Malaysian Journal of Sustainable Environment
Special issue, Dec (2024) 241-266
doi: 10.24191/myse.v11i3.3926

THE ADOPTION AND IMPACT OF BUILDING INFORMATION MODELLING (BIM) TOWARDS FACILITIES MANAGEMENT (FM) IN MALAYSIA

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Received: 03 June 2024
Accepted: 30 September 2024
Published: 31 December 2024

ABSTRACT

Building Information Modelling (BIM) is gaining traction in the construction industry for its potential to enhance Facilities Management (FM) through advanced visualization, analysis, and control. However, in Malaysia, the integration of BIM within FM is still emerging, with significant untapped potential. This paper explores the adoption and impact of BIM in FM in Malaysia. A qualitative research approach through interviews were conducted with five (5) FM professionals, including facility managers, BIM coordinators, and consultants, selected through purposive sampling to ensure a broad understanding of BIM in FM. The results were then analysed using content analysis to assess the current practice of BIM implementations in FM, potential applications, and the level of interest in the utilization of BIM in FM. The findings highlight a budding interest in BIM among FM professionals in Malaysia. It revealed, an adoption pattern concentrated in high-value projects and characterized by challenges such as the absence of standardized BIM practices in FM, limited BIM knowledge among professionals, and concerns over implementation costs. Despite these hurdles, the consensus among participants points towards *an optimistic future for BIM in FM, driven by the recognized need for enhanced operational efficiencies and the potential for BIM to significantly improve FM practices. This paper concludes by advocating for increased BIM education among FM professionals, the establishment of FM-specific BIM standards, and initiatives to showcase the long-term benefits of BIM, thereby fostering a more robust adoption of BIM in the Malaysian FM sector.*

Keywords: *Building information mmodelling, BIM adoption, BIM impact, facilities management, BIM in FM*

INTRODUCTION

Building Information Modelling (BIM) represents a transformative advancement in the construction industry, offering a digital approach to architectural and engineering plans that extends beyond mere drawings (Ji et al., 2019). BIM integrates multidimensional information, making it a critical tool for enhancing facilities management (FM) (Farghaly et al., 2019). As countries globally embrace BIM for its potential to streamline project execution and operational management, Malaysia stands at a pivotal juncture in its adoption journey (Doukari et al., 2022).

Globally, the adoption of BIM has seen significant progress, particularly in developed countries. In the United States, the United Kingdom, and various European nations, BIM is mandated for public sector projects and is increasingly being adopted in private sector projects as well (Hamma-adama & Kouider, 2019). The benefits observed include improved project outcomes, enhanced collaboration among stakeholders, and greater efficiency in building operations and maintenance. These countries have recognized BIM's capacity to revolutionize the construction and facilities management landscape, integrating advanced visualization, analysis, and control capabilities into their workflows (Jiang et al., 2022).

While recent studies have highlighted the growing adoption of BIM in developed countries, earlier research indicated that this adoption was not without challenges. For instance, Lewis et al. (2018) discussed the initial resistance to BIM due to the steep learning curve and financial barriers, which is still prevalent today. However, newer studies (e.g., Pinti et al.,

2022) suggest that despite these challenges, the long-term benefits of BIM in FM, such as enhanced operational efficiency and improved collaboration, outweigh the initial hurdles.

In contrast, Malaysia is still in the early stages of BIM adoption. Although there have been initiatives like the Construction 4.0 Strategic Plan (2021-2025) and National Construction Policy 2030 that aim at enhancing technology adaptation, the integration of BIM within FM remains nascent (Wong & Yip, 2023). The Malaysian construction sector is gradually recognizing BIM's potential to enhance efficiency, reduce costs, and improve project management outcomes (Yusnida Ariffin et al., 2023). However, several challenges persist, including a lack of standardized practices, limited BIM knowledge among professionals, and significant financial barriers (Azmi et al., 2023). Despite these obstacles, there is a growing recognition of the strategic value of BIM in enhancing the efficiency and sustainability of Malaysia’s expanding infrastructure and urban development (Wills et al., 2018).

