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Adoption and Impact of Building Information Modelling (BIM) on Sustainable Construction in Malaysia: A Systematic Review

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ABSTRACT

The Malaysian construction industry is experiencing a digital shift, with Building Information Modelling (BIM) playing a key role in improving efficiency, cost control, and sustainability. Despite its potential, BIM adoption remains inconsistent due to challenges such as high implementation costs, limited technical expertise, and weak regulatory support. This study presents a systematic literature review (SLR) of 89 studies from 2007 to 2024, following the PRISMA framework, to assess the current state of BIM in Malaysia. Findings highlight that while government incentives, training programs, and technological advances have improved adoption rates, integration barriers still exist particularly in aligning BIM with national green certification standards. BIM has shown benefits in boosting productivity, enabling accurate cost estimation through 5D BIM, and promoting sustainable practices via Green BIM. The study recommends stronger policy support, enhanced industry collaboration, and more empirical research to accelerate BIM integration. These insights can guide policymakers, practitioners, and researchers in advancing Malaysia's construction industry toward greater efficiency and sustainability.

1. Introduction

The construction industry plays a pivotal role in national economic growth, contributing significantly to employment, infrastructure development, and technological advancement. In Malaysia, this sector has demonstrated steady growth, generating RM205.1 billion in gross output in 2022 alone [1]. This industry also serves as a key driver for related sectors, creating a multiplier effect that enhances overall economic productivity. However, despite its economic significance, the construction industry remains one of the largest consumers of energy and natural resources, accounting for approximately 40% of global energy consumption and 25% of greenhouse gas emissions [2]. In Malaysia, the construction sector contributes 24% of the country's total carbon emissions, a figure that continues to rise with rapid urbanization and infrastructure expansion [3]. This environmental burden underscores the need for more efficient and sustainable construction practices.

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The environmental impact of conventional construction methods extends beyond carbon emissions, as excessive material waste and high energy consumption contribute to ecological degradation. Studies indicate that construction waste accounts for 30% of landfill deposits in developing nations, with Malaysia generating an estimated 6 million tons of construction-related waste annually [4]. In addition, poor resource management leads to inefficiencies that escalate project costs and delay timelines, further compounding sustainability challenges. As a result, industry stakeholders have sought innovative solutions to enhance efficiency, minimize waste, and reduce environmental harm. One such approach is the adoption of digital technologies, particularly Building Information Modeling (BIM), which offers a structured and data-driven framework for optimizing resource use and improving project outcomes [5].

Beyond environmental concerns, the construction sector's reliance on traditional methodologies has had significant public health implications. Studies have linked emissions from construction activities to an increased prevalence of respiratory diseases, particularly in urban areas where air quality is already compromised. The release of fine particulate matter (PM2.5) from construction dust and vehicular emissions has been associated with long-term health risks, including asthma and cardiovascular diseases [6]. Addressing these issues requires a comprehensive shift towards sustainable practices that not only reduce emissions but also enhance worker safety and community well-being. The integration of advanced construction technologies, such as BIM, can play a crucial role in achieving these goals by enabling precise planning, real-time monitoring, and optimized energy efficiency [7].

Despite its potential benefits, BIM adoption in Malaysia has been gradual, with several barriers limiting widespread implementation. Organizational challenges, including resistance to change, lack of technical expertise, and high initial investment costs, remain significant obstacles [8]. A survey conducted among Malaysian construction firms revealed that only 13% had fully integrated BIM into their workflows, with smaller firms struggling due to financial constraints and limited access to training programs [9]. Additionally, regulatory frameworks have yet to establish mandatory BIM adoption policies, further slowing industry-wide implementation [10]. In contrast, countries such as the United Kingdom and Singapore have successfully integrated BIM through government-mandated policies and incentives, demonstrating the potential for structured regulatory support to drive digital transformation [11].

The Malaysian government has recognized the importance of BIM and incorporated it into national development plans such as the Construction Industry Transformation Plan (CITP) 2021–2025. This initiative aims to enhance construction efficiency, reduce waste, and improve sustainability through digital adoption [7]. Moreover, the integration of Green BIM has been identified as a key strategy for achieving energy-efficient and eco-friendly construction practices. Green BIM enables energy performance analysis, life cycle assessment, and real-time simulation of sustainable building designs, aligning with Malaysia's National Green Technology Policy [12]. However, the lack of comprehensive studies examining the practical implementation of Green BIM in Malaysia highlights an area requiring further research [3].

To address these existing gaps in knowledge, this study undertakes a comprehensive and systematic review of the current state of Building Information Modelling (BIM) adoption within the Malaysian construction industry. The focus is placed on identifying and critically evaluating key barriers that hinder effective BIM implementation, as well as the success factors that facilitate its adoption in practice. Additionally, the study examines the potential contributions of BIM toward promoting sustainable construction practices, including efficiency improvements, cost management, and environmental performance. By employing a structured and methodical analysis of relevant literature, this research seeks to provide valuable insights into the challenges faced by industry stakeholders, ranging from contractors and consultants to policymakers, and to highlight practical recommendations for enhancing BIM integration across various stages of construction projects. Ultimately, the findings of this review are intended to contribute to a more comprehensive understanding of BIM's transformative potential in the Malaysian construction sector and to support evidence-based decision-making for future policy development, strategic planning, and adoption strategies within the industry.

While several studies have examined BIM adoption either globally or within specific national contexts, existing reviews tend to focus on isolated aspects such as technical implementation, general adoption barriers, or sustainability outcomes, often without integrating these dimensions into a unified analytical framework [13,14]. In the Malaysian context, prior studies are largely fragmented, with limited efforts to systematically synthesize the interrelationships between organizational, technological, financial, and sustainability dimensions of BIM adoption. Therefore, this study contributes to the literature in three key ways. First, it provides a holistic synthesis of BIM adoption in Malaysia by integrating five critical themes which are barriers, implementation strategies, productivity impacts, 5D BIM for cost management, and Green BIM for sustainability within a single systematic review. Second, it moves beyond descriptive analysis by critically evaluating gaps, inconsistencies, and the lack of empirical validation in existing studies, offering deeper insights into the structural and institutional challenges shaping BIM adoption. Third, the study uniquely positions BIM within the broader context of sustainable development by examining its potential alignment with national sustainability priorities and global development agendas, thereby offering a more policy-relevant and forward-looking perspective. Collectively, this review advances current knowledge by bridging fragmented research streams and providing a comprehensive, critical, and context-specific understanding of BIM adoption in Malaysia.

