Enshassi et al., 2018 Saleh & Bakri, 2021
8	Time and Cost Savings:	Saleh & Bakri, 2021 Enshassi et al., 2018 Maliha, 2019
9	Clash Detection:	Saleh & Bakri, 2021
10	Accurate Cost Estimation and Documentation	Saleh & Bakri, 2021
11	Accurate and Updated Quantities:	Saleh & Bakri, 2021
12	Project Size and Complexity Management	Saleh & Bakri, 2021
13	Comprehensive Integration	Saleh & Bakri, 2021
14	Enhanced Visualization	Maliha, 2019

Despite the promising benefits of BIM, its adoption in the AEC industry, including in the Gaza Strip, has been slow. This slow adoption could be due to various challenges, such as the fragmented nature of construction projects, lack of knowledge sharing, communication issues among stakeholders, rising costs, delays, waste, and lack of interest in maintenance of buildings (Enshassi et al., 2018).

No.	Challenges	Author
1	Lack of Awareness	Enshassi et al., 2018
2	Skill Deficit and Training	Enshassi et al., 2018 Maliha, 2019 Saleh & Bakri, 2021
3	Limited Client Demand	Enshassi et al., 2018 Maliha, 2019 Enshassi et al., 2019
4	Lack of Governmental Regulations	Enshassi et al., 2018 Saleh & Bakri, 2021 Maliha, 2019 Enshassi et al., 2016
5	MEP (Mechanical, Electrical, and Plumbing) Implementation Challenges	Enshassi et al., 2018 Saleh & Bakri, 2021
6	Incomplete Implementation Sequence	Enshassi et al., 2018 Maliha, 2019 Enshassi et al., 2019
7	Limited Adoption and Inefficient Utilization	Enshassi et al., 2018 Saleh & Bakri, 2021
8	Unawareness of BIM Benefits:	Daoor, 2018
9	Lack of Training	Daoor, 2018 Saleh & Bakri, 2021
10	Lack of Qualified Staff	Daoor, 2018 Saleh & Bakri, 2021 Enshassi et al., 2019
11	Lack of Interest in BIM	Enshassi et al., 2016
12	Organization's Resistance to Change Workflows	Enshassi et al., 2016 Enshassi et al., 2019
13	Lack of BIM Knowledge	Enshassi et al., 2016
14	Cost, Implementation, and Cultural Barriers	Enshassi et al., 2016 Enshassi et al., 2019
15	Lack of information sharing	Enshassi et al., 2019
16	High of implementation cost (software, training,..etc)	Enshassi et al., 2019

The Challenges of Adoption of BIM Globally

The adoption of BIM in the Palestinian AEC industry likely faces challenges similar to those identified in recent global studies. Even though specific studies focusing on the Palestinian context are scarce, insights can be drawn from broader recent research. Technological challenges remain a significant barrier, with issues surrounding the integration of BIM into

existing systems, software compatibility, and hardware requirements. Recent studies like Smith (2019) and Nguyen et al. (2020) emphasize the need for robust technological infrastructure for effective BIM implementation. Besides, skill gaps and the necessity for specialized training are also highlighted in contemporary literature. For instance, Liu et al. (2019) discuss the urgent need for training programs to equip professionals with the necessary BIM skills. This is compounded by the resistance to change among staff accustomed to traditional methods, a challenge noted by Jones et al. (2018) in their study on organizational adaptation to BIM.

Cultural and organizational resistance is another challenge. Recent research by Fernandez-Solis et al. (2020) indicates that transitioning to BIM requires significant changes in organizational culture and workflows, necessitating effective change management strategies. The importance of regulatory support and standardization in BIM adoption is underscored in the study by Zhang et al. (2021), highlighting the need for industry-wide standards and regulations to ensure consistency and collaboration across different projects. Financial considerations, particularly for smaller firms, are a critical factor affecting BIM adoption. The initial investment in BIM, as discussed by Wang et al. (2020), can be a significant barrier, making the justification of return on investment a crucial aspect of decision-making. Finally, the challenge of stakeholder collaboration is central to BIM implementation. As per the findings of Kim et al. (2021), effective communication and collaboration among all parties involved in a construction project are vital for the successful application of BIM. In conclusion, these global challenges, as identified in recent studies, provide a comprehensive view of the potential barriers to BIM adoption in any region, including Palestine. Addressing these challenges requires a multi-faceted approach involving government initiatives, industry-wide collaborations, and an organizational shift towards embracing technological advancements and innovation.