Despite the proven benefits of BIM, such as improved visualization, enhanced collaboration, and increased efficiency of operations, its integration within Malaysian FM is still at a nascent stage (Altohami et al., 2021). With the rapid growth of infrastructure development in the country, understanding the dynamics of BIM adoption is crucial. Hence, the primary objective of this study is to explore the adoption and impact of BIM in FM in Malaysia through a qualitative research approach.

LITERATURE REVIEW

Building Information Modelling (BIM)

Building Information Modelling (BIM) has revolutionized the construction sector, particularly in the areas of design and construction (Liu et al., 2020). The integration of BIM into these phases has resulted in significant improvements in project outcomes, making it a cornerstone of modern construction practices. Gu and London (2010). In the design phase, BIM enables the creation of detailed, multidimensional digital models that facilitate comprehensive visualization of a project. This capability allows architects, engineers, and stakeholders to collaborate more effectively, ensuring that all elements of the design are fully integrated before construction begins. Gao and Pishdad-Bozorgi (2019) highlight that BIM's 3D modeling capabilities are instrumental in clash detection, where potential conflicts between different building systems (e.g., electrical, plumbing, and HVAC) are identified and resolved in the design phase, reducing the need for costly changes during construction.

Meanwhile, during the construction phase, BIM continues to play a crucial role in enhancing efficiency and accuracy. Jiang et al. (2022) emphasize that BIM facilitates precise project scheduling and cost estimation, enabling construction managers to plan and execute projects with greater accuracy. The use of BIM in construction sites allows for real-time monitoring of progress, ensuring that any deviations from the plan are promptly addressed. This capability reduces delays and rework, which are common in traditional construction methods. Despite the proven successes of BIM in design and construction, its adoption in the Facilities Management (FM) sector remains limited. The transition from construction to FM is often fraught with challenges, primarily due to differences in the operational focus of these sectors. While construction projects benefit from the detailed and structured nature of BIM data, FM practices are traditionally more fragmented and reactive, and rely heavily on manual processes and outdated systems.

In conclusion, while BIM has achieved remarkable success in transforming design and construction practices, its integration into the FM sector is still in its infancy. The construction sector has demonstrated the value of BIM in improving project outcomes, but significant gaps and constraints remain in translating these benefits to FM. Addressing these gaps particularly in standardization, financial accessibility, and expertise will be crucial in realizing the full potential of BIM across the entire lifecycle of a building, from design to demolition. Hence, this study aims to explore these gaps further and propose strategies to overcome the barriers to BIM adoption in FM, with a focus on enhancing the efficiency and effectiveness of facility management practices in Malaysia.

Adoption of BIM in FM

BIM has been widely adopted in FM across developed regions such as the United States, the United Kingdom, and Western Europe, largely driven by governmental mandates (Valdepeñas et al., 2020). These regions have recognized BIM's potential to enhance project management and operational processes in FM by facilitating improved collaboration and information exchange. In contrast, emerging economies like Brazil, India, and China are still in the early stages of BIM adoption, viewing it as a strategic tool to manage rapid infrastructure development, boost construction productivity, and handle urban growth more effectively (Abideen et al., 2022).

In Malaysia, the adoption of BIM in FM reflects a growing trend towards digital transformation in the construction sector, albeit at a slower pace compared to more developed regions like Europe and North America (Husairi Hussain et al., 2022). Recognizing the strategic value of BIM, Malaysia is progressively integrating this technology to enhance the efficiency and sustainability of its expanding infrastructure and urban development (Husain et al., 2018). This shift is largely driven by governmental initiatives aimed at improving project delivery and building sustainability. For instance, the Construction 4.0 Strategic Plan (2021-2025) specifically aims to enhance digital transformation across the construction sector, particularly in public projects, by setting new benchmarks and encouraging the private sector to adopt advanced digital technologies. Thus, driving the industry towards the Fourth Industrial Revolution (Yusoff, S. N. S., Brahim, J., Nordin, R. M., & Haron, N, 2023).

Impact BIM in FM

BIM holds transformative potential for FM, promising to elevate the efficiency and sustainability of building management practices (Pinti et al., 2022). However, the adoption of BIM faces significant technological challenges, primarily concerning the interoperability of BIM software with existing management systems (Dijmarescu & Christopher's Hospice, 2021; Azmi et al., 2023; Lewis et al., 2018; Tezel et al., 2022). Many FM teams struggle to integrate BIM data effectively due to differences in software features and capabilities, which often results in compatibility issues. Additionally, the data-heavy nature of BIM models necessitates robust hardware and IT infrastructure, which can be a hefty investment for smaller firms or projects operating under tight budgets (Al-Ashmori et al., 2020).