2. Terminologies Definition

2.1 Building Information Modelling and BIM Dimensions

Building Information Modeling (BIM) is more than just a digital 3D model of a building; it serves as a centralized knowledge resource that carries critical information throughout a structure's lifecycle. BIM not only represents the physical and functional characteristics of a facility but also integrates key data that support design, construction, and operational decision-making [15]. Originally introduced in the architecture, engineering, and construction (AEC) industry in the early 21st century, BIM has evolved significantly. While early applications focused on basic 3D modeling, modern BIM now incorporates additional layers of data, extending its capabilities beyond visualization. Today, BIM includes time-based scheduling (4D BIM), cost estimation (5D BIM), and sustainability assessment (6D BIM), making it an indispensable tool for managing complex projects [16,17].

Understanding BIM's multi-dimensional framework helps highlight its value in the construction industry. The traditional 3D model provides spatial visualization, allowing stakeholders to see how a structure will take shape. The introduction of 4D BIM brings in time-based modeling, enabling project teams to plan construction phases more efficiently and avoid scheduling conflicts [18]. 5D BIM takes it a step further by linking cost-related data to each element of a project, helping teams manage budgets more accurately [19]. Meanwhile, 6D BIM focuses on sustainability, incorporating data on energy efficiency, material impact, and lifecycle assessments to promote environmentally responsible construction [20].

As BIM continues to advance, new dimensions such as 7D BIM and beyond are being introduced. These further extensions integrate facility management, operational performance monitoring, and long-term maintenance planning, solidifying BIM's role as a comprehensive project lifecycle management tool [21,22]. By enhancing collaboration, transparency, and risk management, BIM helps stakeholders streamline decision-making, improve productivity, and optimize project outcomes. Ultimately, its growing adoption is reshaping the AEC sector by transforming the way projects are designed, built, and maintained [23,24].

2.2 Green BIM and Sustainability

Green Building Information Modeling (Green BIM) combines the principles of Building Information Modeling (BIM) with sustainable design and construction practices, helping to minimize the environmental impact of buildings while optimizing their performance. By integrating digital design tools, Green BIM enables project teams to analyze key sustainability factors such as energy efficiency, material selection, and overall building lifecycle performance [25,26]. This synergy between BIM and green construction strategies allows stakeholders to assess a building's sustainability performance through tools like life-cycle assessments (LCA) and energy simulations, ensuring environmentally responsible decision-making [27,28].

Studies show that adopting Green BIM improves decision-making on sustainable materials and building techniques, while also enhancing compliance with green certification standards such as LEED and BREEAM [15,16]. Beyond regulatory compliance, Green BIM offers a multi-dimensional approach to environmental impact analysis by evaluating resource depletion, energy consumption, and sustainability metrics, fostering a culture of innovation in the architecture, engineering, and construction (AEC) industry [29]. More than just a tool for meeting sustainability requirements, Green BIM supports continuous performance improvement throughout a building's lifecycle, enabling a proactive approach to climate resilience and resource efficiency [30,31]. As knowledge and technology in Green BIM continue to advance, its role becomes increasingly critical in addressing global challenges such as climate change and resource scarcity, reinforcing its contribution to the broader sustainable development goals (SDGs) [32].

3. Methodology

Stage 1: Planning and Identification

The first step in this study was to select a reliable academic database for sourcing relevant literature. Scopus was chosen due to its broad coverage of peer-reviewed articles and its frequent use in systematic [33,34,35,36]. To ensure a structured and repeatable search process, Boolean search techniques were applied using key terms like "building information modelling," "BIM," and "Malaysia". The search query was carefully designed to retrieve the most relevant articles while minimizing unrelated results [37], as shown in Table 1. Additionally, the study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to maintain methodological transparency and rigor [38].

The selected time span of 2007–2024 was chosen to capture the evolution of BIM from its early introduction phase to its more mature stage within the Malaysian construction industry. Around the late 2000s, BIM began gaining international recognition as a transformative digital technology, with early adoption frameworks and industry applications emerging globally [14]. In Malaysia, structured BIM initiatives and policy discussions only began to gain traction after 2010, particularly with the introduction of government-led programs and strategic frameworks such as the BIM Roadmap developed by CIDB [7,39]. Compared to more advanced countries, where BIM adoption was driven earlier through regulatory mandates and national strategies, Malaysia's adoption timeline reflects a later but steadily growing trajectory [11]. Therefore, this timeframe ensures comprehensive coverage of both the initial adoption phase and recent advancements, allowing for a longitudinal assessment of trends, challenges, and impacts.

Table 1
Search strings and results

Search Engine	Search Strings	Results
Scopus	(TITLE-ABS-KEY("Building Information Modelling" OR "BIM") AND TITLE-ABS-KEY(Malaysia))	372
	AND PUBYEAR > 2007 AND PUBYEAR < 2024	371
	AND (LIMIT-TO(LANGUAGE,"English" OR "Malay"))	370
	AND (EXCLUDE "ERRATUM" AND "EDITORIAL" conference review	339

Total articles published from Scopus: 372
After first screening: 339After duplicated articles removed: 338
Articles available for full-text online retrieval: 310
After title and keywords screening: 213
After abstract screening: 106
After full-text screening: 89
Total articles used in the study: 89

To ensure a more precise and rigorous selection of relevant studies, inclusion and exclusion criteria were carefully established (see Table 2). These criteria were guided by the SPIDER framework (Sample, Phenomenon of Interest, Design, Evaluation, Research Type), which is especially effective for qualitative and mixed-method research [40,41]. By using this well-structured and widely recognized framework, the review aimed to capture a comprehensive and in-depth understanding of BIM adoption in Malaysia's construction sector from multiple perspectives, including technological, organizational, and environmental aspects, thereby ensuring that the analysis reflects a broad and representative overview of current practices and challenges.

