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Utilization of Building Information Modelling Among Architects, Engineers and Contractors Towards Malaysia Construction Industry Performance: A Review

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Abstract

Building Information Modelling (BIM) is a modelling technology that can assist with digital representation, design, project scheduling, cost, and time management. BIM enables the creation of 3D models that become a central location for stakeholders, especially the Architect, Engineer, and Contractor (AEC), to add or extract project data accurately, up-to-date, and accessible to the entire project team during design, construction, and operation stages. However, the implementation of BIM in Malaysia is still poor due to high adoption costs, complexity of advanced technology, and resistance to change for new technology. Nevertheless, BIM offers several benefits that can help boost construction performance. This study aims to analyse the integration of BIM into construction industry performance in Malaysia. The objective of this paper is to highlight the advantages of the utilization of BIM among AECs in Malaysia towards the performance of the construction industry. Previous studies based on the article journal and other secondary sources will be reviewed to gather the information. The review of this study will highlight the benefits of BIM among AEC in connection to construction industry performance. The review of this study will be significant in further research as it is beneficial to construction stakeholders, especially AEC.

1. Introduction

The rise of technology in construction can drive significant advancements in the construction industry, enhancing various aspects of project delivery and operations. In Malaysia, adopting Industry 4.0 (IR4.0) technologies is crucial for driving rapid development and ensuring the country keeps pace with modern technological advancements (Yusof *et al.*, 2022). New technologies are being employed to digitize the construction industry and its supply chain, known as "Construction 4.0." (CIDB, 2020). Consistent with the idea of Industry 4.0, the focus of Construction 4.0 is on merging digital and physical technology pattern advances (Jaafar *et al.*,2024). The Architecture, Engineering, and Construction (AEC) organization has experienced a significant transformation towards the digitization and automation of design, construction, and operational procedures utilizing Building Information Modeling (BIM) (Ismail et 2023). BIM is a process of intelligent models that connects AEC professionals, providing efficiency in the design, construction and operation of buildings and infrastructure (Panteli *et al.*,2020).

Nevertheless, based on the current Malaysian construction industry situation, Construction 4.0 is still far behind in its establishment, and the number of BIM adopters is still low (Ibrahim *et al*.,2019). The implementation of BIM in Malaysia is believed to be facing several challenges that might hinder BIM development in Malaysia; listed are high adoption costs as BIM requires investment of equipment, software, hardware, and training (Wong & Ang, 2021), lack of education and training (Wong & Gray 2019) and resistance to change for new technology (Farouk *et al*.,2023). The objective of this paper is to highlight the advantages of the utilization of BIM among AEC in Malaysia in relation to the performance of the construction industry. The findings from this research will highlight several benefits of BIM among AEC in connection with construction industry performance. It is urgent to adopt BIM as part of a valuable approach to help industry practitioners minimize uncertainties and effectively complete their construction projects (Syed Jamaludin *et al*., 2022).

2. Literature Review

2.1 BIM Definition

BIM is an advanced system for managing digital information that may effectively support project operations and the distribution of information (Lee *et al*.,2022). The purpose of BIM is to consolidate and incorporate dispersed documents and data into a comprehensive BIM model, which encompasses architectural and structural designs as well as other pertinent information for construction execution (Mohamed *et al*.,2023). BIM building projects should comprehensively employ the notion of BIM across the whole construction process, encompassing the design stage, project execution, commissioning, and operation (Al-Ashmori *et al*.,2022). Understanding the definition of BIM is vital for optimizing collaboration, enhancing efficiency, improving decision-making, and achieving better project outcomes. It equips stakeholders with the knowledge needed to leverage BIM's capabilities fully and integrate its benefits throughout the project lifecycle. According to Ahmadi and Arashpour (2020), BIM is a digital representation of a project's functional and physical characteristics that is seen as a potential solution to the design and construction phase challenges. Salleh (2023) affirmed that BIM is the process of encoding architectural facilities from various perspectives from the parties involved using a database system.

Understanding the definition of BIM is crucial for professionals in the AEC industry because it fundamentally transforms how projects are designed, executed, and managed. By grasping BIM's definition, professionals can harness its advanced visualization and simulation tools to enhance accuracy, streamline workflows, and make more informed decisions. Moreover, it aids in complying with industry standards and regulations, improving communication, and ensuring that projects are completed on time and within budget. A deep understanding of BIM empowers AEC professionals to leverage its benefits for better project outcomes, increased efficiency, and a competitive edge in the industry.

2.2 BIM in Building Lifecycle

BIM encompasses the process of digital modelling and managing the complete lifecycle of a construction project (Aziz *et al*.,2022). BIM implementation involves 5 phases: design, construction, operation and maintenance, renovation and retrofitting and end-of-life decisions (Abuhussain *et al*.,2024). In the design phase, BIM is essential for generating accurate digital models of a building's physical and functional characteristics throughout the design stage of a construction project (Ishak *et al*.,2023). Following is the construction phase, BIM encompasses six essential modules for construction management: time, cost, safety, quality, service procurement, and acceptance management (Li *et al*.,2021). Moreover, the operation and maintenance phase in the BIM life cycle refers to the stage after construction completion when the building or infrastructure is occupied and operated. In this phase, numerous BIM-based building management systems have been created and implemented to gather, control, and examine information about maintenance and repair (Cao *et al*.,2022).

The renovation phase is when existing buildings or infrastructure undergo upgrades, refurbishments, or expansions. BIM models provide accurate as-built documentation for renovations, verify anticipated changes, and detect incompatibilities between new and old sections during refurbishment design (Abuhussain *et al*.,2024). The end-of-life phase is when existing buildings or structures are systematically dismantled, removed, or deconstructed. The BIM model contained information regarding the procedures of demolition, the different stages of demolition, the specific areas inside the building model where garbage is located, the duration of the demolition process, the number of hours required by the workforce, and the volume of waste generated (Nikmehr *et al*.,2021). Understanding BIM utilization throughout the entire building lifecycle is crucial for maximizing the value and efficiency of construction projects. BIM offers comprehensive advantages not only during the design and construction phases but also throughout the building's operational life. By integrating BIM from the initial planning stages to the building's end-of-life, stakeholders can significantly improve project management, cost control, and sustainability.