Organizational challenges also significantly hinder the widespread adoption of BIM in FM (Azmi et al., 2023b; Chin et al., 2018; Dijmarescu & Christopher, 2021; Lewis et al., 2018). There is a notable knowledge gap among FM professionals regarding the capabilities and full potential of BIM, leading to its underutilization. Moreover, there exists a cultural resistance within many organizations reluctant to make a transition from traditional construction and management methods to more modern, digital approaches (Azmi et al., 2023b; Chin et al., 2018; Dijmarescu & Christopher, 2021; Lewis et al., 2018). This resistance is often rooted in misconceptions about BIM's benefits and a fear of the steep learning curve associated with new technology adoption.

One of the critical challenges in the adoption of BIM in FM is the financial implication, particularly for smaller firms. The high initial investment required for BIM software, hardware, and training poses a significant barrier (Lewis et al., 2018). Moreover, practitioners often struggle with justifying these costs against the potential long-term benefits. While studies have shown that BIM can lead to substantial savings through enhanced operational efficiency and reduced errors (Pinti et al., 2022), the upfront costs remain a deterrent. This financial burden is exacerbated by a lack of standardized BIM practices, which leads to inefficiencies and further increases costs. Understanding these financial implications is crucial for stakeholders considering BIM adoption, particularly in regions where funding for such innovations is limited.

To overcome these obstacles, a concerted effort towards education and training is essential. Ensuring that FM professionals are well-versed in BIM technologies and their applications will be crucial. Additionally, the development of standardized BIM practices and protocols tailored for the FM sector could facilitate smoother integration and operational efficiency (Ariffin et al., 2021; Azzran et al., 2018; Carbonari et al., 2018). These initiatives, supported by industry leadership and governmental mandates, could accelerate the adoption of BIM, ultimately reducing costs, enhancing facility management efficiencies, and setting a new standard for the construction industry in Malaysia.

Although there has been significant research on the adoption of BIM in developed countries, these studies often overlook the nuanced challenges faced in emerging markets like Malaysia (Lewis et al., 2018). Previous work has primarily focused on the technological advantages of BIM, with less attention paid to the organizational and cultural barriers (Gao & Pishdad-Bozorgi, 2019). A synthesis of these studies revealed a recurring theme, while the potential benefits of BIM are well-documented. There is a critical gap in understanding the practical challenges of its implementation in FM, particularly in terms of financial viability and knowledge dissemination among practitioners. This research aims to address these gaps by providing a focused analysis of the financial and educational challenges specific to the Malaysian FM sector.

Table 1. Summary of Challenges in BIM Adoption for FM

Challenges in BIM Adoption for FM	Description	References
Technological Challenges	Difficulty integrating BIM with existing FM systems due to software incompatibility and high data demands.	Dijmarescu & Christopher's Hospice (2021), Azmi et al. (2023), Lewis et al. (2018), Tezel et al. (2022), Al-Ashmori et al. (2020)
Organizational Challenges	Lack of BIM knowledge and resistance to adopting digital methods among FM professionals.	Azmi et al. (2023b), Chin et al. (2018), Dijmarescu & Christopher (2021), Lewis et al. (2018)
Financial Challenges	High initial costs for BIM software, hardware, and training deter smaller firms.	Lewis et al. (2018), Pinti et al. (2022)

METHODOLOGY

This research employed a qualitative approach using semi-structured interviews to gain in-depth insights into the adoption and impact of BIM in FM within Malaysia. Given the exploratory nature of this study, semi-structured interviews were chosen to allow for flexibility in probing the participants' experiences and perspectives. Interviews were conducted with five (5) construction professionals who have direct experience with BIM-FM projects (Refer Table 2). The sample included three Facility Managers (R1, R2, R3) and two BIM Coordinators (R4, R5). The Facility Managers had between 6 to 12 years of experience in the field, while the BIM Coordinators had between 8 to 10 years of experience. This diverse group was selected to ensure a comprehensive understanding of the challenges and opportunities in BIM adoption across different roles within the industry.