Table 2
Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Journal articles accessible in the Scopus database	Duplicate articles
Review articles available in Scopus	Articles not accessible online
Articles published between 2007 and 2024 in English or Malay	Non-English language articles
Articles containing content aligned with the authors' research objectives	Articles published outside the 2007 –2024 timeframe
Relevant articles addressing the research questions	Research studies that do not align with the authors' objectives
	Articles that do not address the research questions

Stage 2: Screening and Reviewing

The systematic review took place between October 2024 and January 2025, with articles carefully screened through multiple sequential stages. First, articles that did not meet the established inclusion criteria such as those published outside the 2007–2024 range or not categorized as journal articles, conference papers, book chapters, or review papers were excluded. In continuation of that process, duplicates were systematically removed, after which titles, keywords, and abstracts were thoroughly reviewed to assess their relevance to the research objectives and to ensure that only studies directly addressing BIM adoption in Malaysia were considered for further analysis.

A single-reviewer screening process was employed, with the first author handling the initial selection while the second author validated all choices to minimize potential bias and enhance reliability [42]. The inclusion criteria were consistently applied to all full-text articles to maintain methodological rigor and ensure uniformity across the review. Mendeley was selected for its efficiency in managing large-scale systematic reviews and was utilized as the primary reference management tool, helping to streamline the screening process, remove duplicates, organize references, and support collaborative reviewing efforts among the research team [40].

Stage 3: Categorization and Analysis

After the screening process, a total of 89 articles were carefully selected for inclusion in the final analysis. A narrative synthesis approach was employed to examine the findings systematically and comprehensively, enabling the clear identification of key themes, recurring patterns, and relationships across the selected studies. This method was specifically chosen due to the qualitative nature of the research and the considerable variety in study designs, methodologies, and contexts, allowing for a thorough understanding of BIM adoption practices in Malaysia.

To effectively organize the synthesis, the selected articles were grouped into five main themes, which were carefully aligned with the study's specific research questions and overall objectives. These themes included core aspects of BIM adoption, such as barriers and enablers, implementation challenges, productivity impacts, financial management through 5D BIM, and contributions toward sustainable construction practices, providing a structured framework for analyzing the literature and drawing meaningful conclusions.

1. Barriers of BIM Adoption in the Malaysian Construction Industry
2. Success Factors and Initiatives of BIM Implementation Across Project Stages in Malaysia
3. Impact of BIM on Productivity and Workflow Efficiency in Malaysian Construction Projects
4. Role of BIM in Cost Estimation and Financial Management in Malaysian Construction
5. Green BIM and Its Contribution to Sustainable Construction Practices in Malaysia

The categorization process was iterative, with themes continuously refined, reviewed, and carefully validated to ensure the synthesis accurately and comprehensively captured the full breadth and depth of the literature. The findings from each theme were then systematically integrated into the discussion section, providing valuable insights into the current state of BIM adoption in Malaysia and highlighting potential directions for further investigation, development, and future research.

