Journal of Project Management Practice
Faculty of Built Environment, Universiti Malaya.
E-ISSN: 2805-4768
https://ejournal.um.edu.my/index.php/JPMP/

Enhancing Project Efficiency: The Role of Building Information Modelling (BIM) in Cost and Time Management

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Submission date:
13th May 2025

Revised date:
26th June 2025

Acceptance date:
13th November 2025

How to cite this paper:
Bakri, A. S., Burhanuddin, N. F., Ab Rahim, N., & Khaderi, S. S. (2025). Enhancing Project Efficiency: The Role of Building Information Modelling (BIM) in Cost and Time Management. Journal of Project Management Practice, 5(2), 01-13.

ABSTRACT

Building Information Modelling (BIM) has emerged as a transformative technology in the construction industry, particularly in developed countries, by offering a digital approach to project management that can improve cost and time control. Despite its potential, many construction projects continue to face challenges such as budget overruns, project delays, and inefficient resource management, which limit their ability to fully leverage BIM's advantages. This study aims to explore the application of BIM technology for enhancing project efficiency in construction projects, focusing on its impact on cost and time control. The research specifically examines the extent of BIM adoption across different project phases, including design, construction, and maintenance, and identifies the challenges that hinder its effective use. Data for this study were collected through a structured questionnaire survey and analysed using descriptive statistical methods with SPSS. The findings reveal a low level of awareness and adoption of BIM technology for cost and time control in construction projects, despite its recognized benefits in cost estimation, project scheduling, and maintenance management. Key challenges identified include the high cost of training and software, a lack of standardized BIM guidelines, and the limited availability of skilled professionals. These findings provide critical insights for industry stakeholders seeking to improve BIM integration for better cost and time management, emphasizing the need for targeted training programs, improved standardization, and greater industry collaboration to maximize BIM's potential.

Keywords: *Building Information Modelling, cost control, time management, construction technology, project efficiency*

1.0 INTRODUCTION

The construction industry in Malaysia faces significant challenges, including cost overruns, project delays, design changes, and competitive tendering processes (Yap et al., 2019). These persistent issues can lead to increased construction costs, reduced profit margins, contract termination, and broader negative impacts on industry performance (Yap et al., 2020). Traditional project management approaches in the Malaysian construction sector often result in poor site management, construction errors, low productivity, and ineffective resource coordination, further delaying project delivery and reducing international competitiveness (Othman et al., 2021; Abas et al., 2018).

Building Information Modelling (BIM) has emerged as a powerful digital technology that can address these challenges by enhancing the planning, execution, and monitoring of construction projects. BIM integrates 3D modelling with time (4D) and cost (5D) data, providing a comprehensive digital representation of a building's lifecycle. This approach allows for improved design coordination, clash detection, real-time cost estimation, and more accurate project scheduling (Ismail et al., 2017). BIM also facilitates effective decision-making by providing accurate, real-time project data that supports resource optimization, risk management, and long-term cost control (Othman et al., 2020). As a result, BIM has gained widespread acceptance in developed countries as a critical tool for enhancing project efficiency and reducing lifecycle costs (Schneider et al., 2016).

Despite these advantages, the adoption of BIM in Malaysia remains limited. Several barriers hinder its widespread use, including a lack of technical skills, insufficient training, high implementation costs, and the absence of standardized guidelines and protocols (Latiffi et al., 2016; Hatem et al., 2018). Additionally, resistance to change among industry professionals, limited awareness of BIM's benefits, and concerns about job displacement further slow its adoption (Zainon et al., 2018). A study by Waqar et al. (2023) identified critical barriers to BIM deployment in small construction projects, categorizing them into technical adoption, behavioural, implementation, management, and digital education barriers. Similarly, Yi et al. (2023) emphasized the need to overcome these digitalization barriers among quantity surveyors by proposing targeted strategies and policy interventions. These obstacles are compounded by a lack of standardized guidelines, high implementation costs, and limited availability of skilled professionals. These challenges highlight the need for a more structured approach to BIM integration, including targeted training programs, stronger industry collaboration, and clearer standards to guide BIM implementation.

