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Challenges in Integrating Building Information Modelling into Safety Management Practices among G7 Contractors

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ABSTRACT

The construction industry faces major safety challenges despite the prevailing technological advancement. Building Information Modelling (BIM) is a commonly known tool that can be applied to enhance performance of the construction projects. Nevertheless, it is still not fully integrated into the safety management practices due to numerous implementation barriers. The purpose of this study is to identify and examine the major issues that affect the implementation of BIM in safety management within the Malaysian construction industry. A quantitative research approach was adopted using a structured questionnaire distributed to G7 contractors in Selangor. A total of 346 questionnaires were distributed, and 70 valid responses were collected, representing a response rate of 20.2%. Data were analysed using descriptive statistical analysis through the Statistical Package for Social Sciences (SPSS). The findings reveal that the main challenge is the lack of knowledge in BIM technology, followed by lack of government support, lack of practical training, high initial cost and investment, low data quality and inconsistency, and integration difficulties. Although respondents demonstrated high awareness and usage of BIM, the application of BIM in safety-related tasks remains limited due to insufficient technical competency and institutional support. The findings further indicate that human capability and policy-related issues have a greater influence on BIM adoption than financial constraints, particularly among large contractors. This study provides deeper insight into the barriers preventing BIM-based safety management implementation and offers useful references for policymakers, industry practitioners, and researchers in improving construction safety management practices.

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INTRODUCTION

Building Information Modelling (BIM) is a computer-aided software tool for 3D modelling developed in the 2000s (Al-Ashmori et al., 2020). It is a major change in the digitalisation of the Architecture, Engineering and Construction (AEC) industry, as it shifts old practices towards more integrated, technology-oriented processes. BIM is no longer merely a modelling tool; it functions as a digital information management system that supports coordination throughout the project lifecycle. It is a technological advancement that can assist parties in the construction industry. The implementation of BIM improves project visualisation, coordination, communication, and decision-making among stakeholders involved in construction projects (Othman et al., 2020). Through its collaborative environment, BIM enables clients, engineers, architects, and contractors to access updated project information in real time, reducing design conflicts and minimising rework.

Despite advances in construction technologies, safety performance on construction sites remains a major concern globally. The construction industry is well known as one of the most dangerous industries due to the nature of its activities, changes in the site environment, and the presence of numerous stakeholders. Zhang et al. (2024) estimate that 60,000 accidents occur on-site per year. These incidents not only cause injuries and fatalities but also result in financial losses, project delays, and reputational damage to construction firms. Therefore, innovation in safety management is necessary to reduce such incidents.

In Malaysia, construction safety issues remain alarming due to inadequate implementation of safety protocols and ineffective supervision practices (Harahap et al., 2024). Common accidents such as falls from heights, slips, trips, and machinery-related incidents are frequently reported on construction sites. According to Krishnasamy et al. (2025), the presence of a large number of low-skilled workers further increases safety risks due to limited safety awareness and insufficient training. Traditional safety management methods primarily rely on paper-based reports, 2D drawings, and verbal communication among project stakeholders (Marlizan, 2024). These conventional approaches are often ineffective at visualising potential hazards and proactively identifying safety risks.

To overcome these limitations, BIM has increasingly been recognised as a proactive tool that can improve construction safety management practices. BIM allows stakeholders to conduct hazard identification, safety simulations, clash detection, and risk assessment during the planning stage before physical construction begins. Through 3D visualisation and simulation capabilities, BIM can improve site safety planning and reduce accident risks by enabling early identification of hazardous situations (Afzal et al., 2021). Furthermore, BIM enhances communication and coordination among project participants through a centralised digital platform.

However, despite the growing awareness of BIM in the construction industry, efforts to integrate BIM into safety management practices remain limited due to several implementation barriers. Previous studies identified major obstacles to BIM adoption, including a lack of BIM knowledge and skills, insufficient practical training, limited government support, high implementation costs, integration difficulties, and low data quality (Tajuddin et al., 2025; Waqar et al., 2023). Accordingly, this study aims to identify and examine the major challenges affecting the integration of BIM into safety management practices among G7 contractors in Selangor. The findings of this study are expected to contribute to improving BIM implementation strategies and enhancing safety management practices within the Malaysian construction industry.