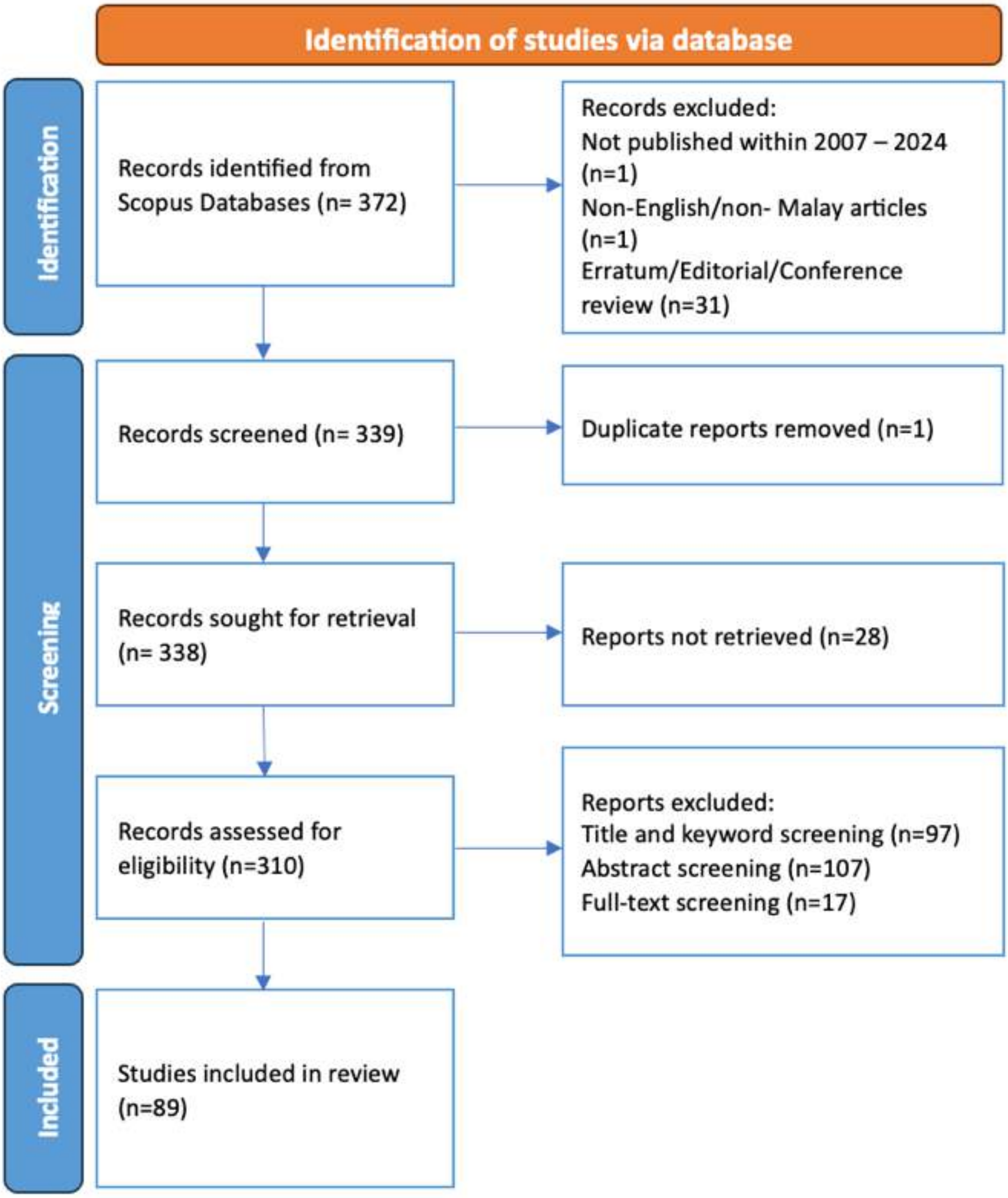

Fig. 1. Articles screening procedures flowchart utilising PRISMA [38]

4. Results

This section presents the key findings and detailed analysis from the retrieved articles sourced from the Scopus database, covering the publication period from 2007 to 2024, and carefully selected according to the clearly defined inclusion and exclusion criteria established for this study.

4.1 Articles Per Year

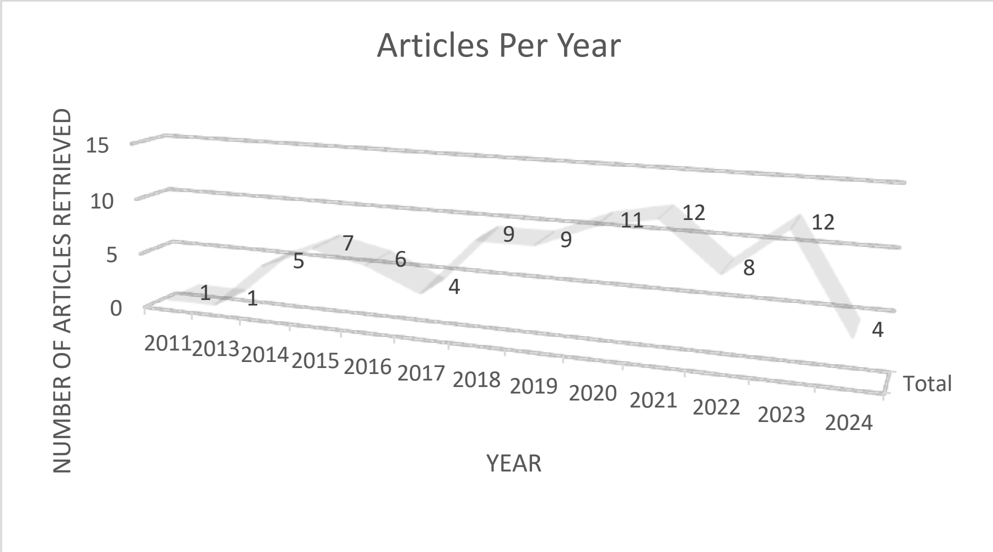

Fig. 2 *The* total count of articles published annually in the Scopus database

Following the retrieval and screening process, a total of 89 articles were selected for inclusion in this systematic review. Figure 2 illustrates the annual distribution of these papers, focusing specifically on BIM adoption in the Malaysian construction industry from 2007 to 2024. The findings indicate that between 2013 and 2015, there was a gradual but noticeable increase in awareness regarding BIM adoption within the building and construction sector in Malaysia. Since 2014, research on Building Information Modelling (BIM) adoption in the Malaysian construction industry has demonstrated a notable and consistent upward trend, reflecting growing academic and industry interest in this transformative technology. This increase can be attributed to heightened awareness among stakeholders, supportive government policies, and the ongoing digital transformation initiatives within the sector. Although the number of publications has fluctuated over the years, the highest output was recorded in 2021 and 2023, with 12 articles published in each of these years. While a slight decline was observed in 2022 (8 articles), the overall research output remains significantly higher than in the earlier years. The lower count in 2024 (4 articles) does not necessarily indicate a decrease in BIM-related research, as the data collection process may have excluded studies published later in the year or in less accessible sources.

Despite searching for papers from 2007 to 2024, the earliest publications retrieved were from 2011, with no papers identified from 2012. This gap may be due to the slow initial adoption of BIM in Malaysia, as the construction industry was still in the early stages of exploring and implementing digital construction technologies. Furthermore, BIM-related research in Malaysia might not have gained significant academic traction until after 2013, when government policies, industry demand, and institutional support began to drive interest and investment in this topic. The absence of papers from certain years suggests that while BIM adoption has grown steadily over time, early research was limited, possibly due to a combination of factors such as lack of funding, low awareness among practitioners and academics, or the novelty of the technology within the local construction context. These early gaps highlight the challenges of initiating technology-driven research in emerging construction markets.