Given the opportunities and challenges associated with Building Information Modelling (BIM) implementation, this study aims to evaluate the current level of BIM application for cost and time control in the Malaysian construction industry. The research specifically seeks to assess the extent to which BIM is adopted across different phases of construction projects, including the design, construction, and maintenance stages, as well as to identify the key challenges that hinder its effective implementation. By addressing these gaps, the study aims to provide valuable insights into how BIM technology can be better leveraged to enhance project efficiency and improve the overall competitiveness of Malaysia's construction sector. To achieve these objectives, the study is guided by two main research questions: (1) To what extent is BIM applied for cost and time control across different phases of construction projects in Malaysia? and (2) What are the key challenges that hinder effective BIM implementation?

2.0 LITERATURE REVIEW

2.1 Construction Cost & Time Control

Project cost control involves monitoring and updating project costs, managing changes to the cost baseline, and utilising tools like earned value management, forecasting, and performance reviews (Tahir et al., 2018). Inputs include the project management plan, funding requirements, work performance data, and process assets, while outputs consist of work performance information, cost forecasts, change requests, and updates to project documents and organizational processes. Recent studies emphasize the critical role of digital tools like BIM in enhancing cost control by providing real-time cost data, reducing rework, and minimizing budget overruns. For instance, Mohamed (2024) highlighted that the adoption of BIM in the Malaysian Public Works Department (PWD) significantly improved cost estimation accuracy and reduced project delays through integrated cost management systems.

On the other hand, project time control focuses on monitoring project activities, updating progress, and managing changes to the schedule baseline (PMI, 2017). Inputs for time control include the project

management plan, scheduled work program data, project calendar, and organisational process assets (PMI, 2013). Tools and techniques such as performance reviews, project management software, resource optimisation, modelling techniques, schedule compression, and scheduling tools are employed. Outputs encompass work performance information, schedule forecasts, change requests, and updates to project documents and organisational processes (Yun et al., 2016). Recent advancements in digital project management tools have further highlighted the importance of integrating BIM for effective time control.

In summary, managing cost and time control are vital in construction projects, with BIM technology being particularly beneficial for cost control. The inputs for cost control include the project management plan, work performance data, and process assets, while the inputs for time control include the project management plan, schedule work program data, project calendar, and organisational process assets.

2.2 BIM Application in Construction Projects in Malaysia

BIM is defined as a digital technology that facilitates modelling, visualization, coordination, and integration of design and construction data to enhance project planning, execution, and facility management (Alsafiani, 2024). This technology assists to integrate graphical and information data flows and processes under an integrated software environment, enabling individual executors to work as teams and decentralised tools to become complex solutions. Moreover, BIM technology facilitates the performance of life cycle operations in construction projects with greater efficiency and reduced costs. Recent studies have reinforced this view, emphasizing the role of BIM as a critical enabler for digital transformation in the construction sector. For example, Graham (2024) noted that the Malaysian government has mandated the use of BIM for all public projects above RM10 million starting August 2024, aiming to improve efficiency and transparency in project delivery (Graham, 2024). This move is expected to significantly accelerate BIM adoption across the industry, aligning with the goals of the National Construction Policy 2030.

Ji and Chen (2020) posited that BIM technology creates a virtual construction project with a logical building information database that simulates the real state of the building through digital information. It integrates the entire process from design to operation and has five characteristics, including visualisation, coordination, simulation, optimisation, and graphing. BIM technology in construction companies enables real-time communication through simulation and integrated features, allowing all parties to monitor the construction period, cost, and environmental impact of the site (Ji & Chen, 2020). Therefore, functionalities within BIM allow the professionals to manage the variables that impact the project time and cost controls. BIM functionalities will allow effective change management and efficient resource scheduling, which can be performed as part of continuous checks and review across project stages.