2.3 BIM in Malaysia

BIM has grown increasingly popular in the global built environment sector, and it has garnered the attention of governments worldwide, particularly in developed countries, who are actively promoting the adoption of BIM in the construction industry (Kordi *et al*.,2020). The adoption of BIM in Malaysia has primarily been spearheaded by the business sector since 2009, despite Malaysia's first introduction of the concept by the Public Work Department (PWD) in 2007 (Ismail *et al*.,2022). The adoption rate in Malaysia increased from 49% in 2019 to 55% in 2021, which is a high difference compared to other developed countries such as the US 80%, Australia (Architects) 76% and Germany 70% in 2021 (CIDB, 2019). In preparation for the Industrial Revolution 4.0, adopting digital technology is crucial, thus encouraging the use of BIM among construction professionals. It is crucial to promptly embrace BIM as a helpful strategy to assist industry professionals in reducing uncertainties and efficiently completing their construction projects (Syed Jamaludin *et al*.,2022). As Malaysia becomes more conscious and prepared for the Industrial Revolution 4.0, there is a growing demand for implementing technology processes and advancements. Despite its significant contribution to the economy, the building industry in Malaysia falls behind other economic sectors (Mustafa *et al*.,2019).

The Malaysian government has implemented various measures to encourage the widespread use of BIM among professionals in the building industry to benefit multiple economic sectors (Zul *et al*.,2023). A collaborative approach between the government and industry stakeholders is essential for BIM to gain widespread acceptance and utilization in Malaysia's construction industry. This collective effort will benefit individual projects and advance the entire construction sector, positioning Malaysia as a leader in modern construction practices. BIM tools allow future newly constructed buildings to be designed toward sustainability, in other words, energy-efficiency (Ali *et al*., 2022).

2.4 BIM Among AEC

BIM is a centralized storage system that necessitates merging separate fields such as architecture, engineering, and construction. Its purpose is to enhance the overall performance of buildings throughout their lifespan. BIM utilization in projects will significantly value the construction industry and stakeholders' relationships (Muhamad *et al*., 2021). The Malaysia BIM Report 2019 by CIDB indicates that the usage of BIM by professionals is as follows: architects (19%), civil and structural engineers (16%), and contractors (16%). Shahruddin *et al*. (2022) stated that architects utilized the BIM process, which involves exploring, developing, documenting, and managing project assets from a single source of information, to strengthen their expertise and leadership in coordinating interdisciplinary design. The smooth integration of Grasshopper and Dynamo, in conjunction with Rhino and Revit, allows architects to create sustainable structures using an iterative and data-driven method, improving both microclimatic factors and aesthetics in architectural design (Khan,2024).

Apart from the architect, engineers require more detailed analysis before the construction phase. BIM becomes valuable because it provides a more precise picture in the form of 3D drawings for engineers to review [Lee *et al*.,2020]. BIM technology offers valuable guidance to enhance efficiency, collaboration, and insightfulness in civil engineering project management (Nsimbe & Di, 2024). Contractors usually use Naviswork to find any design issues before the contract starts to identify potential outcomes and problems affecting the quality of the project through detailed costing and scheduling (Holkar & Pataskar, 2021). 5D BIM Cost Framework (5D-CF) allows contractors to enhance communication, reduce unforeseen events, and decrease disputes in project sequencing that could result in risks, uncertainties, and hazards impacting the final project cost (Mohammed *et al*.,2022).

AEC is indeed the main pillar of the construction industry, each playing a crucial role in ensuring the successful completion of construction projects. Deepening BIM expertise within the AEC sector can fundamentally transform Malaysia's construction industry by improving project outcomes and operational efficiency. Enhancing AEC expertise in BIM is pivotal for advancing Malaysia's construction industry. It leads to more efficient project execution, superior design and quality control, and increased global competitiveness. By embracing and excelling in BIM, Malaysia can elevate its position in the global construction market, attract international opportunities, and establish itself as a leader in innovative and sustainable construction practices.

2.5 BIM Utilization in the Construction Industry

Table 1 *BIM Utilization in the Construction Industry*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Visualisation	√		√	√	√		√			√		√	√		√				√	
Clash Detection	√	√	√	√		√			√	√	√		√	√						
Coordination	√							√			√	√			√					√
Communication &Collaboration		√	√			√		√			√	√	√	√			√	√		√
Scheduling and Planning	√		√	√		√		√		√	√					√			√	
Monitoring and Tracking						√						√			√					
Productivity and Efficiency		√				√						√		√						
Safety and Health				√					√			√				√			√	
Time and Cost Management					√	√			√	√				√		√		√	√	√
Facility Management		√							√			√						√		
Waste Management			√	√				√	√			√								
Document Accuracy			√						√				√		√		√	√		
Information Management	√	√	√						√			√	√	√			√	√		
Heritage Building							√		√											
Sustainability			√					√	√		√					√				

1. (Saar *et al*.,2019) 2. (Ibrahim *et al*.,2019) 3. (Jamal *et al*.,2019) 4. (Ariffin *et al*.2020) 5. (Lee *et al*.,2020) 6. (Al-Ashmori *et al*.,2020) 7. (Mustafa *et al*.,2020) 8. (Haruna *et al*.,2021) 9. (Ismail *et al*.,2021) 10. (Rosli *et al*.,2021) 11. (Mohammed *et al*.,2022) 12. (Aziz *et al*.,2022) 13. (Ya'acob *et al*.,2022) 14. (Lee *et al*.,2022) 15. (Mohammed *et al*.,2023) 16. (Rafindadi *et al*.,2023) 17. (Salleh *et al*.,2023) 18. (Ariffin *et al*.,2023) 19. (Alaloul *et al*.,2023) 20. (Mohammed *et al*.,2024)