4.2 Publishers and Document Type of Retrieved Articles

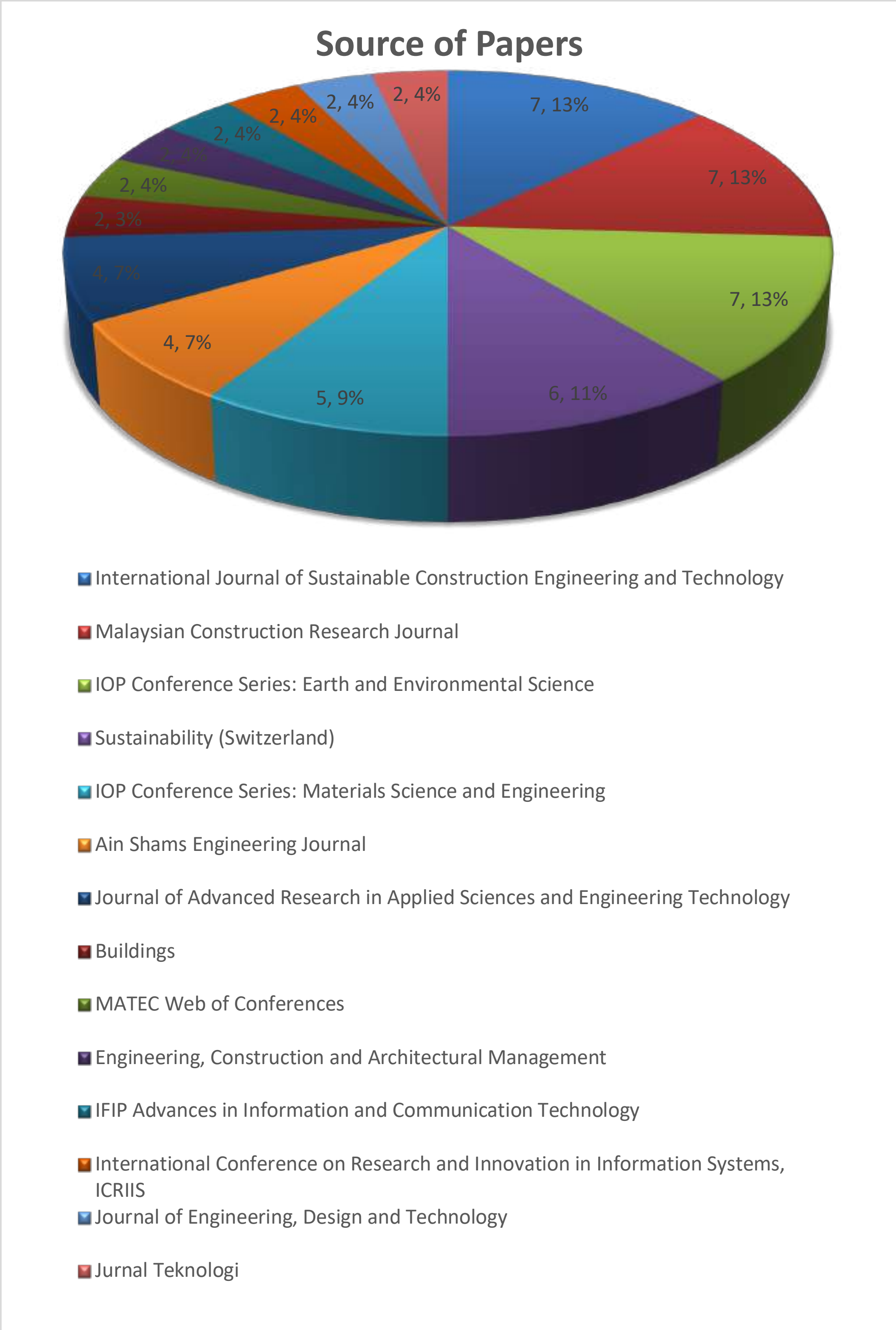

Fig. 3 Paper publication sources

Fig. 3 presents the detailed sources of the papers included in this study, highlighting the top 10 journals and conferences where relevant research on BIM adoption has been published. Among these sources, the International Journal of Sustainable Construction Engineering and Technology, Malaysian Construction Research Journal, and IOP Conference Series are the most prominent, each contributing 7 papers, followed by Sustainability (Switzerland) with 6 papers. Other notable sources include Materials Science, Ain Shams Engineering Journal, and the Journal of Advanced Research in Applied Sciences and Engineering Technology, which collectively contributed between 4 and 5 papers each. This distribution not only reflects the diversity of publication outlets but also highlights the interdisciplinary and evolving nature of research on BIM adoption in the Malaysian construction sector, demonstrating the wide-ranging academic and practical interest in this field.

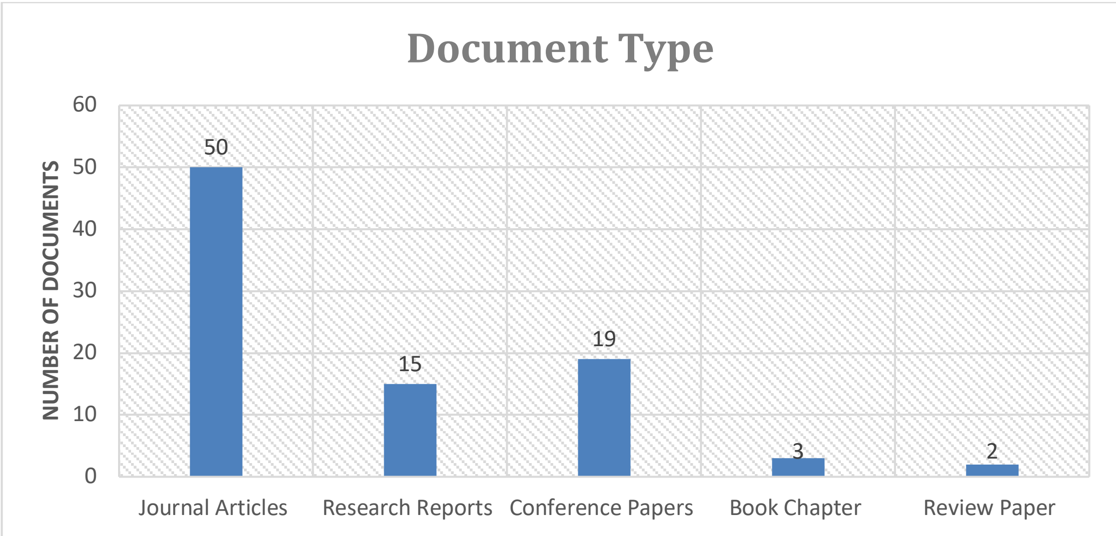

Fig. 4 Types of documents retrieved for review

The articles reviewed in this study consist of various document types, including 50 journal articles, 19 conference papers, 15 research reports, 3 book chapters, and only 2 review papers, as shown in Fig. 4. The low number of review papers suggests that more comprehensive and in-depth systematic reviews are still needed to thoroughly analyse and synthesise the current state of BIM adoption in Malaysia, particularly to identify trends, challenges, and gaps that could inform both academic research and industry practice. Addressing these gaps will not only advance scholarly understanding but also support policymakers, industry stakeholders, and practitioners in developing effective strategies, improving implementation, and promoting wider adoption of BIM technologies across the construction sector.