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BUILDING INFORMATION MODELLING (BIM)

BIM is defined as a process of creating and managing digital representations of buildings or infrastructure throughout the project lifecycle (Khattra & Jain, 2024). Unlike traditional construction methods, which rely heavily on two-dimensional drawings and manual coordination, BIM integrates graphical and non-graphical information into a centralised digital environment. This enables stakeholders to visualise construction activities more effectively and identify potential safety hazards before construction begins. Rodrigues et al. (2022) stated that BIM produces coordinated, consistent information that improves project visualisation and simulation. In the context of safety management, these capabilities allow project stakeholders to detect design clashes, unsafe work sequences, and hazardous site conditions at an early stage. Through BIM-based visualisation and simulation, construction teams can proactively plan for safety and reduce the likelihood of accidents during site operations.

In addition, BIM functions as a collaborative platform that improves communication and coordination among project stakeholders, including clients, architects, engineers, contractors, and project managers. Through a centralised database, all parties can access updated project and safety-related information in real time. This functionality enhances the effectiveness of safety briefings, hazard inspections, and safety coordination meetings by ensuring stakeholders receive consistent, accurate information on potential risks and site conditions. Real-time updates also allow safety officers and project teams to respond quickly to design modifications or emerging hazards during construction activities. Furthermore, BIM improves decision-making processes related to construction safety by enabling stakeholders to evaluate alternative construction methods, identify high-risk activities, and implement preventive safety measures before physical work begins (Mi & Li, 2024). Therefore, BIM supports a more proactive, systematic approach to safety management in the construction industry.

The Role of BIM in Safety Management

Building Information Modelling (BIM) is used during proactive safety planning in construction to transform safety management from a reactive to a proactive approach (Marlizan, 2024). BIM is a more effective method than the traditional paper-based methods and 2D drawings. This is because BIM allow stakeholders to detect and reduce the risks in the pre-construction stages. The construction industry is a highly risky sector. Traditional safety management methods only rely on manual inspections and post-incident investigations. This method is only responsive to hazards after they have occurred. Pereira et al. (2025) highlight that this reactive approach only contributes to increased occupational incidents, project delays, and additional expenses.

In contrast, BIM integrates safety considerations into design and planning, allowing early hazard mitigation before construction begins (Farghaly et al., 2021). A BIM tool like Navisworks enables advanced visualisation and clash analysis. Also, it can be used to identify space collisions and spatial conflicts that are challenging to depict in 2D drawings. According to Rodrigues et al. (2022), BIM-based visualisation improves the identification of design conflicts and unsafe working conditions during the planning stage.

Early identification of overlapping systems, restricted working spaces, and potential design clashes enables project teams to implement preventive safety measures before construction begins. This proactive approach reduces accident risks, minimises costly rework, and improves overall construction safety performance (Farghaly et al., 2021). In addition, BIM visualisation enables stakeholders to inspect temporary structures, such as scaffolding, formwork, and safety barriers, in a virtual environment, thereby improving planning accuracy and compliance with safety regulations. Furthermore, BIM tools support safety coordination and risk management throughout the project lifecycle by enabling project stakeholders

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to monitor site conditions, communicate safety information, and respond more effectively to potential hazards.

BIM models can simulate the actual site layout into a digital model. This simulation includes access routes to the site, equipment locations, material storage facilities, and temporary facilities. This feature allows clear visualisation of potential risks. Stakeholders can predict congestion, unsafe access paths, and risky work zones in advance through detailed modelling. Thus, stakeholders will be able to identify the required measures to prevent the risk from occurring. In this way, it is possible to turn safety management into proactive rather than reactive activities, enabling project stakeholders to manage potential risks effectively. Time-based analysis is also supported by the ability to simulate construction sequences (4D BIM), which identifies risks arising from overlapping activities and significantly improves overall site safety performance (Ismail et al., 2022; Tajuddin et al., 2025). Integrating BIM into safety management helps construction teams better prepare to address uncertainties and minimise accidents before actual site operations.