BIM technology is not only highly beneficial in cost control by allowing for information sharing among stakeholders, including designers, architects, engineers, contractors, and subcontractors (Tahir et al., 2018), but it also assists in early risk identifications before the project start date. The technology facilitates the examination of design drawings and construction documentation, consolidating and collecting the quantitative changes in the project, updating the BIM model on the real-time changes taking place, evaluating and sharing the real-time information on a collaborative management platform, and settling the project costs (Ha, 2021).

2.3 BIM Application in Construction Cost and Time Control at Different Project Phases

BIM technology has proven beneficial in various stages of construction, including the design, construction, maintenance, and decommissioning phases. In the design phase, BIM helps with simulated modelling of the entire project, estimation, statistics for project cost management, and design evaluation against building codes and sustainability before construction starts. Additionally, BIM increases the speed of the design phase by using a rich database, reduces communication with engineers, and enables the construction management team to minimise time consumption for redoing and corrections.

During the construction phase, BIM technology provides the platform for professionals to track work in real-time, manage site resources, and demonstrate the construction process. It also helps control cost and time, as the contractor can access all critical information needed in the BIM database and reduce the time it takes to get back to the designer on certain project parts. BIM is also useful in the construction phase because 4D BIM will link the construction plan to the 3D objects in a design so that the construction progress of every stage of construction can be estimated. According to Mustafa et al. (2023), the introduction of 5D Building Information Modelling (BIM) has transformed the construction industry by combining cost information with 3D visual models.

In the maintenance phase, BIM technology aids track the operation of the facilities in a building and the facilities can be monitored for any potential issues. BIM technology also assists with the planning and managing maintenance and repairs, reducing the need for costly replacements. Overall, BIM technology is useful in construction cost and time control, providing a comprehensive view of the project and enabling efficient project management throughout its lifecycle.

BIM tools have played a pivotal role in spreading the concept of BIM and achieving its goals. BIM tools are applied to manage construction projects, and most of them are designed for specific purposes to meet users' needs, while a few are designed for multiple functions and information collection (Tahir, et al., 2018). The use of these tools depends on the purpose, the type of users, and the stage of the project. Therefore, BIM will create a unified system that interacts with the participants who have access to the platform, which allows the project participants to engage actively across the project lifecycle. Table 1 below depicts the technology application and function of the BIM tools.

Table 1. Building Information Modelling (BIM) Tools.

No	Tools/Technology	Function
1.	Revit Architectural	'Autodesk's Revit Architecture software for the preparation of 3D BIM models. By using 'Autodesk's Revit Architecture software, it helps in quantity estimation and cost for different items from the model (Kulkarni & Mhetar, 2017).
2.	Revit Structural	Revit software enables architectural design, structural design, and MEP integration in building information modelling for professional building design practice (Habte & Guyo, 2021; Gowry et al., 2023)
3.	Cost X	CostX functions as a BIM-based cost estimating tool that supports detailed and automated quantity take-off, live linking of quantities to cost rates, and efficient cost control through rate library management. (Babatunde et al., 2019; Sepasgozar et al., 2022)
4.	Navisworks	Autodesk's Nevis Work software used to obtain a simulated view of a project in terms of time and cost as a 4D and 5D model. It can be performed by integrating both the Microsoft Project schedule and data cost for each item from an Excel sheet (Kulkarni & Mhetar, 2017). It manages 3D model-based design and clash detection (Tahir, et al., 2018).
5.	Vico Office	For analysis of various 3D models for coordination, scheduling, and estimating (Tahir et al., 2018). It enables integrated 5D modeling by linking quantity take-off with cost and schedule data, supporting efficient planning and estimation for complex building projects (Pavličič et al., 2017)