2.5.1 Visualization

Visualization refers to creating and using graphical representations of a building or infrastructure project to communicate design, construction, and operational information. According to Saar *et al.* (2019), BIM's 3D architectural visualization enables architects to assess visual aesthetics early in the design phase. Alaloul *et al.* (2023) highlights that BIM visualizes and analyses and helps prevent hazards throughout the project lifecycle. Mustafa *et al.* (2020) describe BIM's ability to provide visual access to information through 3D illustrations as a groundbreaking advancement in the AEC industry. Similarly, Jamal *et al.* (2019) and Ya'acob *et al.* (2022) emphasize that BIM allows for early and accurate visualizations, which are crucial for avoiding design errors before construction begins. Ariffin *et al.* (2020) and Lee *et al.* (2020) note that improved visualization improves construction safety performance. It enhances construction quality by providing a clearer understanding of the proposed building. Mohamed *et al.* (2023) points out that BIM models facilitate design visualization and simulation, aiding communication between construction firms, clients, and consultants. Finally, Rosli *et al.* (2021) and Aziz *et al.* (2022) underscore that BIM-generated visualizations assist contractors during construction by offering more apparent, more detailed models that help resolve constructability issues and improve overall project understanding. Visualization in BIM is crucial in enhancing construction project design, planning, and management. It provides various graphical tools and techniques that improve understanding, communication, and decision-making throughout the project lifecycle.

2.5.2 Clash Detection

Clash detection is critical for identifying and resolving conflicts between building systems or components before construction begins. According to Saar *et al*. (2019), BIM's clash detection ensures that Integrated Building Systems (IBS) components are precisely sized and dimensioned for perfect installation. Ibrahim *et al*. (2019) highlights that BIM identifies potential clashes early in the design stage and serves as a comprehensive reference for ongoing project details, thereby mitigating issues during construction. Jamal *et al*. (2019) and Ariffin *et al*. (2020) emphasize that BIM effectively detects clashes between various disciplines and addresses them before construction begins, saving time and costs. Ya'acob *et al*. (2022) point out that early clash detection reduces the likelihood of variation orders later in the project. Lee *et al*. (2020) notes that detailed clash detection reports, including figures and descriptions, can be generated to facilitate corrective actions. Al-Ashmori *et al*. (2020) and Ismail *et al*. (2021) underline that BIM's clash detection capabilities eliminate design conflicts, while Mohammed *et al*. (2022) and Rosli *et al*. (2021) highlight its role in preventing construction issues, reducing reworks, and improving overall project cost and time efficiency. Clash detection is a fundamental aspect of BIM that helps to ensure the successful coordination and execution of construction projects. By identifying and resolving conflicts early in the design phase, stakeholders can avoid costly errors, improve project efficiency, and deliver higher-quality results.

2.5.3 Coordination

Coordination involves managing and aligning the contributions of various disciplines such as architecture, structural engineering, mechanical, electrical, and plumbing (MEP) and contractors to ensure that all project components work harmoniously together. Saar *et al*. (2019) emphasize that BIM's composite model coordination allows stakeholders to review and collaborate on models across different disciplines, fostering better information sharing. Mohamed *et al*. (2023) further highlights the importance of coordination activities in which architectural firms engage with various project consultants. Aziz *et al*. (2022) note that BIM improves coordination between clients, consultants, and contractors and streamlines collaboration. Mohammed *et al*. (2022) and Mohamed *et al*. (2024) describe how the BIM 360 environment supports improved coordination by enabling teams to exchange project templates and organize planning, ensuring all design stakeholders are aligned. Additionally, Haruna *et al*. (2021) point out that BIM facilitates more effective coordination of project information, allowing for updates and the development of increasingly practical building models. Coordination in BIM is essential for ensuring that all aspects of a construction project are aligned and integrated effectively. By utilizing BIM tools and technologies, fostering collaboration, and adhering to best practices, stakeholders can improve project efficiency, reduce errors, and achieve higher-quality outcomes.

2.5.4 Communication and Collaboration

Communication and collaboration in BIM involve using BIM technology to enhance the exchange of information and coordination among project stakeholders throughout the lifecycle of a building project. Ibrahim *et al*. (2019) note some concerns that BIM might offer limited improvement in communication among stakeholders. Jamal *et al*. (2019) and Ya'acob *et al*. (2022) report that BIM promotes a high level of collaboration and improves integration and communication between multidisciplinary teams throughout the project lifecycle, reducing communication lags. Salleh *et al*. (2023) agree that BIM enhances communication by providing a clear context for the project's complexity, while Al-Ashmori *et al*. (2020) emphasize its role in improving multi-party communication and maintaining synchronization. Mohammed *et al*. (2022) and Aziz *et al*. (2022) point out that BIM facilitates better collaboration and communication by enabling the sharing and versioning of BIM models, which helps minimize waste during the planning and design stages. Lee *et al*. (2022) highlights that BIM streamlines collaboration by involving all stakeholders early in the design process, ensuring transparent and clear workflows. Mohamed *et al*. (2024) and Ariffin *et al*. (2023) further affirm that BIM improves communication and collaboration, particularly in integrating Facility Management (FM) with early-stage project understanding. Haruna *et al*. (2021) conclude that BIM's capability to share and integrate data among all project partners, consultants, architects, contractors, and subcontractors enhances project collaboration. BIM's capabilities significantly enhance communication and collaboration, resulting in more effective project management and execution.