The sample size was determined based on qualitative research guidelines, which suggest that a small, focused sample can be adequate for exploratory studies where the goal is to understand complex phenomena rather than to generalize findings. Past studies, such as those by Guest, Bunce, and Johnson (2006), have shown that data saturation can often be achieved with as few as six interviews, particularly when participants are well-informed and the research topic is focused. Meanwhile, Marshall et al., (2013) also have proof that five interviews were deemed sufficient to achieve data saturation ensuring that the key themes and insights relevant to this study's objectives were thoroughly explored.

The interviews, lasting between 1-2 hours each, were conducted via Google Meet. The questions were designed to explore both the benefits and challenges of BIM adoption in FM, ensuring that the participants could share their experiences and insights in detail. The interview data were then transcribed verbatim and analyzed using content analysis. This involved systematically coding the data to identify recurring themes and patterns.

To enhance the credibility of the findings, the study focused on ensuring that the selected participants represented a range of perspectives within the operation maintenance industry, specifically targeting those actively involved in BIM-FM projects. However, to avoid confusion, it is noted that this research did not include a list of consultants in the response, but rather focused on professionals that actively engaged in BIM-FM projects.

Table 2. Respondents' Background Information

Respondents	Position	Category
R1	Facility manager	12
R2	Facility manager	10
R3	Facility manager	6
R4	BIM Coordinator	8
R5	BIM Coordinator	10

Source: Author

Limitation of study

While this study provides valuable insights into the adoption and impact of Building Information Modeling (BIM) in Facilities Management (FM) within the Malaysian context, it is important to acknowledge certain limitations that may affect the generalizability and scope of the findings. These limitations stem from the study's methodology, sample size, and the specific focus of the research. Understanding these constraints is crucial to interprete the results and guide future research efforts that aim to build upon this work. The key limitations of this study are outlined below:

- Small Sample Size: The study was conducted with a small sample size of five (5) respondents. , while it may be sufficient for an exploratory qualitative study, it may not fully capture the diversity of experiences and perspectives within the broader FM industry in Malaysia. This limitation may affect the generalizability of the findings, as the insights gathered may not represent all potential challenges and benefits of BIM adoption across different organizations or regions.
- Focus on Specific Roles: The study primarily included Facility Managers and BIM Coordinators, which means that perspectives from other key stakeholders in the FM industry, such as consultants, contractors, or policy makers were not explored. This could lead to a narrower view of the challenges and opportunities related to BIM adoption in FM.
- Potential for Response Bias: Given that the interviews were conducted with professionals who are already engaged in BIM-FM projects, there may be a positive bias in their responses on the benefits of BIM. The study may have benefited from including perspectives from professionals who have not yet adopted BIM, to better understand the barriers to adoption.

RESULTS AND FINDINGS

The respondents for the interviews are all BIM-FM practitioners who have used or are actively utilizing BIM in FM. The Facility Managers and BIM Coordinators are those who took part in the interviews, as shown in Table 1 below. All respondents are in charge of managing BIM in FM for maintenance operations. The content analysis of interview data revealed several key themes pertaining to adoption patterns, benefits, challenges, and the overall impact of BIM on FM operations.

Adoption Patterns

The study identified a nascent but growing adoption of BIM within the Malaysian FM sector. Notably, adoption rates were still at an infancy level as it required greater resources and more complex operations. R1 explained that they have integrated BIM into FM, and the benefits in terms of coordination and efficiency are substantial. Moreover, R2 mentioned that the adoption BIM into FM has transformed how they manage the assets. The detailed visualization and data integration capabilities have made the maintenance processes much more efficient. This is supported by previous studies (Ashworth et al., 2019; Pinti et al., 2022; Yusnida Ariffin et al., 2023; Pinti et al., 2022) that specify BIM enables facility managers to visualize the entire facility, leading to more efficient maintenance planning and execution by providing a comprehensive digital model of facilities. However, R3 commented that smaller projects and firms appeared slower in adopting BIM, primarily due to resource constraints, initial costs and lack of skilled personnel. Further, R2, R3 and R5 mentioned that investing in BIM technology was challenging, as they often have to weigh the immediate costs against the long-term benefits, which are not always feasible given to the budget constraints. This is in line with research by Azmi et al. (2023b) and Pinti et al. (2022) that were also mentioned on the financial and lack of skill personnel can delay the adoption process.