2.4 The challenges in the application of BIM technology in cost and time management

Building Information Modelling (BIM) is a technology that provides tools for managing construction projects. Given all the advantages of BIM implementation mentioned earlier, it would be wrong to generalise that all BIM implementations guarantee positive outcomes. In effect, various challenges and difficulties are associated with adopting BIM in the construction industry. This article discusses the various challenges that need to be addressed to implement BIM successfully. One of the main challenges is the lack of skill and expertise in BIM. The users may not be aware of the new technology and, therefore may not have the capability or the know-how to connect to the system. This issue with upskilling may hinder or inhibit access to BIM. Obtaining sufficient knowledge and expertise in BIM can be difficult and prohibitively expensive, and it is essential to provide the correct BIM technology expertise in a company (Zainon et al., 2018).

Another challenge is employers' and employees' unwillingness to adopt BIM technology in a company. The reluctance or resistance to change of practice may be due to lack of interest in learning the new technology and exploring its benefits. It could also be that professionals may not identify the benefits or incentive in investing their time to learn while managing current workload. The fear that their roles will be taken over by the software and hardware required for BIM to function effectively may also contribute to the low uptake of

BIM technology. Another challenge is employers' and employees' unwillingness to adopt BIM technology in a company. Resistance often arises from perceived inefficiencies or inequities in how BIM is implemented, particularly among senior staff (Wang et al., 2020). A lack of collaborative culture, insufficient training, and inadequate support from senior management further exacerbate this reluctance (Magalhães et al., 2023). These are critical individual and organizational barriers that must be addressed for successful BIM integration.

Cost is another significant challenge in deploying BIM, especially for small-scale companies. The initial cost of purchasing software and upgrading hardware may be a barrier to implementation, as the return on investment may not be perceived as profitable. Alternatively, the returns are taking such time to gain the benefits of the investment. Additionally, the shortage of experts in the BIM field drives up the cost of hiring them. The lack of interoperability between relevant BIM software can lead to ineffective collaboration and workflow. BIM technology is not standardised and may not be user-friendly for some projects with unique characteristics. Hence, standardised BIM processes and guidelines are necessary to clarify how BIM can be integrated into current business practices (Hatem et al., 2018; Ismail et al., 2017; Sriyolja et al., 2021).

The lack of active participation or uptake from consultants in the project team is also a limiting factor. This lack of uptake among professionals can impair communication and disrupt collaboration among team members, and consultants may not be updated with changes or schedules used in the project due to lack of access or inability to manage the new adoption due to lack of skills or simply the refusal to implement the change. The reluctance of stakeholders in the project team to use BIM technology can also harm the collaboration among stakeholders (Jamal et al., 2019; Musa et al., 2018).

Implementing BIM technology can provide numerous benefits but also presents several challenges. The challenges include the lack of skill and expertise, the unwillingness of employers and employees to adopt the technology, the high cost of initial investment, the lack of interoperability, and a lack of active participation from consultants. It is pertinent to provide the correct BIM technology expertise in a company, provide adequate training and exposure, and establish standardised BIM processes and guidelines to overcome these challenges. All stakeholders in the project team should be responsible and supportive of implementing BIM technology, and senior leadership should lead the way in driving change in the organisation.

3.0 METHODOLOGY

Both secondary and primary data collection methods were employed in the research to gather data relevant to the study. The main primary data collection method used was a questionnaire, which was prepared in the form of an online survey using Google Forms and distributed via email and various social media networks such as Facebook, Instagram, Twitter, and LinkedIn. The target respondents were construction practitioners working in the Klang Valley area of Malaysia, including Quantity Surveyors (QSs), contractors, architects, and engineers. To provide diversified views, the study enlisted BIM users with different organisational roles (e.g., consultants, contractors, QS firms, and design professionals), levels of BIM exposure, and years of BIM experience. Hence, developing a more extensive and well-balanced understanding of BIM applications in cost and time management throughout the project life cycle. Secondary data collections for the study were gathered from literature in use, including peer-reviewed journals, academic articles, newspapers, and other research publications. These sources' information was utilized to guide the formulation of close-ended questions for the questionnaire. The sample size was determined using the available number of professionals within the construction industry within the Klang Valley region. A total of 400 respondents were targeted for the survey distribution via various social media platforms. The collected responses were analysed using descriptive statistics with the aid of Statistical Package for the Social Sciences (SPSS) software, version 26. All responses were treated at a 95% confidence level. The data were collected between January to March 2022.