The Challenges of BIM Adoption in the Palestinian AEC Industry

The adoption of BIM in the Palestinian AEC industry faces several challenges, as highlighted in various studies. A consistent theme across multiple studies, including those by Enshassi et al. (2016), Enshassi et al. (2019), Al Daoor (2018), and Saleh and Bakri, is the evident lack of awareness and understanding of BIM's benefits. This lack of awareness is compounded by a deficiency in training and qualified personnel skilled in BIM, as emphasized by both Al Daoor (2018) and Saleh and Bakri (2021). (Saleh & Bakri, 2021) particularly highlighted the absence of education and training on BIM in universities and training centers, alongside a general disinterest from clients in BIM technology and a lack of supportive governmental regulations. For instance, Enshassi et al. (2016) pointed out the lack of interest in BIM and the organization's resistance to change workflows as significant barriers. Similarly, Enshassi et al. (2019) emphasized challenges such as the requirement of a large culture change within organizations and lack of senior management support. These findings are in line with the observations in the study by Al Daoor (2018), which highlighted unawareness of BIM benefits, lack of training, and lack of qualified staff as major obstacles (Al-Mabhouh et al., 2021; Hyarat et al., 2022; Musleh, 2018). The recurrent theme of awareness and knowledge deficit suggests a profound need for educational and promotional efforts to enhance understanding and acceptance of BIM in the Palestinian AEC sector.

Another significant challenge is the financial and resource constraints associated with BIM adoption. Enshassi et al. (2016) and Enshassi et al. (2019) point out the cost and technological barriers, including the high expense of implementing BIM and the cultural resistance towards adopting new technologies. Saleh and Bakri also mention the lack of governmental support as a barrier, underscoring the need for a more supportive policy environment to facilitate BIM adoption. The reluctance to adopt new innovations, as noted by (Maliha, 2019), further exacerbates these challenges, indicating a broader resistance within the industry towards technological change. Collectively, these studies portray a scenario where both cognitive and material obstacles hinder BIM adoption in the Palestinian AEC industry. Addressing these challenges necessitates a multi-dimensional strategy, including educational initiatives, policy reforms, and possibly economic incentives, to nurture a conducive environment for the integration of BIM technologies.

The study of (Enshassi et al., 2019) conducted an in-depth investigation into the factors constraining the adoption of BIM within the construction industry in Gaza Strip. Through the distribution of a well-structured questionnaire to industry professionals with an impressive response rate of 95.58%, the research identified five significant categories of limitations. The most prominent obstacle was the "Personnel Category," characterized by a lack of expertise and resistance to change. Following closely were limitations in the "Management Category," pertaining to senior management support and knowledge deficits, while the "Technological Category" highlighted issues with BIM software capabilities. The "Cost Category" emphasized the financial burden of BIM implementation, and the "Legal Category" addressed concerns regarding data privacy and intellectual property. Alos, another issue is the high upfront investment in software, hardware, and training is prohibitive for most firms (Ata et al., 2024). Besides that, the adoption of BIM in Palestine is profoundly shaped by regional and cultural realities that differ markedly from those encountered in other parts of the world. Unlike in more politically stable and economically affluent regions, Palestinian construction firms operate under conditions of chronic instability, resource scarcity, fragmented industry structures, and infrastructural limitations. These unique factors significantly influence both the feasibility and the manner of BIM implementation. Understanding the interplay between political, economic, and cultural forces is therefore essential to accurately assess the current state of BIM adoption and to formulate strategies tailored to Palestine's specific developmental needs.

The Palestinian context uniquely shapes BIM adoption:

1. Political Instability: Continuous conflict disrupts investment in long-term infrastructure technologies (Cheng et al., 2024).
 2. Sector Fragmentation: A preponderance of SMEs complicates collaboration (Enshassi et al., 2016).
 3. Economic Hardship: Financial and material resource scarcity forces prioritisation of survival over innovation (Maliha, 2020).
 4. Cultural Heritage Protection: BIM's application in heritage preservation projects, such as those explored by Amro and Ammar (2024), offers a new frontier for its local relevance.
- Nonetheless, researchers like Suleiman and Asaad (2024) argue that strategic adoption of BIM could drive greater efficiency and resilience across the sector.