Furthermore, respondents indicated that the most common applications of BIM in FM involved asset management and maintenance planning, whereas R4 explained that using BIM for maintenance planning has streamlined the operations, allowing them to predict and address issues before they become major problems. This was supported by R5 which mentioned that the ability to visualize the entire facility in a digital model has significantly improved the space management as now they can plan and execute maintenance tasks with greater precision and less disruption. This is in line with Tsay et al. (2022), where the integration of BIM in FM facilitates the creation of maintenance schedules, prioritization of repair needs, and identification of areas for improvement.

Table 3. Comparison Response of Respondents

Respondent	Key Points	Supporting Studies
R1	Integrated BIM into FM; substantial benefits in coordination and efficiency.	Ashworth et al., 2019; Pinti et al., 2022; Yusnida Ariffin et al., 2023
R2	BIM has transformed asset management; improved visualization and data integration, leading to more efficient maintenance processes. Highlighted challenges in weighing immediate costs against long-term benefits.	Pinti et al., 2022; Azmi et al., 2023
R3	Smaller projects and firms slower in adopting BIM due to resource constraints, initial costs, and lack of skilled personnel. Mentioned financial challenges and the need for skilled personnel.	Pinti et al., 2022; Azmi et al., 2023
R4	Using BIM for maintenance planning has streamlined operations, allowing for predictive maintenance and issue resolution before problems escalate.	Tsay et al., 2022
R5	BIM's visualization capabilities have improved space management, allowing for precise maintenance planning and execution. Highlighted challenges similar to R2 and R3.	Tsay et al., 2022

Benefits of BIM in FM

Interviewees consistently reported that BIM offers substantial benefits for FM, enhancing both the efficiency and effectiveness of facility management processes. Key benefits highlighted included improved visualization of facilities, which aids in more effective space planning and management, and enhanced data management capabilities that improve decision-making processes. In which R1 explained that the 3D models provided by BIM have revolutionized how they view and manage the spaces. Every detail can be seen, which helps in optimizing space utilization and planning for future needs. Further mentioned by R3 that BIM's detailed visualization has allowed them to identify and address potential issues before they escalate, saving them both time and money. This is in line with previous studies by Hoang et al., (2020) and Love et al., (2014) stating on how BIM would allow more comprehensive data for facility managers to create effective maintenance schedules, prioritize repair needs, and make informed decisions on asset management.

Several respondents provided examples where BIM facilitated better coordination between different departments, leading to reduced operational conflicts and smoother project execution. R4 explained that by having a centralized BIM model, the maintenance team, operations staff, and contractors can access the same up-to-date information. This has drastically reduced misunderstandings and errors. Furthermore, R5 added that BIM also able to help them coordinate the installation of HVAC systems with other ongoing construction activities, avoiding delays and additional costs. This is supported by Carbonari et al. (2018), Deng et al. (2021), Pavón et al. (2020) and Thabet et al., 2016, where their studies described BIM capabilities towards easy visualization and integration of complex systems, help to prevent delays and reduce costs associated with rework and conflicts during the installation phase.

In addition, enhanced data management capabilities were also highlighted as a significant benefit of BIM. R2 mentioned that with BIM, they have a comprehensive digital database of all the assets. This makes it easier to track maintenance schedules, monitor performance, and make informed decisions about repairs and replacements. As explained by Hosseini et al. (2018), BIM's structured data management capabilities enable facility managers to maintain detailed records of asset conditions, maintenance history, and performance metrics, which streamline decision-making processes. Moreover, R3 remarked that the ability to integrate real-time data into our BIM models means they can quickly respond to issues and maintain optimal operational efficiency.