2.5.5 Scheduling and Planning

Scheduling and planning in BIM refer to the use of BIM technology to enhance and optimize the scheduling and planning processes throughout the lifecycle of a construction project. Saar *et al*. (2019) note that BIM assists in generating construction schedules by detailing the sequence of work. Al-Ashmori *et al*. (2020) emphasize BIM's ability to integrate construction scheduling and planning effectively. Ariffin *et al*. (2020) highlight that BIM models support preparing detailed construction plans and equipment fabrication. Rosli *et al*. (2021) describes how BIM's 4D modelling enables contractors to combine the model with the schedule, leading to more effective project analysis and planning. Alaloul *et al*. (2023) add that scheduling simulations with BIM provides insights into site conditions and allows for analyzing schedules, resources, and management expenses. Jamal *et al*. (2019) and Haruna *et al*. (2021) further underline the importance of 4D BIM for construction phasing and scheduling improvements. Mohammed *et al*. (2022) discusses the use of scheduling strategies during the design stage, and Rafindadi *et al*. (2023) confirm that BIM facilitates advanced planning and scheduling, contributing to overall project efficiency. Effective scheduling and planning optimize construction workflows by organizing tasks in a logical sequence, reducing downtime, and ensuring that activities are carried out efficiently

2.5.6 Monitoring and Tracking

Monitoring and tracking in BIM involves overseeing and recording the progress of a construction project about the project's plans and schedules. BIM significantly enhances progress monitoring and change management throughout the construction process. Al-Ashmori *et al*. (2020) highlight BIM's capability to monitor and track progress during construction, ensuring that the project stays on schedule. Mohamed *et al*. (2023) further discusses how BIM supports project changes and management through collaboration tools with features such as markup functions, file version tracking, transmittals, and issue assignments, which improve the handling of modifications and updates. Aziz *et al.* (2022) add that BIM allows for future updates of asset information, ensuring that current data remains accurate and relevant throughout the project's lifecycle. Together, these capabilities facilitate effective management and adaptation to changes, contributing to overall project success. In summary, BIM capabilities in tracking progress, managing project changes, and updating asset information contribute to more effective project execution and long-term asset management.

2.5.7 Productivity and Efficiency

Productivity and efficiency in BIM refer to how effectively BIM tools and processes enhance the performance of construction projects by improving various aspects of the project lifecycle. BIM's impact on productivity and efficiency varies across different aspects of the construction process. Ibrahim *et al*. (2019) suggest that while BIM might not significantly enhance individual staff efficiency, its involvement in the design phase ensures that the construction team can make more accurate decisions aligned with design intent. Conversely, Al-Ashmori *et al*. (2020) and Aziz *et al*. (2022) emphasize that BIM generally increases productivity and efficiency, particularly in design production. Lee *et al*. (2022) highlight BIM's role in improving efficiency and predictability by minimizing human errors and reducing manual operation errors in tasks such as producing bills of quantities. These perspectives underscore BIM's ability to enhance overall project efficiency, though its effects on individual staff efficiency may be more nuanced.

2.5.8 Safety and Health

Safety and health in BIM refer to the integration and management of health and safety considerations within the BIM framework throughout the lifecycle of a construction project. Ariffin *et al*. (2020) note that BIM improves safety by integrating safety considerations into construction. Alaloul *et al*. (2023) highlight how BIM aids in understanding complex designs and arrangements, thereby educating project participants about potential safety issues. Ismail *et al*. (2021) emphasize that BIM automatically checks construction models and schedules for safety, ensuring safety standards are met. Aziz *et al*. (2022) further explains that BIM enhances the management of security and safety information, reduces safety risks, and improves overall safety and quality by identifying risks early. Rafindadi *et al*. (2023) add that BIM facilitates safety education and training, ensuring that all involved are well-informed about safety practices. Integrating safety and health into BIM enhances the management and mitigation of risks throughout the construction lifecycle. Implementing safety and health measures within BIM leads to safer work environments, better worker well-being, and overall project success.

2.5.9 Time and Cost Management

Time and cost management in BIM refers to using BIM tools and processes to effectively plan, track, and control project timelines and budgets throughout the lifecycle of a construction project. Lee *et al*. (2020) explains that integrating time scheduling with cost estimation through BIM allows construction participants to optimize the arrangement of equipment and materials, leading to cost savings. Al-Ashmori *et al*. (2020) highlight BIM's capability to assess design changes' time and cost implications, while Ismail *et al*. (2021) emphasize that BIM provides greater predictability for project timelines and budgets. Rosli *et al*. (2021) notes that BIM tools with 5D features, which integrate visual, schedule, and cost elements, facilitate effective project cost control during construction. Alaloul *et al*. (2023) and Mohamed *et al*. (2024) further confirm that BIM helps reduce time and cost. Ariffin *et al*. (2023) highlight that early involvement of the FM team in BIM processes improves efficiency and lowers overall operating and maintenance costs by providing better insights into costs and energy savings. Rafindadi *et al*. (2023) also stress BIM's role in precise cost estimation. Collectively, these insights illustrate BIM's effectiveness in enhancing cost control and time management throughout the construction lifecycle

2.5.10 Facilities Management

FM in BIM refers to using BIM technology to support the efficient operation, maintenance, and management of buildings and infrastructure throughout their lifecycle. BIM significantly enhances FM by improving the maintenance and management of assets throughout their lifecycle. Ismail *et al*. (2021) highlights that the as-built BIM model facilitates better facility maintenance. Aziz *et al*. (2022) emphasize that BIM provides comprehensive information for managing assets throughout their entire lifecycle. Ibrahim *et al*. (2019) further explain that BIM supports FM by utilizing 3D geometry-oriented data to assist with maintenance services, including essential descriptions, parameter-related data, and maintenance records. Ariffin *et al*. (2023) add that incorporating FM data into the BIM process makes the design team and BIM coordinator more aware of the necessary data to gather, ensuring optimal building performance. These insights underscore BIM's role in enhancing FM through improved data management and maintenance capabilities.

2.5.11 Waste Management

Waste Management in BIM involves utilizing BIM technology to address and mitigate waste issues at various building project stages. BIM plays a crucial role in reducing waste and enhancing sustainability in construction. Ismail *et al*. (2021) and Aziz *et al*. (2022) highlight that BIM minimizes waste through more efficient project management. Jamal *et al*. (2019) further support this by noting that BIM's ability to streamline processes leads to reduced waste. Ibrahim *et al*. (2019) explain that BIM's shared model reduces errors, rework, and the need for duplicative drawings, which significantly enhances construction sustainability. This reduction in rework and waste is made possible by BIM's connection to a centralized database, which ensures that all project requirements are accurately met. Haruna *et al*. (2021) also emphasize that BIM helps minimize wastage, reinforcing its effectiveness in promoting sustainability in construction projects. BIM-integrated models and data-driven approaches significantly reduce waste, improve resource efficiency, and contribute to better sustainability in construction projects.