Descriptive statistics were chosen to suit the exploratory aim of the study, enabling identification of trends and perceptions among a diverse respondent group. Likert scale responses (5-point) were ranked based on mean values to facilitate comparison of perceptions across BIM adoption stages and challenge categories. Inferential methods such as ANOVA or regression were not employed due to the exploratory nature and small sample size.

4.0 RESULT AND DISCUSSIONS

4.1 Respondents' background

The total of questionnaires distributed was 400 and only 100 (25%) were received for data analysis. The first part of the questionnaire comprised the respondents' working experience. The survey results indicated that most respondents (51%) have 5 years or less of experience in the construction industry, followed by 36% with 6-10 years of experience, and 13% with 11-20 years of experience. This information is significant because it provides insight into the level of experience of the survey respondents, which can assist in elucidating their perspectives and opinions on various issues related to the construction industry.

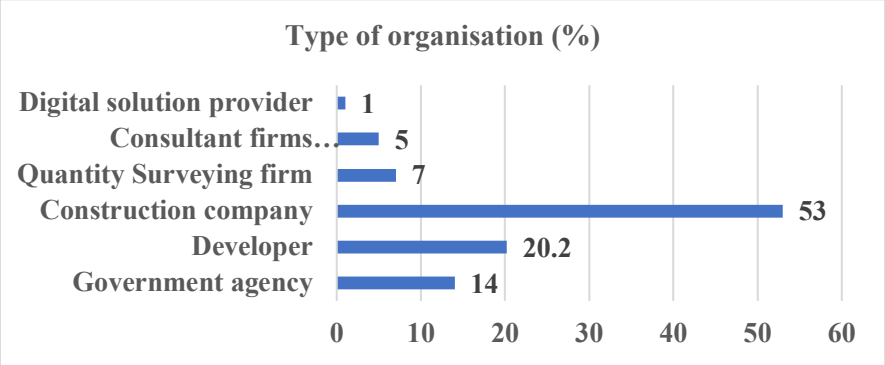

Figure 1. Current organisation business

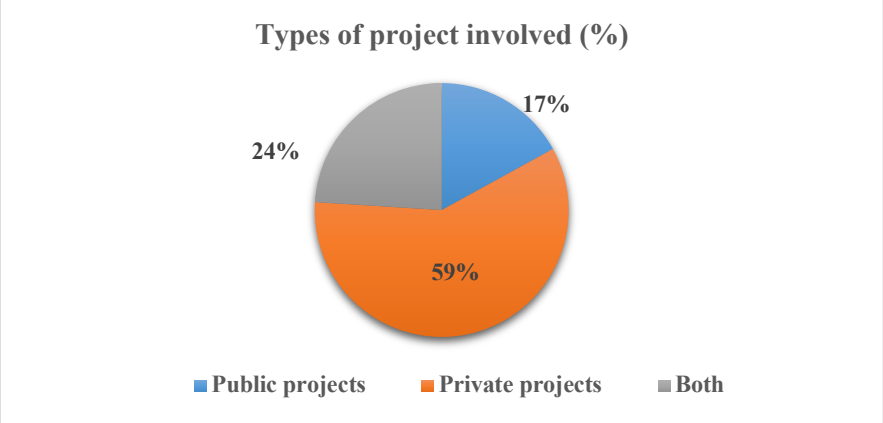

Figure 2. Types of projects involved

The second part of the questionnaire consists of respondents' current organisation business. As depicted in Figure 1, most respondents (53%) work in a contractor firm, followed by 20% working in a developer company, and 14% in a government agency. There were also respondents from quantity surveying firms (7%), consultant firms (5%), and 1% of respondents from a digital solution provider. This information sheds light on the types of organisations that employ professionals in the construction industry and can assist in understanding the distribution of expertise and knowledge within the industry. As shown in Figure 2, the results revealed that the respondents were involved in either public or private construction projects, or both. Most respondents (59%) reported involvement in private projects, while 17% were involved in public projects. A significant portion of respondents (24%) were involved in public and private projects. This information is relevant in using BIM for time and cost control in construction projects, as it provides insight into the types of projects where BIM can be applied. For instance, BIM can be beneficial in private projects where time and cost control are critical to project success, and in public projects where accountability and transparency are essential.

4.2 Application of BIM Technology to Improve Cost and Time Control in Construction Projects

According to the results presented in Table 2, BIM technology is commonly used for quantity take-off (19.5%) and cost estimates (19%). BIM technology is also utilised for project scheduling (14.4%), database management (11.5%), and maintenance management (3.4%) in construction projects. Notably, a significant proportion of respondents (32.2%) have never used any BIM software in construction projects. The study's findings indicate that BIM is perceived as a valuable tool for cost and time control, with particular benefits in design and construction phases.

Table 2. Purpose of using BIM technology in construction project.

Purpose of Using BIM	**Responses**	
	Frequency (No)	**Percentage (%)**
Project Scheduling	25	14.4%
Cost estimates	33	19.0%
Quantity Take-off	34	19.5%