Additional examples provided by R1 further described how BIM improved their emergency preparedness, whereas with BIM, they can simulate different emergency scenarios and plan their responses more effectively. It has been invaluable in ensuring the safety and readiness of their facility. This is in accordance with Pinti et al. (2022) where BIM models allow facility managers to quickly respond to issues and maintain optimal operational efficiency. R2 further highlighted how BIM has streamlined their project by allowing them to visualize the entire project and make adjustments in real-time. This is in line with Altwassi et al.'s (2024) explanation where BIM enables the visualization of entire projects, allowing for real-time adjustments and streamlines project processes.

Table 4. Summary Comparison Response of Respondents

Respondent	Key Points	Supporting Studies
R1	-3D models revolutionized space management -Every detail can be seen, aiding in space optimization and future planning -Improved emergency preparedness through simulation of scenarios	Hoang et al., 2020; Love et al., 2014; Pinti et al., 2022; Altwassi et al., 2024
R2	-Comprehensive digital database of assets -Easier tracking of maintenance schedules, performance monitoring, and decision-making -Streamlined project visualization and real-time adjustments	Hosseini et al., 2018; Pinti et al., 2022; Altwassi et al., 2024
R3	-Detailed visualization helps identify and address potential issues -Saves time and money by preventing issues from escalating -Integration of real-time data into BIM models for quick response and operational efficiency	Hoang et al., 2020; Love et al., 2014; Pinti et al., 2022
R4	-Centralized BIM model improves coordination between maintenance team, operations staff, and contractors -Reduces misunderstandings and errors, leading to smoother project execution	Carbonari et al., 2018; Deng et al., 2021; Pavón et al., 2020; Thabet et al., 2016
R5	-BIM helps coordinate the installation of HVAC systems with ongoing construction -Avoid delays and additional costs -Improved space management and maintenance task precision	Carbonari et al., 2018; Deng et al., 2021; Pavón et al., 2020; Thabet et al., 2016

Challenges in BIM-FM Implementation

Despite the recognized benefits, several significant challenges were reported by the respondents. The predominant challenges included the high cost of BIM software and the associated hardware, which were particularly prohibitive for smaller firms. R2 explained that the initial investment in BIM technology is quite high, and it is challenging for smaller firms to justify the cost. Additionally, a notable skills gap in BIM usage was evident, with a lack of trained professionals capable of leveraging BIM technologies effectively. This has been mentioned by R3 where they struggle to find staff who are proficient in BIM. The learning curve is steep, and there are not enough training programs available to bridge the gap. Further R4 highlight that even when they hire new graduates, they often lack practical experience with BIM tools, which means they have to invest in further training.

Organizational resistance to change from traditional FM methods to BIM was also cited as a recurrent barrier, underpinned by a fear of the complexity and the learning curve associated with BIM technologies. A R2 explained that there is a lot of resistance from the older staff who are used to traditional methods. They find BIM overwhelming and are reluctant to adopt new practices. R1 also shared that changing established workflows is always challenging. People are naturally resistant to change, especially when it involves learning new technology. The respondents also highlighted some potential solutions and strategies to overcome these challenges. Whereas, R1 and R3 suggested that to address the cost issue, smaller firms could consider collaborating with larger firms or seeking government subsidies to make BIM adoption more affordable.

Meanwhile R4 recommended that by investing in comprehensive training programs and workshops can help bridge the skills gap. Furthermore, to mitigate organizational resistance, R5 suggested implementing change management strategies. This was supported by R4 who stated that gradual implementation and providing hands-on training can help ease the transition. Besides, showcasing successful case studies and the tangible benefits of BIM can also help in convincing reluctant staff. R4 also highlighted that it is important to involve all stakeholders in the planning process and to provide continuous support as they adapt to new workflows.

Table 5. Summary Comparison Response of Respondents

Respondent	Challenges	Potential Solutions
R1	-High cost of BIM software and hardware -Organizational resistance to changing established workflows	-Collaboration with larger firms -Seeking government subsidies -Implementing change management strategies -Gradual implementation and hands-on training
R2	-High initial investment -Resistance from older staff accustomed to traditional methods	-Collaborating with larger firms -Seeking government subsidies -Implementing change management strategies -Involving all stakeholders in the planning process