BIM improves safety by enabling collaboration and communication, as it can serve as a central information platform for exchanging project data among stakeholders throughout the design-to-completion process (Jarullah, 2020). This central database will ensure that all safety-related information is always up to date and accessible to all concerned parties. Its ability to create 3D models enables project stakeholders to simulate the project. This simulation enables the stakeholders to review construction processes, site logistics, and hazard zones together. This allows stakeholders to have a firsthand experience, real-time feedback, and improved coordination between project teams. Real-time collaboration minimises the risk of misunderstandings and makes safety requirements easier to understand. Pereira et al. (2025) further stated that such a collaborative environment minimises miscommunication and promotes transparency, resulting in a safer working environment. Enhanced transparency will promote accountability among project participants and influence adherence to set safety standards.

In addition, BIM also offers advanced functionality, such as walk-throughs and clash detection. These interactive walk-throughs enable users to explore the virtual site and view potential safety risks from various viewpoints. This will allow stakeholders to detect hazards during both the design and construction phases. BIM improves understanding of safety measures and reduces reliance on traditional written plans by visualising them, such as an anchorage point for fall prevention. Safety elements are better understood visually, especially for workers who may not understand text-based instructions. The safety planning and communication process is also improved through real-time knowledge sharing and dynamically updated information. Any modifications to design or building processes can be updated instantly in the BIM model, keeping safety plans precise and up to date. In general, BIM will support a proactive risk management strategy by embracing safety in design, enabling stakeholder cooperation, and ensuring that precautions against hazards are taken before construction begins. Such a thorough integration will eventually build a strong safety culture, minimising the risk of accidents on construction sites.

Challenges In Integrating BIM into Safety Management

The main issues related to integrating Building Information Modelling into safety management practices are presented systematically in Table 1. A wide range of literature has been examined to determine the obstacles to implementation. These variables were selected because they are common in the scholarly literature and have been shown to influence the general introduction of BIM within the construction industry. A particular impediment to an effective implementation process is characterised by individually named challenges spanning a spectrum of issues, ranging from technical or organisational complexity on one end to financial constraints and regulatory gaps on the other. The following subsections will discuss

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these variables in more detail, further clarifying their roles and overall effects on the effectiveness of the BIM-based safety management practices.

Table 1. Challenges in Integrating BIM by Past Researchers

No.	Challenges	Citations
1	Interoperability and System Compatibility	Jarullah (2020), Emuze et al. (2023), Waqar et al. (2023), Manzoor et al. (2025), Tajuddin et al. (2025)
2	Lack of Knowledge and Skills	Taat et al. (2022), Piniano and Iwanami (2023), Waqar et al. (2024), Manzoor et al. (2025), Tajuddin et al. (2025)
3	Lack of Practical Training	Van Roy and Firdaus (2020), Taat et al. (2022), Piniano and Iwanami (2023), Waqar et al. (2024), Manzoor et al. (2025),
4	Lack of Government Support	Van Roy and Firdaus (2020), Taat et al. (2022), Piniano and Iwanami (2023), Waqar et al. (2024), Manzoor et al. (2025), Tajuddin et al. (2025),
5	High Initial Cost and Investment	Taat et al. (2022), Waqar et al. (2024), Manzoor et al. (2025), Tajuddin et al. (2025)
6	Low Data Quality and Inconsistency	Taat et al. (2022), Emuze et al. (2023), Waqar et al. (2024), Tajuddin et al. (2025)

Source: Authors (2026)