Database management	20	11.5%
Maintenance management	6	3.4%
Never used any BIMsoftware	56	32.2%
Total	174	100.0%

Table 3. Phase of construction project that used BIM technology

Phases of construction project	**Responses**	
	Frequency (No)	**Percentage (%)**
Planning phase	31	21.4
Construction phase	18	12.4
Design phase	34	23.4
Maintenance phase	7	4.8
Never used any BIMsoftware	55	37.9
Total	145	100.0

In terms of the different phases of construction projects, most respondents reported using BIM technology in the design phase (23.4%) and planning phase (21.4%) as presented in Table 3. The relatively low percentage of respondents who reported using BIM technology in the construction (12.4%) and maintenance phases (4.8%) suggests that there is potential for greater adoption of BIM technology in these phases to enhance project performance and reduce costs

4.3 Application of BIM Technology at Different Project Phases

The utilisation of BIM technology to improve cost and time control in construction projects has been divided into three categories: design, construction, and maintenance. As shown in Table 4, in the design phase, the statement "BIM technology can assist in calculating the estimated cost and performance of the building" received the highest mean value of 4.32. Huang (2021) stated that BIM technology allows every department to participate in the design phase, conduct reasonable analysis, and offer suggestions for modifications, reducing the expenses in the construction phase. Therefore, the respondents chose this statement because BIM provides visualisation and simulation to the user, facilitating decision-making.

Table 4. Application of BIM technology at different project phases

Application of BIM technology	Ranking	Meanvalue	Standard deviation
Design phase			
BIM technology can help to make calculations of estimated cost and performance of buildings.	1	4.32	0.618
BIM technology can generate and stored detailed information of building elements, equipment and sequences of operation which is needed for the redesign process.	2	4.29	0.608
BIM technology is useful to evaluate the design against building codes and sustainability of the project.	3	4.25	0.592
BIM technology also can help to reduce waste material.	4	4.07	0.497
BIM technology can minimise time to redoand correct during the design phase.	5	4.04	0.737
Construction phase			
BIM technology can estimate the construction progress of every stage of construction	1	4.29	0.656
BIM technology can help to track work in real time during the construction	2	4.28	0.604
BIM technology can help to define critical point of view in advance for the critical work preparation.	3	4.21	0.656
BIM technology is useful for better tracking of cost control and cash flow of the large project.	4	4.19	0.631
BIM technology can save time to update the latest information on material.	5	3.86	0.829
Maintenance phase			
BIM technology can provide easy and quick access to important information for maintenance management.	1	4.30	0.644
BIM technology is useful to schedule maintenance and review the maintenance history.	2	4.28	0.668
BIM technology can show the information of the component for the maintenance scheduling and replacement part ordering information.	3	4.20	0.586
BIM technology can automatically update building information and directly show the part needed to repair.	4	4.17	0.652
BIM technology is used to track the operation of the facilities in the building.	5	3.85	0.730