R3	-Skills gap and lack of trained professionals -Steep learning curve for BIM technologies	-Collaboration with larger firms -Comprehensive training programs and workshops -Implementing change management strategies -Providing continuous support for new workflows
R4	-Lack of practical experience among new graduates -Need for further training -Resistance to new technology	-Investing in comprehensive training programs -Hands-on training for gradual implementation -Showcasing successful case studies -Involving all stakeholders and providing continuous support
R5	-High cost of BIM adoption	-Implementing change management strategies

Source: Author

Impact of BIM on FM Operations

The respondents expressed that BIM had a positive impact on operational efficiency, particularly in terms of maintenance management and lifecycle tracking of building components. R4 mentioned where BIM's real-time data access significantly reduced the time required for problem identification and resolution, as a result, it minimizes downtime and operational disruptions. While, R5 mentioned that with BIM, they can quickly identify issues and deploy the necessary resources to address them. This has reduced the downtime by approximately 30% compared to our previous methods. Besides that, R2 highlighted that BIM's real-time data access allows us to monitor the condition of building components continuously. We've seen a 25% improvement in our response time to maintenance requests. Several respondents also mentioned how BIM streamlined maintenance planning and execution. R4 and R6 who are a BIM coordinator explained that BIM provides a comprehensive view of our assets and their maintenance history. This is in accordance with Abdullah et al. (2013), Hilal et al. (2019) and Sabol (2018), where BIM able to provide detailed and up-to-date information. Subsequently, allows for quicker identification of issues and the deployment of necessary resources, which can lead to significant reductions in downtime.

This has enabled them to plan maintenance activities more efficiently and reduce the frequency of unexpected breakdowns. Further, R3 added that the predictive maintenance capabilities of BIM have allowed us to address potential issues before they become major problems, leading to a decrease in emergency maintenance tasks. In addition to these benefits, respondents described how BIM improved coordination and communication among different departments. Whereas R3 shared, by using BIM, they have a unified platform where all departments can access and update information in real-time. This has led to a reduction in coordination errors and a smoother workflow. This was supported by R1 who stated that the centralized data provided by BIM has significantly improved their communication with contractors and suppliers, reducing delays and ensuring timely project completion. This is in accordance with Omayer and Selim, (2022) and Terreno et al. (2019) where enhanced coordination capabilities of BIM are crucial for effective project management and operational efficiency.

The respondents also emphasized the long-term cost savings associated with BIM implementation. According to R3 and R4, although the initial cost of implementing BIM was high, they have already recouped those expenses through reduced operational costs and improved efficiency. R1 also shared that the return on investment with BIM is clear. In addition, the savings they achieve from reduced downtime and better maintenance management have more than compensated for the initial expenditure. This is in line with Deng et al. (2021), where BIM role in improving coordination and communication helps prevent costly emergency repairs and extends the life of building components, leading to substantial cost savings over time.

Table 6. Summary Comparison Response of Respondents

Respondent	Key Points	Supporting Studies
R1	-Significant improvement in communication with contractors and suppliers -Reduced delays and ensured timely project completion -Clear return on investment through reduced downtime and better maintenance management	Omayer & Selim, 2022; Terreno et al., 2019; Deng et al., 2021
R2	-Real-time data access for continuous monitoring of building components -25% improvement in response time to maintenance requests -Streamlined maintenance planning and execution	Abdullah et al., 2013; Hilal et al., 2019; Sabol, 2018

R3	-Predictive maintenance capabilities address issues before they become major problems -Decreased emergency maintenance tasks -Unified platform for real-time information updates, reducing coordination errors	Abdullah et al., 2013; Omayer & Selim, 2022; Terreno et al., 2019
R4	-Real-time data access reduces time for problem identification and resolution -Minimized downtime and operational disruptions -Comprehensive view of assets and maintenance history for efficient planning	Abdullah et al., 2013; Hilal et al., 2019; Sabol, 2018
R5	-Quick identification and resource deployment for issue resolution -Approximately 30% reduction in downtime -Improved coordination during HVAC system installations -BIM provides a comprehensive view of assets and their maintenance history	Abdullah et al., 2013; Hilal et al., 2019; Sabol, 2018