Thematic Categorizing of Barriers to BIM Adoption

While BIM offers transformative potential for the Palestinian AEC industry, its adoption remains uneven and fraught with multifaceted challenges. To provide analytical coherence and enhance the interpretability of findings, the barriers examined in this section are categorised into six primary domains: financial, technological, skills-related, organisational, regulatory, and contextual. This classification is informed by a thematic categorisation approach, a well-established method in qualitative research that enables the synthesis of recurring concepts across multiple data sources. Specifically, this analysis draws upon framework-based thematic synthesis, which integrates findings from previous empirical studies to identify consistent themes and group them according to their nature and origin. This methodology is firmly grounded in academic research, where similar thematic structures have been employed to frame BIM adoption challenges in developing contexts (Enshassi et al., 2016; Maliha, 2019; Ata et al., 2024). It reflects a growing scholarly consensus that barriers to BIM adoption are not isolated, but rather arise from a network of interrelated systemic, organisational, and contextual factors. Categorising the barriers in this way not only aids clarity but also enables the formulation of targeted, domain-specific recommendations. Each category encompasses both direct operational issues (e.g., cost of software or lack of training) and broader structural or cultural impediments (e.g., organisational inertia or political instability) that shape technology adoption in the Palestinian construction sector. The six domains of barriers are:

a) Financial and Technological Constraints

One of the most significant impediments is the high cost associated with BIM implementation. The financial burden of acquiring software licences, upgrading hardware, and investing in continuous training is prohibitive for many firms, particularly small and medium-sized enterprises (Ata et al., 2024; Enshassi, Al Hallaq, & Tayeh, 2019). Furthermore, technological limitations — including poor internet connectivity, inadequate digital infrastructure, and concerns over data storage and intellectual property — exacerbate the difficulty of effective BIM integration (Maliha et al., 2020; Enshassi, Al Hallaq, & Tayeh, 2019).

b) Skills Deficit and Human Capital Challenges

The shortage of skilled personnel capable of utilising BIM effectively is a recurring theme across multiple studies (Maliha, 2019; Saleh & Bakri, 2021; Enshassi et al., 2019). This includes not only operational-level users but also project managers lacking expertise in applying BIM across key project management knowledge areas (Raza et al., 2023; Maliha, 2019). The absence of formal BIM education and insufficient professional training further compound this skills gap (Daoor, 2018; Saleh & Bakri, 2021).

c) Organisational and Cultural Resistance

Resistance to change within firms remains a substantial barrier to BIM adoption. Traditional workflows, conservative mindsets, and an aversion to technological innovation contribute to slow uptake (Nguyen et al., 2023; Enshassi et al., 2016). Furthermore, fragmented communication among stakeholders and a lack of knowledge sharing, particularly in multi-disciplinary projects such as MEP (Mechanical, Electrical, and Plumbing) coordination, hinder BIM's collaborative potential (Enshassi et al., 2018; Saleh & Bakri, 2021). Also, organisational culture is often characterised by limited senior management support, reluctance to allocate

necessary resources, and a general disinterest in digital transformation (Ata et al., 2024; Enshassi et al., 2019; Enshassi et al., 2016).

d) Absence of Regulatory Support and Client Demand

The lack of governmental policies mandating or incentivising BIM use represents a further obstacle (Suleiman & Asaad, 2024; Sbeih, 2024). Without regulatory frameworks or public sector leadership, firms have little external pressure to invest in BIM adoption. Simultaneously, there is limited client demand for BIM-integrated project delivery, reducing market incentives (Enshassi et al., 2018; Maliha, 2019; Saleh & Bakri, 2021).

e) Sectoral Fragmentation and Regional Constraints

The fragmented structure of the Palestinian construction industry, dominated by SMEs with limited technological capacity, makes the collaborative nature of BIM difficult to realise (Enshassi et al., 2016). Sector fragmentation results in inconsistent adoption practices, varying levels of digital literacy, and a lack of coordinated project delivery (Enshassi et al., 2019). Additionally, regional and cultural realities pose significant challenges. Continuous political instability disrupts investment in infrastructure and long-term planning (Cheng et al., 2024), while economic hardship forces firms to prioritise immediate survival over digital innovation (Maliha, 2020). Nevertheless, strategic use of BIM — particularly in areas such as cultural heritage preservation, as explored by Amro and Ammar (2024) — offers new avenues for its contextual relevance.