Interoperability and System Compatibility

Interoperability and system compatibility issues represent significant barriers to implementing BIM in safety management practices within the construction industry (Waqar et al., 2023). These challenges include difficulties integrating different BIM software platforms, maintaining real-time data updates, and ensuring accurate automated safety checks throughout construction projects. According to Emuze et al. (2023), the dynamic nature of construction sites makes real-time integration and automated safety checks difficult, particularly when unsafe conditions change rapidly. The nature of construction environments is dynamic, with changes in work development, site layout modifications, and unexpected situations, so it is difficult to keep digital models up to date. Additionally, safety regulations cannot be fully automated because their interpretation must be carried out manually and converted into machine-readable structures. Such a manual translation procedure increases the risk of misinterpretation and reduces the precision of automated rule-checking systems. The lack of detailed safety databases that include modelling data, best practices, and safety algorithms also undermines the utility of BIM (Manzoor et al., 2025). Safety analysis would lack consistency and reliability without organised and standardised data repositories. Moreover, interoperability between BIM systems, including Revit, Navisworks, Tekla, and ArchiCAD, leads to data inconsistency and impacts information exchange (Tajuddin et al., 2025). Variations in file formats, software features, and data structures create compatibility issues that not only impede seamless collaboration but also reduce the overall productivity of BIM-based safety management.

Lack of Knowledge of BIM Technology

Lack of knowledge of BIM technology among construction stakeholders limits its usefulness in safety management (Manzoor et al., 2025; Piniano & Iwanami, 2023; Taat et al., 2022; Tajuddin et al., 2025; Waqar et al., 2023). This problem affects stakeholders at multiple levels, including project managers, site supervisors, safety officers, and technical personnel directly involved in the project's execution. The majority of practitioners lack experience with advanced 3D modelling features and are unaware of BIM's advanced safety capabilities, such as hazard simulation and rule-based checks (Manzoor et al., 2025). Their knowledge is also limited to simple modelling and coordination, without fully exploiting its analytical and preventive potential. According to Piniano and Iwanami (2023), BIM technology is ineffective at detecting hazards, assessing risks, and planning safety due to insufficient knowledge. Lack of proper knowledge can cause the user to fail to set up models correctly or key in valuable safety information. This limits BIM's ability to support proactive safety management. As a result, safety management remains reactive, with hazards addressed only after they are detected on site. Lack of knowledge contributes to BIM being used primarily for visualisation rather than for proactive safety planning. The lack of technical expertise also hinders stakeholders' ability to extract safety-related information, leaving them still bound to traditional safety measures.

Lack of Practical Training

A lack of practical training is a major constraint on the effectiveness of BIM in safety management (Taat et al., 2022). Most training programs focus on theoretical aspects rather than practical training and leave users without the necessary knowledge to use BIM tools for safety-based planning and hazard identification in the real world (Manzoor et al., 2025). In addition, the absence of practical training increases the incidence of ineffective safety management (Krishnasamy et al., 2025). Traditionally, training was conducted like classroom learning, which lacked interactive, hands-on experience. Uz Zaman et al. (2024) highlighted that these elements are crucial in training programs to effectively train stakeholders to optimise the use of BIM, especially in complex environments that require high knowledge to integrate complex safety information. Without adequate training, project stakeholders may also fail to recognise the full potential of BIM to proactively identify and mitigate safety hazards (Alotaibi & Gambatese, 2025; Manzoor et al., 2025). Hence, they often utilise BIM merely as a 3D visualisation tool rather than a decision-support system. As a result, they may understand BIM concepts, but without sufficient training, stakeholders struggle to apply BIM for safety simulations, risk analysis, and proactive accident prevention (Alotaibi & Gambatese, 2025).

Lack of Government Support

The role of government in the industry is essential in influencing industry practices, especially in the adoption of technology and compliance with regulations. The absence of clear policies, regulations, and standardised BIM policies leads to inconsistent adoption in the construction industry (Tajuddin et al., 2025; Waqar et al., 2023). Construction firms can decide whether to implement BIM on the project. Thus, it results in inconsistent implementation due to unclear government policies and guidelines. The lack of a financial incentive and a low enforcement rate discourage small firms from investing in BIM technologies. There are no tax incentives, subsidies, or grant schemes either, which further discourages them from upgrading their digital infrastructure. BIM tends to be implemented in large construction firms, including G7 contractors and developers themselves, due to their greater financial capacity and technical skills (Ademci & Gündeş, 2021; Saka et al., 2022). Big organisations can better absorb the initial expenditure and offer in-house training on technical aspects. Therefore, as highlighted by Manzoor et al. (2025), smaller companies often face challenges in adopting BIM technologies.