In the construction phase, the statement with the highest mean value of 4.29 was "BIM technology can estimate the construction progress of every stage of construction." Wei and Mydin (2017) emphasised the usefulness of BIM in the construction phase, particularly 4D BIM, which links the construction plan to the 3D objects in a design, allowing the estimation of the construction progress of every stage. This information is vital in ensuring that the project is still within control and completed within the construction period.

During the maintenance phase, the highest mean value of 4.30 was recorded for the statement "BIM technology can provide easy and quick access to important information for maintenance management." According to Guzman and Ulloa (2020), maintenance managers can analyse and make informed decisions based on the data from the BIM model.

Overall, BIM technology has proven useful in improving cost and time control in construction projects, particularly in the design, construction, and maintenance phases, through its ability to estimate costs, performance, construction progress, and maintenance management.

4.4 The challenges in the application of BIM technology in cost and time management

Implementing BIM technology in the construction industry is facing various challenges that can be grouped into people, technology, and process-related challenges, as shown in Table 5.

Table 5. The challenges to implementing the BIM technology in construction projects

Challenges to implementing BIM technology in construction projects	Ranking	Meanvalue	Standard deviation
In terms of People			
Lack of BIM training for the staff.	1	4.38	0.693
Lack of support from the employer and senior staff to the new staff about the new technology used in the project.	2	4.14	0.792
The unwillingness of the employer and employee of the company to adopt BIM technology	3	4.14	0.697
Lack of exposure to the importance and benefits of BIM technology	4	4.08	0.813
Lack of skill and expertise in BIM technology in the company	5	3.99	0.785
People are afraid to take risks to adapt to technological changes in the construction process.	6	3.98	0.752
The top management of the company does not accept the new technology.	7	3.97	0.731
In terms of technology			
It also required additional costs for training and wages of specialists for the application of the BIM technology.	1	4.38	0.678
High cost of BIM experts due to the lack of experts in the BIM field.	2	4.35	0.716
BIM technology costs are high and require huge funds to buy software and hardware.	3	4.32	0.634
Ineffective collaboration and workflow because of the limited interoperability between relevant BIM software.	4	4.27	0.694
BIM technology is also not user-friendly because it is difficult and complex.	5	4.10	0.835
Unwillingness to purchase software and upgrade existing hardware.	6	3.94	0.827
In terms of process			
Lack of BIM standards, guidelines and protocols	1	4.13	0.706
The reluctance of changes among the project team stakeholders to use BIM technology.	2	4.12	0.756
Lack of active participation from consultants in a project team.	3	3.79	0.743

The major challenges identified in this study, including the high cost of BIM software, lack of skilled professionals, and absence of standardized guidelines, are consistent with recent literature. Mohamed (2024) emphasized that overcoming these challenges requires substantial investment in training and capacity building, along with stronger industry collaboration to develop standardized BIM protocols (Mohamed, 2024). The people-related challenge that received the highest rank was the lack of BIM training for staff (4.38), which indicates that the staff lack the necessary skills and knowledge required for the application of BIM technology (Zainon et al., 2018). The lack of training is attributed to the reluctance of top management to embrace new tools and explore new things.