Table 3

Summary of Key Barriers to BIM Adoption in the Palestinian AEC Industry with Supporting Literature

BARRIER CATEGORY	SPECIFIC CHALLENGES	SOURCES
FINANCIAL	High implementation costs; lack of funding and financial incentives.	Ata et al. (2024); Enshassi et al. (2019)
TECHNOLOGICAL	Inadequate infrastructure, data privacy concerns, limited interoperability.	Maliha et al. (2020); Enshassi et al. (2019)
SKILLS DEFICIT	Lack of BIM-trained professionals and project managers.	Maliha (2019); Saleh & Bakri (2021); Daoor (2018)
ORGANISATIONAL RESISTANCE	Conservatism, fragmented workflows, lack of management support.	Nguyen et al. (2023); Enshassi et al. (2016, 2018, 2019) Ata et al., (2024)
REGULATORY AND CLIENT FACTORS	Absence of regulations; limited client awareness and demand.	Suleiman & Asaad (2024); Sbeih (2024); Saleh & Bakri (2021)
REGIONAL AND CULTURAL CONTEXT	Political instability, economic hardship, sector fragmentation.	Cheng et al. (2024); Amro & Ammar (2024); Maliha (2020)

Solutions for BIM Adoption in the Palestinian AEC Industry

The analysed studies provide a valuable set of strategic solutions to address the multifaceted barriers to BIM adoption within the Palestinian AEC sector. A predominant recommendation across studies is the enhancement of awareness and technical capacity among industry professionals. Al Daoor (2018) emphasises the importance of improving the skills and awareness of construction personnel through targeted training sessions and workshops. Such

initiatives are vital for fostering a workforce proficient in BIM tools and workflows. Complementing this, Daoor (2021) and Saleh and Bakri (2021) advocate for the integration of BIM into engineering and architectural education programmes, while Maliha (2019) calls for professional training focused on equipping project managers with the necessary competencies to apply BIM in managing project scope, cost, time, quality, and risk effectively. Beyond educational reform, several studies underline the necessity of cultivating a collaborative and innovation-driven ecosystem. Saleh and Bakri (2021) highlight improved coordination between MEP designers and contractors through iterative modelling processes, whereby initial BIM models are created by designers and refined by contractors. This collaborative approach not only reduces design clashes but also exemplifies the tangible benefits of BIM in real-world projects. Enshassi et al. (2018) further contribute by illustrating how BIM enhances project outcomes through improved cost control, design quality, decision-making, and construction efficiency—benefits that can serve as motivational levers for stakeholders hesitant to adopt the technology.

To support adoption at a systemic level, Enshassi et al. (2019) identify several organisational and human-related impediments, including lack of senior management support, insufficient staff training, resistance to workflow change, and a general absence of BIM-related knowledge. Addressing these factors necessitates a cultural shift within organisations alongside technical upskilling. In parallel, AbuHamra (2018) and Daoor (2021) argue that professional associations and academic institutions should actively raise awareness and disseminate knowledge through workshops, seminars, and professional networks.

Financial support mechanisms are also deemed essential. Abdullah et al. (2024) and Rinchen et al. (2024) suggest that government bodies and international donors provide financial incentives such as grants, tax rebates, and subsidised loans, especially targeting small and medium-sized enterprises (SMEs). These measures would help alleviate the cost barriers associated with software procurement and workforce training. In tandem, the provision of free or trial BIM software, as proposed by Al Daoor (2018), is a pragmatic strategy to lower initial adoption costs and encourage experimentation.

Furthermore, the development of regulatory frameworks is a critical enabling factor. Abdullah et al. (2024) and Rinchen et al. (2024) stress the importance of establishing national BIM standards and embedding BIM use into public procurement policies. Such regulatory measures would institutionalise BIM practices, promote consistency across projects, and legitimise its use within the wider construction sector.

In summary, effective BIM adoption in Palestine requires a holistic and coordinated approach. This encompasses investment in education and training, financial incentives, promotion of collaborative practices, cultural transformation within organisations, and the development of enabling regulatory frameworks. These integrated strategies collectively form a roadmap for accelerating the transition toward a digitally-enabled AEC industry in Palestine.