High Initial Cost and Investment

Following this issue, the lack of government support worsens the financial burden of BIM implementation. Without any appeal to relevant incentives, subsidies, or policy-based assistance, construction companies must be held fully accountable for expenditure related to BIM adoption. The situation directly relates to the high initial cost barrier typically associated with implementing BIM in safety management. Adoption of BIM requires significant investment in software licensing, hardware acquisition, continuous system maintenance, and workforce training. This makes them especially expensive for small-and medium-sized construction companies, as they usually have limited resources (Manzoor et al., 2025). The high licensing fee and ongoing technological advancements are additional factors that discourage companies from fully adopting BIM in the short run, though it has longer-term positive impacts. Consequently, the introduction of BIM remains primarily confined to well-established companies. This creates a technological gap in the construction sector, limiting the extent of improvements in safety management practices.

Low Data Quality and Inconsistency

Low data quality and inconsistent data entry have a significant impact on the integration of BIM into safety management practices. The lack of standardised data structures across BIM systems results in incomplete, outdated, or incompatible safety information (Emuze et al., 2023; Taat et al., 2022; Tajuddin et al., 2025). Safety-related data may not be shared or updated appropriately across platforms when different stakeholders use various data formats and modelling standards. Data input and quality control are also extremely poor, further reducing the quality of BIM models and complicating their ability to reflect actual site conditions (Emuze et al., 2023). The incorrect models may also fail to indicate real hazards, temporary work, or modified site layouts. This is even more of a challenge in complex projects such as a high-rise development, where multiple stakeholders and interconnected systems further complicate the risk of miscommunication. The ability of BIM to identify hazards and make decisions is weakened by inaccurate and incomplete safety data, thereby reducing its effectiveness as a safety management system (Emuze et al., 2023). As a result, the full potential of BIM in enhancing the construction process's performance in terms of safety cannot be realised without sound, standardised data management practices.

RESEARCH METHODOLOGY

Research Scope

Selangor consistently records the highest value of construction projects in Malaysia. Hence, this study focuses on Selangor, given its rapid development in the construction sector compared to other states in Malaysia. It provides more relevant context required in this study. Furthermore, research indicates that firms in Selangor are actively seeking BIM training to modernise practices and address critical inefficiencies in productivity and cost management (Ang et al., 2022; Chai et al., 2026). In addition, according to DOSH, Selangor recorded the highest number of occupational injuries, including non-permanent disabilities, permanent disabilities, and fatalities (Rani et al., 2025). Major safety issues in the construction industry include falls from height, machinery-related accidents, and structural failures (Ayob et al., 2018; Rani et al., 2025). Integrating BIM into safety management can help address these challenges by enabling early hazard identification, 3D visualisation, clash detection, and 4D safety planning (Farghaly et al., 2021; Manzoor et al., 2025; Rodrigues et al., 2022). These capabilities enable stakeholders to identify potential risks during the design stage, improve safety coordination, and implement preventive safety measures before construction activities begin. Furthermore, BIM enhances communication and collaboration among project stakeholders by enabling centralised, real-time information sharing, thereby contributing to more effective safety management practices throughout the project (Manzoor et al., 2025). This makes it particularly important to conduct the study in Selangor to understand the challenges of integrating BIM into safety management in a state with the most construction activities and the highest safety risks.