2.5.12 Document Accuracy

Document accuracy in BIM refers to the precision and reliability of the documentation generated and managed through BIM processes. BIM significantly enhances documentation and data management throughout the construction process. Jamal *et al*. (2019) note that BIM provides comprehensive data on providers and product details, while Ya'acob *et al*. (2022) emphasize that BIM centralizes data storage, facilitating proper documentation. Salleh *et al*. (2023) report that BIM improves the accuracy of construction documents, leading to fewer mistakes in drawings and better coordination among stakeholders. Mohamed *et al*. (2023) highlights the effectiveness of BIM in constructability analysis, with high mean values for developing detailed construction documents and specifications from 3D models before construction begins. Ismail *et al*. (2021) further support this by noting improvements in document management and earlier, more accurate design visualization. Mustafa *et al*. (2020) add that BIM can extract and utilize attribute data, such as floor area and component variations, to enhance overall project accuracy and efficiency. Document accuracy in BIM is crucial for the successful execution and management of construction projects. By ensuring that all models, drawings, specifications, and related documents are precise, consistent, and up-to-date, BIM helps to reduce errors, improve efficiency, and enhance overall project outcomes.

2.5.13 Information Management

Information Management in BIM refers to the systematic organization, control, and utilization of the data and information generated, shared, and maintained within BIM processes throughout the lifecycle of a building or infrastructure project. BIM significantly enhances information management and access across the construction and facilities management processes. Ya'acob *et al*. (2022) note that BIM's single repository cloud storage enables faster data retrieval and efficient claim evaluation and analysis. Salleh *et al*. (2023) highlight that BIM facilitates a holistic design approach, reducing design changes and information requests while providing valuable data for comprehensive facilities and asset management. Ibrahim *et al*. (2019) emphasize that BIM offers detailed physical information about the building, such as furniture and finishes, reducing the risk of losing project details during the management phase. Jamal *et al*. (2019) and Aziz *et al*. (2022) underscore BIM's role as an information platform for better communication and as a single source of information for project handover. Ismail *et al*. (2021) point to increased productivity through easy information retrieval, while Lee *et al*. (2022) highlights the interoperability BIM provides among stakeholders, ensuring no loss of information with updated digital models. Ariffin *et al*. (2023) add that early BIM-FM integration enhances performance and information management throughout the building's lifecycle. Saar *et al*. (2019) further emphasize BIM's effectiveness in preparing high-quality shop drawings and presenting complex information through models. These insights illustrate BIM's critical role in improving information management, accessibility, and communication in construction and facilities management. BIM capabilities in centralizing and managing information, improving communication, and boosting productivity contribute to more effective project execution and better outcomes across the construction lifecycle.

2.5.14 Heritage Building

Heritage buildings are structures of historical, architectural, or cultural importance, and integrating BIM into their management involves creating detailed digital models that capture and preserve their unique characteristics. Ismail *et al*. (2021) highlight that BIM improves conservation work through virtual design and construction, significantly benefiting heritage projects. Mustafa *et al*. (2020) add that BIM enhances cooperation among various stakeholders in the Malaysian heritage industry, facilitating more effective collaboration and management. Together, these statements underscore BIM's role in advancing conservation efforts by improving the technical aspects of virtual design and the collaborative dynamics among project participants.

2.5.15 Sustainability

Sustainability in BIM refers to the application of BIM technology to promote environmentally responsible and resource-efficient practices throughout the lifecycle of a building. BIM is pivotal in advancing sustainability and energy efficiency in the Malaysian construction industry. Haruna *et al*. (2021) emphasize BIM's application in developing sustainable buildings, while Ismail *et al*. (2021) highlights its contribution to enhanced energy efficiency and overall sustainability. Jamal *et al*. (2019) and Rafindadi *et al*. (2023) further support this by noting that BIM facilitates environmental simulation and analysis, enabling better performance assessment of buildings. Additionally, Mohammed *et al*. (2022) underscores the importance of the BIM Execution Plan (BEP), which includes steps for executing, monitoring, and controlling BIM technology, thereby reducing wastage and promoting efficient resource use. Collectively, these insights illustrate BIM's comprehensive impact on improving sustainability, energy efficiency, and waste reduction in construction projects.

3. Proposed Methodology

This study proposes a quantitative approach, specifically through a questionnaire survey, to collect data from architects, engineers, and contractors in the Klang Valley region. Quantitative will enable the collection of measurable data that can be statistically examined. According to the BIM Report 2019, the Klang Valley area has a large-scale project, and AEC professionals in the construction industry contribute to a solid commitment to using BIM and technology breakthroughs. This combination of factors creates a very successful environment for the AEC sector in the Klang Valley area to enhance technologies in the construction industry. The literature review revealed 15 factors related to the benefits of BIM, sourced from 20 articles spanning the years 2019 to 2024. These variables will form the basis of the questionnaire, which will ask participants to evaluate their level of agreement with various statements using a five-point Likert scale. The data will be analyzed using descriptive analysis, which is fundamental in summarizing data and serves as a foundation for more complex statistical analyses (Dong, 2023). The findings will present the mean values and rank from highest to lowest. This approach highlights the most significant benefits of BIM as perceived by AEC. Using mean values and rankings can effectively illustrate the perceived advantages of BIM utilization, helping stakeholders understand its most valuable benefits and guiding decision-making in BIM implementation strategies.