4.3 Citation Analysis Of Retrieved Articles

This citation analysis highlights the impact of research on BIM adoption within the Malaysian construction industry and its contribution to knowledge advancement in sustainable construction. Figure 5 presents the most cited articles identified in this study, with [51] receiving the highest number of citations (226), followed by Rogers et al. (2015) with 189 citations and Shoubi et al. (2015) with 124 citations. These highly cited papers indicate a strong research focus on BIM implementation, sustainability, and construction efficiency. Notably, only five studies have exceeded 100 citations, while the remaining papers show a gradual decline in citation impact. This pattern suggests that while

BIM research is gaining recognition, only a select few studies have achieved widespread influence within the academic and industry communities.

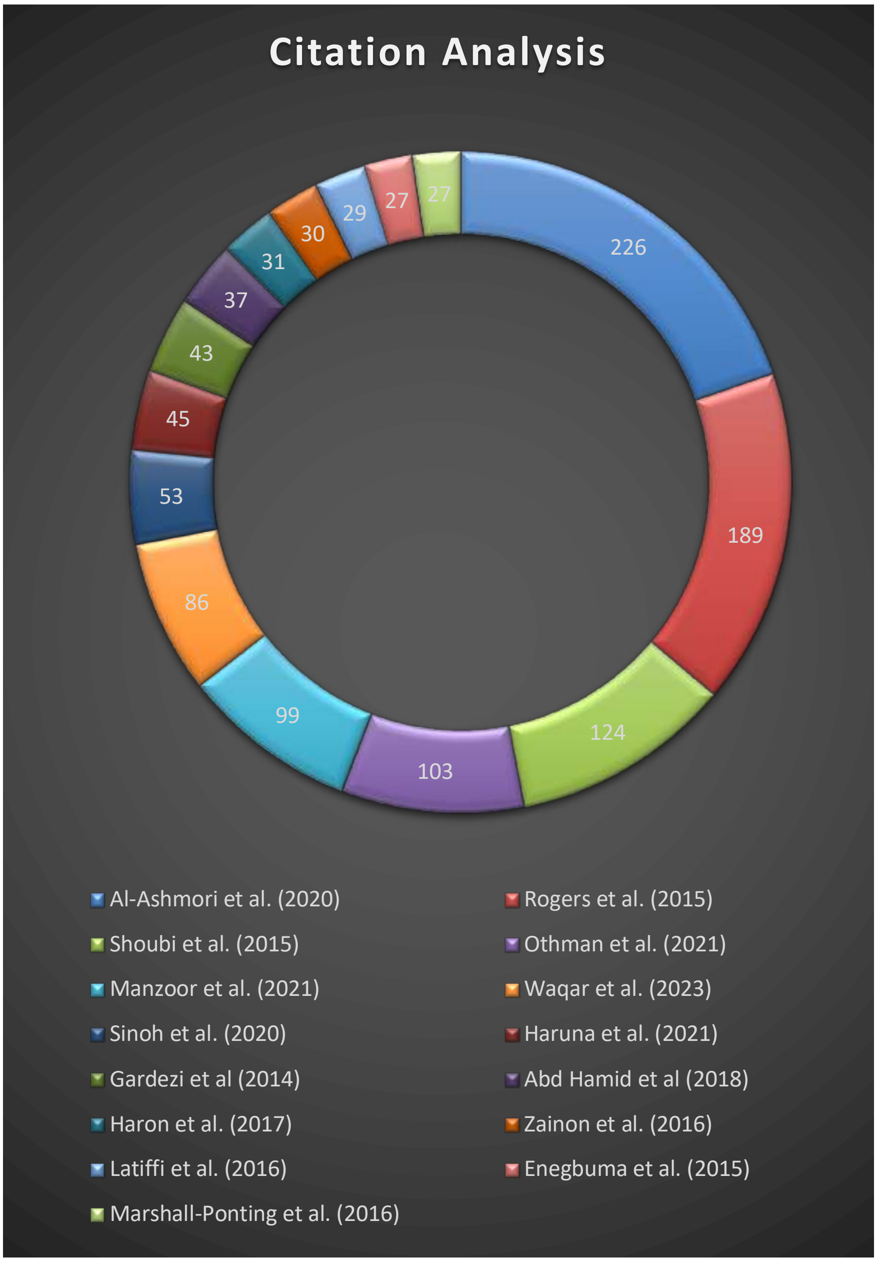

Fig. 3 Most frequently cited articles among the retrieved papers.

5. Discussion

This systematic review of 89 studies (2007–2024) reveals that BIM adoption in Malaysia has gained momentum but remains fragmented across industry stakeholders. While government programs and training initiatives have stimulated uptake, significant barriers persist. Rather than presenting findings descriptively, this section critically synthesizes the literature to highlight conceptual gaps, contradictions, and opportunities for advancing both research and policy. Importantly, the findings are considered in relation to the United Nations Sustainable Development

Goals (SDGs), given Malaysia's national commitment to sustainable development and carbon reduction.

Uneven Adoption and Structural Barriers

BIM adoption in Malaysia is disproportionately concentrated among large contractors and government-led projects, while small- and medium-sized enterprises (SMEs) continue to lag behind [8,9]. Financial limitations, lack of expertise, and limited access to training create a digital divide within the industry [43,44]. Current research often reports adoption trends in aggregate, masking disparities and failing to explain how structural inequalities shape adoption outcomes.