Additionally, the respondents are from G7 Contractors due to their large financial capacity and the administrative structures required to invest in expensive BIM software, hardware, and specialised training

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(Lan & Aziz, 2022; Rogers et al., 2015). This is to ensure a high adoption rate of BIM technology, as they are most likely to have the necessary and sufficient resources to invest in it. Clients and government bodies (such as JKR) increasingly mandate BIM for large-scale projects, which are exclusively handled by G7 firms (Zahrizan, 2013). They are often used as a benchmark because they are more likely to have already integrated Industrial Revolution 4.0 (IR 4.0) technologies into their safety and project management workflows (Isa & Abidin, 2021; Kasim et al., 2025). Hence, this approach ensures that the collected data is precise, accurate, and aligned with the research objectives.

Sampling and Population

This study adopted a quantitative research methodology to identify the challenges associated with integrating BIM into safety management practices. Although many studies have discussed BIM adoption in general, limited research specifically examines the challenges of integrating BIM into safety management practices in the Malaysian construction industry, particularly among G7 contractors in Selangor. G7 contractors were selected for this study because they represent large-scale contractors with greater financial capability, greater exposure to digital technologies, and more complex construction projects than smaller contractors. These firms are more likely to implement BIM technologies and are often considered industry benchmarks for construction best practices. Therefore, investigating BIM integration challenges among G7 contractors provides a more relevant understanding of current industry practices and implementation barriers.

The targeted respondents in this study are G7 Contractors in the building categories in the state of Selangor, totalling 3500 firms, as verified through the official contractor registry (Construction Industry Development Board Malaysia, 2025). The "Krejcie and Morgan Table" simplifies the process of sample size calculation, providing a standard reference that researchers use to ensure their sample is statistically representative (Memon et al., 2020; Palpanadan et al., 2021). Therefore, according to Krejcie & Morgan table, the appropriate sample size is 346 contractor firms. Statistical Package for the Social Sciences (SPSS) software is used to perform data analysis accurately and efficiently.

FINDINGS AND DISCUSSION

A total of 346 questionnaires were distributed to the target respondents, and 70 were returned, yielding a response rate of 20.2%. Although the response rate of 20.2% (70 valid responses) may appear low, it is consistent with established norms in Malaysian construction research, where rates between 20% and 30% are typical (Minhas & Potdar, 2020; Takim, 2009). Research specifically targeting G7 firms in the Selangor and Kuala Lumpur regions has previously reported an acceptable response rate of 20.9%, noting that such figures are common when surveying specialised professional groups (Takim, 2009; Takim & Adnan, 2009). Although the sample size is 70, the data's credibility is reinforced by the 'expert' profile of the participants. The respondents—including Site Engineers (27.1%), Safety Officers (20.0%), and Project Managers (12.9%)—represent the key decision-makers and technical leaders responsible for site operations.

Section A: Demographic Information

Table 2 shows the demographic information on this research. The results show that all respondents were representatives of G7 contractors (100%), reflecting the opinions mainly of large, well-resourced organisations. That is why the familiarity with BIM (88.6%), implementation (85.7%), and current usage (82.9%) remain very high, as these companies typically manage complex projects and have sufficient financial and technical resources to adopt BIM technologies. The majority of respondents were directly

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involved in site operations and comprised site engineers, safety officers, project supervisors, and project managers, totalling 77.1%. This enhances the practical application of the findings, as the responses were based on actual construction-site experiences rather than theoretical views. Their interventions in daily site operations also reinforce the heavy focus on BIM's role in hazard identification and proactive safety planning.

Table 2. Summary of Demographic Information

Category		**Frequency**	**Percentage (%)**
CIDB Company Registration	G7	70	100%
Position in Company	Site Engineer	19	27.1%
	Safety Officer	14	20.0%
	Project Supervisor	12	17.1%
	Project Manager	9	12.9%
	BIM Coordinator	4	5.7%
	Quantity Surveyor	4	5.7%
	Project Executive	2	2.9%
	Others	6	8.6%
Working Experience	Less than 5 years	27	38.6%
	5 – 10 years	19	27.1%
	11 – 20 years	16	22.9%
	More than 20 years	8	11.4%
Familiarity with BIM	Yes	62	88.6%
	No	5	7.1%
	Maybe	3	4.3%
Implemented BIM into Previous Projects	Yes	60	85.7%
	No	7	10.0%
	Maybe	3	4.3%
Implementing BIM in Current Projects	Yes	58	82.9%
	No	12	17.1%