The conceptual framework presented in Figure X illustrates the dual forces shaping the adoption of Building Information Modeling (BIM) in the Palestinian AEC industry. On the left, the barriers (highlighted in red) capture the technological, organizational, and policy-related obstacles, including limited resources, high software and hardware costs, gaps in Mechanical,

Electrical, and Plumbing (MEP) integration, lack of awareness and technical expertise, resistance to organizational change, and weak regulatory support. On the right, the enablers (highlighted in green) outline the key drivers that can facilitate BIM adoption, such as integrating BIM into university curricula, offering continuous professional development, enforcing governmental mandates, providing financial incentives, promoting public–private partnerships, and leveraging emerging technologies (AI, IoT, VR). Both sets of forces converge toward the central outcome—BIM Adoption in Palestine—reflecting the complex interplay between barriers and enablers.

This framework was developed through a critical synthesis of existing literature on BIM adoption in developing countries, with a focus on studies addressing the Palestinian and regional contexts (Enshassi et al., 2016; Saleh & Bakri, 2021; Rinchen et al., 2024; Ata et al., 2024; Abdallah et al., 2025). The methodological approach involved identifying recurring themes in the literature, categorizing them into “barriers” and “enablers,” and visually mapping their relationship to the adoption outcome. This approach is justified as it provides a structured, context-specific representation of the factors influencing BIM implementation, offering both academic clarity and practical insights. By clearly contrasting inhibitors and facilitators, the framework serves as a guiding tool for researchers, policymakers, and practitioners to prioritize interventions and design strategies that can accelerate BIM adoption in the Palestinian AEC sector.

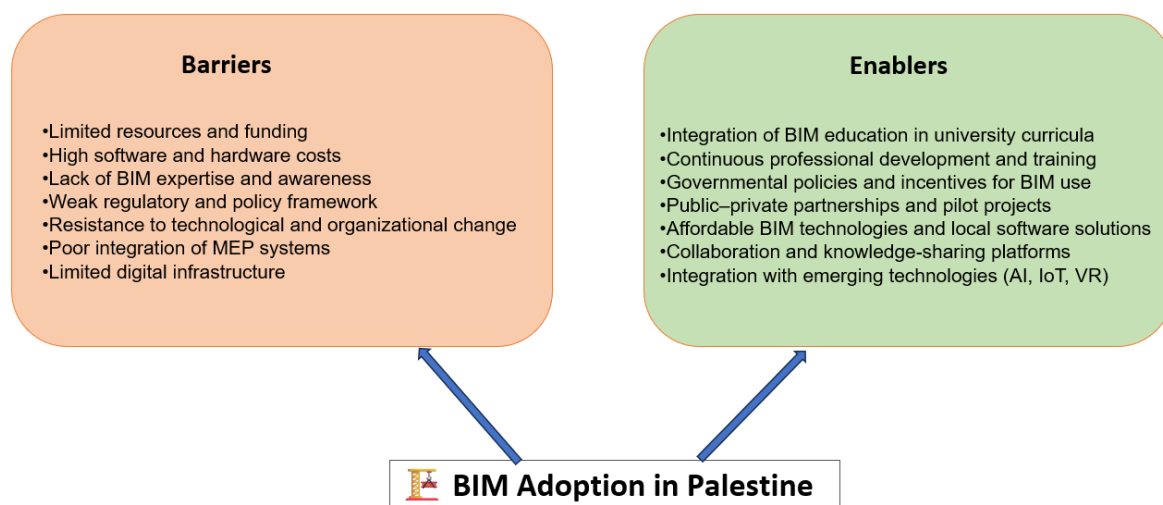


Figure 3 Conceptual framework for barriers and enablers influencing Building Information Modeling (BIM) adoption in the Palestinian AEC industry.

Future Directions to Foster BIM Adoption in the Palestinian AEC Industry

Recent literature provides a roadmap for the future direction of BIM adoption in the Palestinian AEC industry, underlining strategies that match the identified challenges with innovative solutions. For instance, Biswas, Sim, and Lau (2023) discuss the impact of integrating BIM with advanced technologies like machine learning, emphasizing the potential for BIM to evolve beyond its current capabilities and address some of the technological barriers faced by the industry. This integration could provide more sophisticated tools for managing complex projects, thereby addressing the lack of technical proficiency and awareness among professionals. Besides that, Hu et al. (2022) present a critical review of knowledge extraction and discovery based on BIM, suggesting that the future of BIM in AEC

industries lies in its ability to provide comprehensive and actionable insights. This aligns with the need for better understanding and utilization of BIM in the Palestinian AEC sector, particularly in addressing the knowledge and awareness gap among professionals and clients. Moreover, studies like that of Wang et al. (2020) highlight the importance of digital technology adoption in off-site construction, pointing towards a future where BIM is closely linked with other digital innovations. This approach could help in overcoming resistance to technological change and in making BIM more accessible and cost-effective. Furthermore, integrating BIM education in higher academic institutions, as discussed by Jin et al. (2020), could be a critical step in fostering a new generation of AEC professionals well-versed in BIM technologies. This educational initiative would directly address the lack of qualified personnel and the need for cultural change within organizations.