Regarding technology, the highest-ranked challenge (4.38) was the cost associated with implementing BIM technology, which includes the cost of software, hardware, training, and wages of specialists (Hatem et al., 2018). This challenge is attributed to the high initial investment required to implement BIM technology. Respondents selected this statement because the implementation of BIM technology is already costly, and

additional costs for its application. The process-related challenge with the highest mean value (4.13) was the lack of BIM standards, guidelines, and protocols necessary for improved communication and collaboration across disciplines in achieving a fully integrated BIM model. The absence of mutual protocol and standard guidelines makes it difficult for the team in the construction project to use BIM technology as a medium of communication.

The survey results reflect that most of the respondents are new to the construction industry, with mostly five years or less experience. This finding is evident from their lack of exposure to BIM technology, as most respondents have never used BIM software. The findings also confirm that respondents who prioritise easy and quick access to information, the estimation of cost, and the progress of the construction stage were concerned about the application of BIM technology for cost and time control in construction projects.

Finally, the challenges to adopting BIM technology in the construction industry can be attributed to people, technology, and process-related factors. The lack of BIM training, the high initial investment required for its implementation, and the absence of BIM standards, guidelines, and protocols are major challenges that hinder the successful adoption of BIM technology. To overcome these challenges, there is a need for top management to embrace new tools and technologies, and to establish mutual protocols and standard guidelines and framework to ensure effective communication and collaboration among the team members involved in the construction project.

4.5 Practical Implications and Future Research

This study contributes both theoretically and practically to the understanding of BIM adoption in Malaysia's construction industry. Theoretically, it adds to the growing body of knowledge on digital transformation in developing economies by examining the relationship between BIM tools and project performance. Practically, the findings underscore the urgent need for targeted BIM training programs for Quantity Surveyors (QSs), the integration of BIM into cost planning curricula, and enhanced government support, particularly for small and medium-sized enterprises (SMEs).

The recent government mandate for BIM adoption marks a significant step forward. However, successful implementation will require sustained efforts, including continuous professional training, standardized guidelines, and improved collaboration among stakeholders. These findings offer valuable insights for policymakers and construction professionals aiming to enhance project efficiency, cost-effectiveness, and industry competitiveness through digitalisation.

This study is not without limitations. It primarily focuses on respondents from the Klang Valley region, which may restrict the generalisability of the findings to other parts of Malaysia. The response rate was relatively low (25%), which raises the possibility of non-response bias. This limitation may affect the generalizability of the findings, as those familiar with BIM may have been more inclined to respond. Future studies should explore ways to improve engagement, possibly through interviews or mixed-method approaches. The relatively small number of experienced BIM users among respondents may also limit the depth of insight into advanced BIM applications. Therefore, future research should explore in-depth qualitative case studies to better understand how specific organisations overcome BIM-related obstacles and realise its full potential.

5.0 CONCLUSION

In conclusion, this research explored the application of BIM technology to improve cost and time control in the construction industry. The findings from the survey indicated that although BIM technology is useful for the estimation of the cost and performance of buildings, estimation of construction progress, and providing easy and quick access to important information for maintenance management, the level of awareness for the application of BIM technology to improve cost and time control in construction projects is still low. The challenges identified in this study include the lack of BIM training for staff, additional costs for training and wages of specialists, and the absence of BIM standards, guidelines, and protocols. These findings provide valuable insights for construction players to improve their working expertise in applying BIM technology to improve cost and time control in construction projects. This study contributes original insights by quantifying BIM application by project phase and ranking challenges across people, technology, and process dimensions. Further research can explore the effectiveness of training programs for staff in enhancing their skills and knowledge on applying BIM technology in the construction industry.

6.0 ACKNOWLEDGEMENT

We would like to express our gratitude to Pembiayaan Yuran Pembiayaan Artikel (PYPA), Tabung Dana Kecemerlangan Pendidikan (DKP), Universiti Teknologi MARA (UiTM), Malaysia for funding the publication fees of this article.

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