This gap in the literature may stem from the reliance on survey-based studies and aggregated industry data, which tend to prioritize generalizability over firm-level analysis, thereby overlooking heterogeneity between large firms and SMEs [8,45]. Furthermore, limited access to disaggregated industry data and confidentiality concerns among firms may restrict deeper investigation into organizational-level differences.

These challenges are not isolated but structurally interconnected. High implementation costs limit firms' ability to invest in training and digital infrastructure, which in turn reinforces the lack of technical expertise. This creates a self-reinforcing cycle that disproportionately affects SMEs, preventing them from progressing beyond initial adoption stages. Furthermore, the absence of strong regulatory enforcement and incentives reduces the urgency for firms to adopt BIM, allowing resistance to change to persist across the industry. Such structural constraints indicate that BIM adoption is not merely a technological issue but is deeply embedded within organizational capacity and institutional support systems [8].

While some studies suggest that BIM adoption is steadily increasing across the industry, others indicate that adoption remains highly uneven and concentrated among larger firms, revealing a clear contradiction between perceived industry-wide progress and actual distribution of adoption. This inconsistency suggests that reported adoption rates may overestimate the inclusivity of BIM diffusion in Malaysia. From a broader perspective, this uneven diffusion only partially supports conceptual alignment with SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities). While BIM has the potential to contribute to inclusive industrial modernization, its benefits remain unevenly distributed. This highlights the policy relevance of targeted interventions, such as financial incentives and capacity-building programs, to ensure more equitable access to digital innovation across the construction sector.

Productivity and Efficiency

BIM's contribution to productivity and workflow efficiency is consistently highlighted, particularly in reducing design clashes, accelerating scheduling, and improving communication [46,47,48]. Studies estimate that clash detection alone can save up to 10% of project costs and shorten timelines by 7% [46]. Similarly, automation of quantity take-offs has reduced manual errors and improved cost estimation [49].

However, these reported benefits are not uniformly realized across all project contexts. While some studies demonstrate significant efficiency gains, others suggest that such improvements are highly dependent on BIM maturity levels, data integration quality, and stakeholder collaboration. In cases where BIM is only partially implemented, productivity gains may be limited, indicating that technological adoption alone is insufficient without corresponding organizational and process integration. This inconsistency reflects a deeper issue where firms adopt BIM tools without fully transforming workflows, thereby constraining its effectiveness [49].

This divergence highlights a clear contradiction in the literature, where BIM is simultaneously portrayed as a highly effective productivity tool and as having limited impact in practice. Such conflicting findings suggest that BIM benefits are context-dependent rather than universally applicable. Differences in study outcomes may arise from variations in project scale, implementation depth, and measurement approaches, as well as the frequent reliance on perception-based assessments rather than objective performance data [14,49].

From a sustainability perspective, these efficiency gains suggest a potential contribution to SDG 12 (Responsible Consumption and Production), particularly through reduced waste and rework. However, most evidence remains based on simulation studies or practitioner perceptions [50,51], with limited validation in real-world Malaysian projects. This reliance on simulated or perception-based evidence may be due to limited availability of longitudinal project data, difficulties in accessing proprietary industry information, and the relatively low level of full lifecycle BIM implementation in Malaysia. As a result, existing conclusions may overestimate BIM's actual impact under real-world conditions. As such, the linkage between BIM and SDG 13 (Climate Action) remains largely conceptual rather than empirically substantiated. This underscores the policy relevance of establishing project-level data-sharing frameworks to generate measurable evidence of BIM's long-term impact on productivity and environmental performance.

Financial Management and Cost Control

BIM's role in improving cost estimation accuracy through 5D integration is widely acknowledged [52,53,54]. Studies report improvements in cost estimation accuracy within a 3% margin and reductions in unbudgeted changes by up to 40% [47]. Automated cost control also supports resource optimization, which has implications for material efficiency and sustainable procurement.

Despite these advantages, the realization of BIM-driven financial benefits is constrained by systemic and institutional factors. The lack of integration between BIM outputs and existing procurement, taxation, and auditing frameworks limits its practical application in financial decision-making [55]. This disconnect suggests that while BIM tools are technically capable, the surrounding governance systems have not evolved to fully utilize their outputs. Moreover, fragmented adoption across project stakeholders further reduces the consistency and reliability of cost data, undermining trust in BIM-based financial processes. A contradiction emerges in the literature, where BIM is frequently reported to improve cost accuracy, yet its practical use in financial decision-making remains limited. This inconsistency indicates a gap between technical capability and institutional readiness. The persistence of this gap may be attributed to legacy procurement systems, resistance to changing established financial practices, and the absence of standardized protocols linking BIM outputs to formal financial reporting frameworks [45].

Consequently, BIM demonstrates a potential contribution to SDG 12 (Responsible Consumption and Production), particularly in promoting efficient resource use and minimizing waste. However, without institutional integration, this contribution remains largely theoretical. The issue therefore carries significant policy relevance, highlighting the need to embed BIM-based cost reporting within formal procurement and auditing systems. Such integration would enable BIM to move beyond a technical tool toward a mechanism for improving financial transparency and sustainability performance.

Green BIM

Green BIM is presented as a transformative tool for aligning digital construction with sustainability goals, enabling energy modeling, lifecycle assessment, and waste reduction [56,57]. Through tools such as energy simulations, daylighting analysis, and embodied carbon assessments, Green BIM demonstrates strong conceptual alignment with SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action).

However, Malaysian studies remain largely conceptual, with few empirical evaluations of actual environmental performance [58,59]. A key limitation underlying this gap is the reliance on simulation-based models rather than real-world project data. These models often assume optimal conditions and may not fully capture operational inefficiencies, human factors, or deviations during construction and building use. Additionally, the lack of standardized performance metrics and limited integration with national green certification systems further constrain the ability to validate sustainability outcomes. This gap may be explained by the early stage of Green BIM adoption in Malaysia, where few completed projects have undergone full lifecycle assessment, as well as challenges in collecting post-occupancy data and the absence of mandatory reporting requirements for environmental performance.