Looking towards the future, the path to widespread BIM adoption in the Palestinian AEC industry involves strategic planning and sustained efforts. One key direction is the integration of BIM education into the core curriculum of architectural, engineering, and construction programs in universities and technical schools. This educational shift will not only equip new graduates with essential BIM skills but also foster a culture of technological acceptance and innovation. Additionally, there is a need for continuous professional development programs focused on BIM, catering to current industry professionals to bridge the existing skill gap. In parallel, governmental and industry-wide policies should be developed to encourage and possibly mandate the use of BIM in significant construction projects. These policies could include incentives for BIM adoption, such as tax breaks or funding opportunities, and penalties for non-compliance to accelerate the transition. Moreover, a collaborative effort between the public and private sectors to invest in affordable BIM technology solutions could democratize access to these tools, making them more accessible to smaller firms and individual practitioners. Such a public-private partnership could also spearhead pilot projects that demonstrate the efficacy and benefits of BIM, serving as a model for broader industry adoption.

The future also holds potential for harnessing emerging technologies in conjunction with BIM. Integration with technologies like artificial intelligence, virtual reality, and the Internet of Things (IoT) could further enhance the capabilities of BIM, leading to more innovative, efficient, and sustainable construction practices. These advancements could position the Palestinian AEC industry at the forefront of technological innovation in construction, setting a benchmark for the region and beyond. However, it is crucial that these future directions are underpinned by a strong foundation of skilled professionals, supportive policies, and collaborative industry practices to ensure the successful and sustainable integration of BIM and related technologies.

The future trajectory for BIM in Palestine's AEC industry is optimistic, with a focus on aligning education with industry needs, enhancing professional training, and leveraging government policies for broader adoption. By integrating BIM into university curricula and professional development programs, the industry can overcome the current skill gap and resistance to technological change. The implementation of government-led initiatives and incentives could catalyze this transition, further bolstered by public-private partnerships to democratize access to BIM technologies. Looking ahead, this study suggests that the evolution of BIM in Palestine's AEC sector will likely involve embracing emerging technologies like AI, VR, and IoT.

This integration promises to revolutionize construction practices, enhancing efficiency, innovation, and sustainability. However, realizing these potential hinges on a solid foundation of skilled professionals, supportive policies, and industry collaboration, which are crucial for the sustainable and successful adoption of BIM. In essence, this study provides a comprehensive blueprint for navigating the challenges and harnessing the opportunities of BIM in Palestine's evolving construction sector, setting a pathway towards a more technologically advanced and efficient industry.

Based on the comprehensive review, several strategic directions are proposed:

1. Development of a Palestinian BIM Standard and Roadmap: Establishment of clear, mandatory guidelines (Sbeih, 2024; Ata et al., 2024).
2. Sector-Wide Awareness Campaigns: Government, academia, and private sector collaboration to promote BIM literacy (Daoor, 2021).
3. Subsidised Access to Technology: Financial mechanisms to lower the entry barrier for SMEs (Nguyen et al., 2023).
4. Pilot Projects: Use of flagship public projects to showcase BIM benefits (Saleh & Bakri, 2021).
5. Research and Innovation Hubs: Institutions dedicated to BIM localisation and advancement in Palestine (Raza et al., 2023).

In conclusion, the adaption of BIM in Palestine's AEC industry is faced with several challenges, including a shortage of trained BIM professionals, resistance to change workflows, lack of knowledge about BIM, and cultural and cost barriers (Enshassi2016). However, the potential benefits of BIM adoption in Palestine's AEC industry are significant. BIM can improve project coordination and communication, reduce errors and conflicts, enhance productivity and efficiency, optimize resource allocation, and improve overall project outcomes. Therefore, it is important to overcome these challenges and pursue future directions to promote the adoption of BIM in Palestine's AEC industry by increasing awareness and education about BIM through workshops, seminars, and education programs.