Conclusion

BIM is a tool that would contribute to boosting performance in the construction industry. Over the years, there has been much resistance from construction industry players when it comes to embracing technology. This paper highlighted the advantages of BIM among AEC. The level of BIM implementation in Malaysia is still in a low level that both government and industry players should work together to make the transformation successful. It might be challenging for small-scale companies to transform from a traditional 2D model to align with Construction 4.0. BIM acts as a platform that facilitates the integration of all stakeholders in the construction process, which has been demonstrated to be advantageous to AEC. The utilization of BIM in the construction industry contributes to enhanced performance in terms of visual representation, effective communication, and collaborative efforts among the AEC. The AEC should be aware of the beneficial outcomes of BIM to assist them in enhancing construction performance. This research contributes to a review of utilization of BIM among AEC in Malaysia construction industry. By leveraging these insights, future studies can build on this knowledge to advance BIM practices and improve outcomes in the construction industry both locally and globally.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm their contribution to the paper as follows: ***study conception and design:*** *Farah Nadia Razali, Muhammad Haziq Md Anuar;* ***draft manuscript preparation:*** *Farah Nadia Razali, Muhammad Haziq Md Anuar. All authors reviewed the results and approved the final version of the manuscript.*

References

Abuhussain, M. A., Waqar, A., Khan, A. M., Othman, I., Alotaibi, B. S., Althoey, F., & Abuhussain, M. (2024). Integrating Building Information Modeling (BIM) For Optimal Lifecycle Management of Complex Structures. Structures, 60. https://doi.org/10.1016/j.istruc.2023.105831

Ahmadi, P. F., & Arashpour, M. (2020). An Analysis of 4D-BIM Construction Planning: Advantages, Risks and Challenges. Proceedings of the 37th International Symposium on Automation and Robotics in Construction, ISARC 2020: From Demonstration to Practical Use - To New Stage of Construction Robot, 163–170 https://doi.org/10.22260/isarc2020/0025

Alaloul, W. S., Qureshi, A. H., En, Y. P., Khan, S. A., Musarat, M. A., Alzubi, K. M., & Salaheen, M. Al. (2023). Survey Evaluation of Building Information Modelling (BIM) for Health and Safety in Building Construction Projects in Malaysia. Sustainability, 15(6), 4899. https://doi.org/10.3390/su15064899

Al-Ashmori, Y. Y., Othman, I., & Al-Aidrous, A. H. M. H. (2022). "Values, Challenges, and Critical Success Factors" of Building Information Modelling (BIM) in Malaysia: Experts Perspective. Sustainability (Switzerland), 14(6). https://doi.org/10.3390/su14063192

Al-Ashmori, Y. Y., Othman, I., Rahmawati, Y., Amran, Y. H. M., Sabah, S. H. A., Rafindadi, A. D. u., & Mikić, M. (2020). BIM Benefits And Its Influence On The BIM Implementation In Malaysia. Ain Shams Engineering Journal, 11(4), 1013–1019.https://doi.org/10.1016/J.ASEJ.2020.02.002

Ali, S. B. M., Mehdipoor, A., Samsina Johari, N., Hasanuzzaman, M., & Rahim, N. A. (2022). Modeling and Performance Analysis for High-Rise Building Using ArchiCAD: Initiatives towards Energy-Efficient Building. Sustainability (Switzerland), 14(15).https://doi.org/10.3390/su14159780

Ariffin, E. Y., Mustafa, N. E., & Sapri, M. (2023). Perspective Towards The Perceived Benefits And Challenges On Building Information Modelling - Facility Management (BIM-FM) Integration at an Early Stage of BIM Projects. International Journal of Real Estate Studies, 17(1), 70–82.https://doi.org/10.11113/intrest.v17n1.198

Ariffin, T. H., Tiwari, S., Veenadhari, S., & Gupta, S. K. (2020). Using Building Information Modeling (Bim) To Improve Safety Performance in Malaysian Construction Industry. IJARET_11_11_170 International Journal of Advanced Research in Engineering and Technology, 11(11), 1827–1836. https://doi.org/10.34218/IJARET.11.11.2020.170

Aziz, M. A., Wong, C. F., Haron, N. A., Ales, A. H., Effendi, R. A. A. R. A., & Tan, O. K. (2022). Critical Success Factors For Building Information Modelling (BIM) Implementation For Power Plant Projects In Malaysia. IIUM Engineering Journal, 23(1), 34–45.https://doi.org/10.31436/IIUMEJ.V23I1.2119

Cao, Y., Kamaruzzaman, S. N., & Aziz, N. M. (2022). Building Information Modeling (BIM) Capabilities in the Operation and Maintenance Phase of Green Buildings: A Systematic Review. In Buildings (Vol. 12, Issue 6). MDPI. https://doi.org/10.3390/buildings12060830

CIDB. (2019). Malaysia Building Information Modelling Report 2019

https://www.cidb.gov.my/wp-content/uploads/2022/07/208-Malaysia-BIM-REPORT-2019-min.pdf
CIDB (2020). Construction 4.0 Strategic Plan (2021-2025) Next Revolution of Malaysia Construction Industry https://www.cidb.gov.my/wp-content/uploads/2022/12/CR4_web_compressed.pdf

Dong, Y. (2023). Descriptive Statistics and Its Applications. Highlights in Science, Engineering and Technology, *47*, 16-23. https://doi.org/10.54097/hset.v47i.8159

Farouk, A. M., Zulhisham, A. Z., Lee, Y. S., Rajabi, M. S., & Rahman, R. A. (2023). Factors, Challenges and Strategies of Trust in BIM-Based Construction Projects: A Case Study in Malaysia. Infrastructures, 8(1). https://doi.org/10.3390/infrastructures8010013

Haruna, A., Shafiq, N., & Montasir, O. A. (2021). Building Information Modelling Application For Developing Sustainable Building (Multi Criteria Decision Approaching). In Ain Shams Engineering Journal (Vol. 12, Issue 1, pp. 293–302). Ain Shams University. https://doi.org/10.1016/j.asej.2020.06.006

Holkar, Mr. R. N., & Pataskar, Mrs. S. (2021). Quality Management In the Construction Industry By Using Building Information Modelling (BIM). Journal of University of Shanghai for Science and Technology, 23(09), 265–276. https://doi.org/10.51201/JUSST/21/08391