Future Outlook and Interest

The future of BIM in FM in Malaysia was viewed optimistically by the respondents, who anticipated a steady increase in adoption as the barriers are gradually overcome. There was a strong advocacy for more comprehensive training programs and initiatives from both the public and private sectors to enhance BIM competencies among FM professionals. R1, R3 and R5 suggested that government led initiatives, such as subsidies for BIM training programs and certifications, could significantly boost adoption rates among smaller firms. This is in line with Pinti et al. (2022), where the more organizations realize the efficiencies and cost savings provided by BIM, adoption rates are expected to rise steadily. This trend is further supported by government initiatives and industry collaboration, which together create a conducive environment for BIM implementation in FM. R2 and R1 highlighted the importance of industry partnerships, stating that collaborations between educational institutions and FM companies to offer specialized BIM training courses have been very effective to bridge the skills gap. This is supported by CIDB (2021), where industry-academic collaborations can facilitate the development BIM and is seen as a critical factor in driving the widespread adoption of BIM in the FM sector.

R3 and R5 also suggested showcasing successful case studies of BIM in FM to help mitigate resistance and illustrate the tangible benefits of BIM adoption. For instance, according to the R4, seeing real-world examples of BIM success stories can be a powerful motivator for other organizations to adopt the technology. It demonstrates the practical benefits and return on investment. The optimism extended to technological advancements and industry trends that are expected to facilitate BIM adoption. R5 stated as BIM software becomes more user-friendly and affordable, there will be wider adoption across the industry. Additionally, innovations in AI and IoT integration with BIM are also promising developments that could enhance its capabilities. This is in accordance with Mannino and Dejaco's (2021) claim, where evolution of BIM software towards greater usability and affordability is making it more accessible to a broader range of users. Furthermore, R4 explained that the increasing emphasis on sustainability and green building practices will likely drive BIM adoption, as it offers tools for better energy management and environmental impact assessment. This was supported by Nairne Schamne et al. (2022), where BIM can facilitate the implementation of green building standards and certifications by providing accurate data for energy consumption and environmental performance assessments.

CONCLUSION

This study explored the adoption and impact of Building Information Modelling (BIM) in Facilities Management (FM) in Malaysia, revealing both the significant benefits and challenges faced by the industry professionals. While BIM adoption is still in its early stages, there is a growing recognition of its potential to enhance operational efficiency and effectiveness. The key benefits identified include improved visualization for better space planning, enhanced data management for informed decision-making, and better coordination among departments, leading to smoother project execution and significant cost savings. However, adoption is hindered by high initial costs, a shortage of skilled professionals, and organizational resistance to change from traditional FM methods to BIM. Addressing these challenges requires comprehensive training programs, change management strategies, and potential governmental support in the form of subsidies or incentives to make BIM adoption more accessible and feasible.

Despite these barriers, the future outlook for BIM in FM in Malaysia is optimistic. The respondents advocate for more comprehensive training programs and government-led initiatives to boost BIM adoption. In addition, collaborations between educational institutions and FM companies to offer specialized BIM training courses can help bridge the skills gap. Showcasing successful case studies can mitigate resistance and illustrate the tangible benefits of BIM adoption. As technological advancements, such as AI and IoT integration with BIM, and the emphasis on sustainability and green building practices continue to evolve, BIM adoption is expected to increase. Strategic interventions at educational and policy levels, along with collaborative efforts among industry stakeholders, will be crucial in driving the successful integration of BIM into FM practices, ultimately transforming Malaysia's built environment and ensuring its sustainability for the future.

Furthermore, future research should focus on exploring BIM adoption in different types of FM projects or regions within Malaysia to gain a more comprehensive understanding of its impact and potential. Additionally, investigating the long-term effects of BIM integration on operational efficiency and cost savings in FM could provide further insights into its benefits. Strategic interventions at educational and policy levels, along with collaborative efforts among industry stakeholders, will be crucial in driving the successful integration of BIM into FM practices, ultimately transforming Malaysia's built environment and ensuring its sustainability for the future.

ACKNOWLEDGEMENT

This works was supported by Universiti of Teknologi MARA (UiTM) Shah Alam Malaysia, Instructional and Digital Learning Division, Department of Polytechnic and Community College Education and Public Work Department Malaysia.

FUNDING

There is no funding received for this research.

AUTHOR CONTRIBUTIONS

All authors contributed to the design of the research, the questionnaire, and the write-up. All authors have read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declared there is no conflict of interest.

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