Table 3

Thematic Analysis results: Comparative Summary of Key Findings

Study Focus	Key Findings	Primary References
BIM Awareness and Understanding	Awareness is increasing, particularly among younger professionals; however, understanding is still shallow and often limited to visualisation. Definitions of BIM vary between narrow (model-centric) and broad (process-centric) views.	AbuHamra (2015, 2018); Enshassi & AbuHamra (2017); Saleh & Bakri (2021); Ata et al. (2024); Al Daoor (2018); Borkowski (2023)
Benefits of BIM	Significant benefits include project management enhancement, cost and time savings, sustainability improvements, better collaboration, and increased safety and quality management.	Enshassi, AbuHamra, & Mohamed (2016); Raza et al. (2023); Cheng et al. (2024); Maliha et al. (2020); Yasir et al. (2024); Altuhul (2023)
Barriers to Adoption	Financial constraints, lack of trained professionals, cultural resistance, inadequate infrastructure, absence of regulatory frameworks, and	Enshassi & AbuHamra (2017); Enshassi, AbuHamra, & Mohamed (2016); Enshassi, Hamra, & Alkilani (2018);

	fragmented sectoral structure hinder adoption.	Enshassi, Al Hallaq, & Tayeh (2019); Maliha (2019, 2020); Ata et al. (2024); Nguyen et al. (2023)
Role of Education and Training	Integrating BIM into university curricula and offering targeted professional development programmes are essential for building local capabilities.	Daoor (2021); Saleh & Bakri (2021); Maliha (2019); Raza et al. (2023)
Regional and Cultural Context	Political instability, resource scarcity, and fragmentation of the industry create additional challenges. Heritage protection projects reveal new opportunities for BIM application.	Cheng et al. (2024); Suleiman & Asaad (2024); Amro & Ammar (2024); Maliha (2020)
Strategic Recommendations	Calls for a phased adoption roadmap: establishing national BIM standards, subsidising access, launching sector leadership projects, and encouraging localised research and innovation.	Ata et al. (2024); Sbeih (2024); Saleh & Bakri (2021); Suleiman & Asaad (2024); Raza et al. (2023)
BIM for Project Management Knowledge Areas	BIM enhances the practical application of all ten PM knowledge areas, particularly scope, cost, time, quality, and risk management.	Raza et al. (2023); Maliha (2019); Maliha et al. (2020)
BIM and Sustainability	BIM facilitates energy-efficient design, waste minimisation, and sustainable project delivery, critical for Palestinian reconstruction.	Cheng et al. (2024); Saleh & Bakri (2021); Tayeh et al. (2024)
BIM and Construction Safety	BIM integration with safety planning reduces construction site accidents and improves compliance.	Yasir et al. (2024); Enshassi, AbuHamra, & Mohamed (2016)
Future Research Directions	Emphasises the need for BIM localisation, broader empirical studies on Palestinian BIM projects, and strategic public-private-academic partnerships.	Sbeih (2024); Ata et al. (2024); Borkowski (2023); Suleiman & Asaad (2024)

Conclusion

This study synthesises both foundational and recent research on BIM adoption in Palestine, revealing a sector at a formative stage shaped by technological, educational, organisational, and political complexities. BIM holds transformative potential not only to modernise the Palestinian construction sector but also to address deep-seated inefficiencies, improve sustainability, and enhance project management outcomes.

However, widespread adoption faces substantial challenges, including limited awareness, resistance to change, high costs, and inadequate technological infrastructure. Overcoming these barriers is vital to realise the significant benefits BIM offers. A phased adoption strategy — prioritising educational reform, leadership through pilot projects, and proactive government intervention — emerges as the most viable pathway forward. Rather than perceiving BIM adoption as a single transformative leap, Palestinian stakeholders should embrace a staged maturity model, evolving from basic digital modelling towards fully integrated lifecycle project management.

To support this progression, comprehensive education and training initiatives must be implemented. Workshops, seminars, and university curricula reforms are essential to build familiarity with BIM's capabilities across the AEC sector. Parallel investment in technological infrastructure — improving internet connectivity, providing access to advanced software and hardware, and establishing efficient data management systems — will be crucial. Addressing organisational resistance through cultural change initiatives and showcasing successful local BIM implementations can foster acceptance and enthusiasm.

Additionally, targeted financial support, such as grants, subsidies, or tax incentives, could mitigate the high initial investment costs that deter many firms, particularly SMEs. Critically, all efforts must ensure cultural and contextual alignment: BIM systems and training must be localised, affordable, and responsive to the socio-economic realities of Palestine, rather than imported models ill-suited to local conditions.

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