Ibrahim, H. S., Hashim, N., & Ahmad Jamal, K. A. (2019). The Potential Benefits of Building Information Modelling (BIM) in Construction Industry. IOP Conference Series: Earth and Environmental Science, 385(1). https://doi.org/10.1088/1755-1315/385/1/012047

Ishak, N., Azizan, M. A., Ibrahim, F. A., Rahim, N. S. A., Zawawi, E. M. A., Anuar, N. H. K., & Shohime, N. S. (2023). Building Information Modelling (BIM) Application as Risk Mitigation Strategies in Building Refurbishment Project Life Cycle. IOP Conference Series: Earth and Environmental Science, 1216(1). https://doi.org/10.1088/1755-1315/1216/1/012030

Ismail, A. S., Ali, K. N., Iahad, N. A., Kassem, M. A., & Al-Ashwal, N. T. (2023). BIM-Based Automated Code Compliance Checking System in Malaysian Fire Safety Regulations: A User-Friendly Approach. Buildings, 13(6). https://doi.org/10.3390/buildings13061404

Ismail, E. D., Said, S. Y., Jalil, M. K. A., & Ismail, N. A. A. (2021). Benefits and Challenges of Heritage Building Information Modelling Application in Malaysia. Environment-Behaviour Proceedings Journal, 6(SI4), 179–184. https://doi.org/10.21834/ebpj.v6isi4.2917

Ismail, N. A. A., Zulkifli, M. Z. A., Baharuddin, H. E. A., Ismail, W. N. W., & Mustapha, A. A. (2022). Challenges of Adopting Building Information Modelling (BIM) Technology amongst SME's Contractors in Malaysia. IOP Conference Series: Earth and Environmental Science, 1067(1). https://doi.org/10.1088/1755-1315/1067/1/012047

Jaafar, M., Salman, A., Ghazali, F. E. M., Zain, M. Z. M., & Kilau, N. M. (2024). The Awareness And Adoption Level Of Emerging Technologies In Fourth Industrial Revolution (4IR) By Contractors In Malaysia. Ain Shams Engineering Journal, 102710. https://doi.org/10.1016/j.asej.2024.102710

Jamal K. A. A, M. F. Mohammad and N. Hashim, Building Information Modelling (BIM) For Sustainable Industry: The Malaysian Architect's Perspective. In Alam Cipta (Vol. 12). Energizing Green Building. https://doi.org/10.1051/matecconf/201926605003

Khan, H. (2024). Microclimatic Architectural Design By Interfacing Grasshoppers And Dynamo With Rhino And Revit. Measurement: Sensors, 33, 101143. https://doi.org/10.1016/j.measen.2024.101143

Kordi, N. E., Zainuddin, N. I., Taruddin, N. F., Tengku Aziz, T. N. A., & Abdul Malik, A. (2020). A Study On Integration Of Building Information Modelling (BIM) In Civil Engineering Curricular. IOP Conference Series: Materials Science and Engineering, 849(1). https://doi.org/10.1088/1757-899X/849/1/012018

Lee, M., Chai, C., Xiong, Y., & Gui, H. (2022). Technology Acceptance Model For Building Information Modelling Based Virtual Reality (BIM-VR) In Cost Estimation. Journal of Information Technology in Construction, 27, 914–925. https://doi.org/10.36680/j.itcon.2022.044

Lee, M. L., Cheah, W. T., Lau, S. H., Lee, X. S., Abdullahi, A. M., & Wong, S. Y. (2020). Evaluation Of Practicality Of Virtual Design And Construction (VDC) With 5D Building Information Modelling (BIM) Through A Case Study. IOP Conference Series: Materials Science and Engineering, 943(1). https://doi.org/10.1088/1757-899X/943/1/012058

Lee, Y. H., Thien, L. S., Lee, Y. Y., Wong, S. Y., Tan, C. S., & Chai, C. S. (2020). Transformation From 2D Structural Drawing To Building Information Model: Perspectives From A Small-Scaled Company. IOP Conference Series: Materials Science and Engineering, 943(1). https://doi.org/10.1088/1757-899X/943/1/012063

Li, L., Yuan, J., Tang, M., Xu, Z., Xu, W., & Cheng, Y. (2021). Developing A BIM-Enabled Building Lifecycle Management System For Owners: Architecture And Case Scenario. Automation in Construction, 129. https://doi.org/10.1016/j.autcon.2021.103814

Mohamed, H. A., Hashim, N., Yusuwan, N. M., Hanafiah, M. H., & Shamsuddin, S. M. (2024). Assessing Cost And Benefit Attributes Of Building Information Modelling (BIM) Implementation In Malaysian Public Agency: Pls-Sem Approach. Journal of Information Technology in Construction, 29, 308–323. https://doi.org/10.36680/j.itcon.2024.015

Mohamed, H. A., Hashim, N., Yusuwan, N. M., Shamsuddin, S. M., & Said, I. (2023). Building Information Modelling (BIM) Capability In Malaysian Architectural Practices. Asean Engineering Journal, 13(1), 137–144. https://doi.org/10.11113/aej.V13.18551

Mohamed Salleh, R., Mustaffa, N. E., Abdul Rahiman, N., Tajul Ariffin, H. L., & Othman, N. (2019). The Propensity Of Building Information Modelling And Integrated Project Delivery In Building Construction Project. International Journal of Built Environment and Sustainability, 6(1–2), 83–90. https://doi.org/10.11113/ijbes.v6.n1-2.386

Mohammed, M., Shafiq, N., Al-Mekhlafi, A. B. A., Al-Fakih, A., Zawawi, N. A., Mohamed, A. M., Khallaf, R., Abualrejal, H. M., Shehu, A. A., & Al-Nini, A. (2022). Beneficial Effects of 3D BIM for Pre-Empting Waste during the Planning and Design Stage of Building and Waste Reduction Strategies. Sustainability (Switzerland), 14(6). https://doi.org/10.3390/su14063410