A clear contradiction is evident in the literature, where Green BIM is widely promoted as a powerful sustainability tool, yet empirical studies demonstrating measurable environmental benefits remain scarce. This discrepancy suggests that current claims are largely aspirational and based on projected rather than observed outcomes. As a result, Green BIM's contribution to sustainability should be viewed as a potential contribution rather than a proven impact. This gap highlights the strong policy relevance of developing standardized evaluation frameworks and mandating integration between BIM workflows and tools such as MyCREST and GBI. Future research should prioritize Post-Occupancy Evaluations (PEO) to generate empirical evidence on actual reductions in energy consumption, carbon emissions, and resource use within the Malaysian context.

Fragmented Legal and Institutional Frameworks

Legal uncertainties around intellectual property rights, data ownership, and liability remain a persistent obstacle [60,61]. Although CIDB's BIM Roadmap (2015) and initiatives such as the myBIM Centre have provided guidance, enforcement remains inconsistent [60,62]. Without standardized BIM contracts and clear regulatory frameworks, stakeholders are reluctant to fully adopt collaborative BIM practices.

These challenges reflect a broader governance gap, where technological advancement has outpaced regulatory and institutional development. The absence of clear legal structures creates uncertainty in risk allocation and accountability, discouraging stakeholders from engaging in data-sharing and integrated workflows. Furthermore, inconsistent enforcement weakens industry confidence, leading to fragmented adoption and limiting the scalability of BIM implementation. A contradiction is evident between policy intentions and implementation outcomes, where national initiatives promote BIM adoption, yet the lack of enforceable regulations continues to hinder its practical uptake. This gap may arise from institutional inertia, slow policy translation into practice, and limited coordination between regulatory bodies and industry stakeholders.

In this context, BIM demonstrates only a conceptual alignment with SDG 16 (Peace, Justice, and Strong Institutions), as strong governance structures are a prerequisite for its effective implementation. The issue is therefore highly policy relevant, emphasizing the need for standardized BIM contracts, clearer legal definitions, and stronger regulatory enforcement. Lessons from countries such as the UK and Singapore [17] illustrate how regulatory clarity can enhance industry confidence and accelerate BIM adoption, suggesting a pathway for Malaysia to strengthen its institutional framework.

6. Limitations and Potential Biases of the Review

Despite efforts to ensure a systematic and rigorous review process, several potential limitations and sources of bias should be acknowledged. First, this study relied solely on the Scopus database for literature retrieval. While Scopus is one of the largest and most comprehensive academic databases, this approach may have excluded relevant studies indexed in other databases such as Web of Science, Google Scholar, or discipline-specific repositories. As a result, database selection bias may affect the completeness of the literature coverage.

Second, language bias may be present, as the review included only articles published in English and Malay. Studies published in other languages were excluded, which may have led to the omission of relevant findings, particularly from non-English-speaking research communities. Third, publication bias is a potential concern, as studies reporting positive outcomes or significant findings are more likely to be published than those with negative or inconclusive results. This may lead to an overrepresentation of favourable perspectives on BIM adoption and its impacts, potentially skewing the overall interpretation of findings.

In addition, the screening process was primarily conducted by a single reviewer and subsequently validated by a second author, rather than employing a fully independent dual-reviewer screening approach. Although this method improves efficiency and has been adopted in prior systematic reviews, it may introduce selection bias or subjective judgment in the inclusion and exclusion of studies.

These limitations should be considered when interpreting the results of this review. Future studies may enhance methodological robustness by incorporating multiple databases, expanding language inclusion criteria, and adopting fully independent dual-reviewer screening procedures.

7. Conclusion

This systematic literature review assessed 89 studies published between 2007 and 2024 to critically examine the state of Building Information Modelling (BIM) adoption in Malaysia, focusing on its barriers, success factors, and impacts on efficiency, cost management, and sustainability. The findings reveal that although BIM adoption has grown significantly, its diffusion remains uneven, with large contractors and government-led projects benefitting the most while SMEs continue to face financial and capacity-related constraints. While BIM has demonstrated clear potential in enhancing project productivity, improving cost estimation through 5D integration, and supporting sustainable construction via Green BIM applications, much of the existing evidence remains conceptual or simulation-based, with limited empirical validation in real-world Malaysian projects. This reliance on non-empirical evidence constrains the extent to which BIM can be regarded as a proven driver of measurable industry transformation.

From a sustainability perspective, BIM shows strong conceptual alignment with several SDGs, particularly SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). However, these linkages should be interpreted with caution, as they are largely inferred rather than directly evidenced within the reviewed studies. The absence of standardized performance metrics, limited post-occupancy evaluation data, and weak integration with national green certification frameworks such as MyCREST and GBI further restrict the ability to substantiate BIM's actual environmental and sustainability impacts in the Malaysian context.

Importantly, this study contributes to the existing body of knowledge by moving beyond fragmented and descriptive reviews to provide an integrated and critical synthesis of BIM adoption in Malaysia. Specifically, it brings together multiple dimensions which include barriers, implementation strategies, productivity impacts, cost management, and sustainability within a unified analytical framework, while explicitly identifying structural gaps, empirical limitations, and inconsistencies in the literature. In doing so, this review offers a more comprehensive and context-specific understanding of BIM adoption that highlights not only its potential benefits but also the institutional and methodological constraints that shape its real-world implementation.

To advance BIM adoption more effectively, future efforts should prioritize the generation of empirical, project-based evidence, particularly through longitudinal studies and post-occupancy evaluations, while also strengthening regulatory frameworks and promoting inclusive adoption strategies for SMEs. Greater alignment between BIM processes and national governance systems, including procurement, legal, and sustainability certification frameworks, is essential to translate technical capabilities into measurable outcomes.

In conclusion, BIM should be understood not as a universally proven solution, but as a promising yet under-validated approach within the Malaysian construction industry. Its potential contributions to industry modernization and sustainability remain contingent upon stronger empirical evidence, institutional integration, and policy support. By addressing these gaps, stakeholders can better position BIM as a credible tool for supporting more efficient, transparent, and sustainable construction practices in Malaysia.

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