Moses, T., Heesom, D., & Oloke, D. (2020). Implementing 5D BIM On Construction Projects: Contractor Perspectives From The UK Construction Sector. Journal of Engineering, Design and Technology, 18(6), 1867–1888. https://doi.org/10.1108/JEDT-01-2020-0007

Muhamad Zahir, N. I. F., Omar, R., Yahya, M. Y., & Sarpin, N. (2021). The Use of BIM Technology in Construction Design Phase. International Journal of Real Estate Studies, *15*(S1), 82–88. https://doi.org/10.11113/intrest.v15nS1.119

Mustafa, M. H., Ali, M., Has Yun Hashim, K. S., & Mohd Suhaimi, M. S. (2020). Recreating Historical Malay Architecture with BIM Process. International Journal of Built Environment and Sustainability, 7(2), 79–89.https://doi.org/10.11113/ijbes.v7.n2.504

Mustafa, M. H., Ali, M., Mohd Ismail, K., Has Yun Hashim, K. S., & Mohd Suhaimi, M. S. (2019). BIM Backed Decision Support System in the Management of Heritage Building. International Journal of Built Environment and Sustainability, 6(2), 63–71. https://doi.org/10.11113/ijbes.v6.n2.357

Ngiik Zhing, W., & Ang Soon Ern, P. (2021). Trend and Challenges of BIM Training Acceptance in the Construction Industry in Selangor. Progress in Engineering Application and Technology, 2(1), 394–408. https://doi.org/10.30880/peat.2021.02.01.039

Nikmehr, B., Hosseini, M. R., Wang, J., Chileshe, N., & Rameezdeen, R. (2021). BIM-Based Tools For Managing Construction And Demolition Waste (Cdw): A Scoping Review. Sustainability (Switzerland), 13(15).https://doi.org/10.3390/su13158427

Nsimbe, A., & Di, J. (2024). The Impact of Building Information Modeling Technology on Cost Management of Civil Engineering Projects: A Case Study of the Mombasa Port Area Development Project. Buildings, 14(4). https://doi.org/10.3390/buildings14041175

Panteli, C., Kylili, A., & Fokaides, P. A. (2020). Building Information Modelling Applications In Smart Buildings: From Design To Commissioning And Beyond A Critical Review. Journal of Cleaner Production, 265. https://doi.org/10.1016/j.jclepro.2020.121766

Rafindadi, A. D., Shafiq, N., Othman, I., Aliyu, M. M., Alarifi, H., Ibrahim, A., & Yaro, N. S. A. (2023). The Effectiveness of Utilising the Building Information Modelling Based Tools for Safety Training and Job Hazard İdentification. Journal of Technology Management and Business, 10(1). https://doi.org/10.30880/jtmb.2023.10.01.001

Rosli, F., Kasim, N., Zainal, R., Meryam, S., Musa, S., & Noh, H. M. (2021). Study of BIM Tools Implementation among Contractors During Project Construction Phase in Construction Industry. Research in Management of Technology and Business, 2(1), 697–710. https://doi.org/10.30880/rmtb.2021.02.01.054

Saar, C. C., Siang, T. C., Ahmad Bajuri, F. A., Chuing, L. S., Yusof, A. M., & Sheng, L. X. (2019). Building Information Modelling In Malaysian Industrialised Building System. IOP Conference Series: Materials Science and Engineering, 620(1). https://doi.org/10.1088/1757-899X/620/1/012047

Salleh, H., Ahmad, A. A., Abdul-Samad, Z., Alaloul, W. S., & Ismail, A. S. (2023). BIM Application in Construction Projects: Quantifying Intangible Benefits. Buildings, 13(6). https://doi.org/10.3390/buildings13061469

Salleh M, R., Mustapa, N., Hussin, S., & Mohd Akbar, M. (2023). Adoption of Building Information Modelling Technology Among the Design Team in Malaysian Construction Industry. *International Journal Of Business And Technology Management, 5*(S2), 29-37.https://doi.org/10.55057/ijbtm.2023.5.s2.3

Shahruddin, S., Zairul, M., Haron, A. T., & Fared, M. M. (2022). Performance-Based Identity In A BIM Environment: An Architect's Perceptions And Experiences. Open House International, 47(4), 710–731. https://doi.org/10.1108/OHI-07-2021-0147

Syed Jamaludin, S. Z. H., Ismail, N. A. A., Ibrahim, I. H., & Japlun, N. (2022). The Emerging Challenges of Adopting BIM in the Construction Industry: Evidence from Sabah, Malaysia. Journal of Smart Science and Technology, 2(1), 1–14. https://doi.org/10.24191/jsst.v2i1.19

Wong, S. Y., & Gray, J. (2019). Barriers To Implementing Building Information Modelling (BIM) In the Malaysian Construction Industry. IOP Conference Series: Materials Science and Engineering, 495(1). https://doi.org/10.1088/1757-899X/495/1/012002

Ya'acob, I. A. M., Yee, S. L., & Rosli, N. M. (2022). Building Information Modelling (BIM) Is Used to Reduce Unethical Issues In The Malaysian Construction Industry. E3S Web of Conferences, 347. https://doi.org/10.1051/e3sconf/202234701012

Yusof, Y., Morbe, I. F. M., Fatahol-Qarib, M. F., Roddin, R., & Ibrahim Mukhtar, M. (2022). Readiness of Construction Organizations Towards Industrial Revolution 4.0 (IR 4.0). ANP Journal of Social Science and Humanities, *3*(1), 24-32. https://doi.org/10.53797/anp.jssh.v3i1.4.2022

Zul, M., Zulkifli, A., Akmal, N., Ismail, A., Mahat, N., Jasni, D., Azzran, A., Said, S., Iskandar, M., & Malek, A. (2023). Malaysian SME's Contractors Adoption of Building Information Modeling (BIM) (Penerimaan BIM di Kalangan Kontraktor PKS dalam Industri Pembinaan Malaysia). Jurnal Kejuruteraan SI, 6(1), 43–48. https://doi.org/10.17576/jkukm-2023-si6(1)-04