Source: Authors (2024)

In terms of experience, most respondents have less than 10 years of industry experience (65.7%), indicating a workforce that is generally more flexible with digital technologies and innovation. In the meantime, more experienced respondents provided some useful practical suggestions. Still, they might be more oriented toward traditional practices and slower to adopt BIM without appropriate training and organisational support. The mix of experience levels provides a balanced view of the challenges in implementing BIM.

Section B: Challenges in Integrating BIM into Safety Management

Table 3 presents a discussion of the challenges in BIM integration for safety management. Although respondents' familiarity with BIM was high (88.6%) and BIM was implemented in both previous and current projects, knowledge deficiency in BIM technology (mean score: 4.49, SD: 0.654) was identified as the biggest challenge in using BIM to manage safety. Specifically, the 'knowledge deficiency' refers to a lack of proficiency in sophisticated functions such as rule-based safety checking, 4D safety scheduling, and automated hazard simulation (Tajuddin et al., 2025; Yap et al., 2022). This gap exists because current professional development often focuses on general BIM awareness rather than specialised safety-related applications (Kasim et al., 2025; Zahrizan, 2013).

The absence of practical training (Mean Score: 4.44, SD: 0.675) is directly linked to this problem and further limits successful BIM implementation, as current training programmes are largely theoretical rather than practical. Thus, the high familiarity reflects an organisational readiness to adopt the technology, while the identified deficiency underscores a workforce-level gap in digital safety expertise (Ismail et al., 2022; Jamal et al., 2019).

Table 3. Summary of Challenges in Integrating BIM into Safety Management

Rank	Challenges	Mean	Std Deviation	Classification Level
1	Lack of knowledge of BIM Technology	4.49	0.654	Agree
2	Lack of Government Support	4.47	0.675	Agree
3	Lack of Practical Training	4.44	0.651	Agree
4	High Initial Cost and Investment	4.40	0.769	Agree
5	Low Data Quality and Inconsistency	4.37	0.783	Agree
6	Interoperability and System Compatibility	4.20	0.926	Agree

Source: Authors (2025)

Lack of government support (mean score: 4.47; SD: 0.675) was identified as the second most critical challenge. This reflects a lack of policies, standardised guidelines and incentives to promote the wide use of BIM in the construction industry. Lack of regulatory support contributes to inconsistent implementation across the industry and limits the effectiveness of BIM as a safety management tool. Other challenges, such as high initial costs, low data quality, and integration difficulties, were rated slightly lower but remain relevant. Such problems have a specific impact on data reliability, system interoperability, and trust in BIM output. The impact of financial constraints is relatively lower. This shows that, from a large contractor's perspective, cost is less critical than technical competency, data management, and institutional support. Overall, the results indicate that the main factors that limit BIM's full potential to improve construction safety management are human capability, policy support, and data integrity.

CONCLUSION

This study examined the challenges of adopting Building Information Modelling (BIM) for safety management among G7 contractors in Selangor. While awareness and basic use of BIM are relatively high, its application as a comprehensive safety management tool remains limited. The findings reveal that the primary barriers are not technological but human and institutional—particularly a lack of knowledge, limited practical skills, and insufficient government support. Although financial and technical issues such as high initial costs, data quality, and system integration persist, they are secondary to competency-related challenges. BIM is still largely perceived as a visualisation tool rather than a proactive safety management platform, restricting the use of advanced features such as hazard simulation and risk analysis.

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This study contributes to the existing literature by highlighting the critical role of human capacity, structured training, and regulatory frameworks in enabling effective BIM implementation. It suggests that improving technical infrastructure alone is insufficient; a holistic approach integrating competency development, policy support, and data governance is essential. These insights provide a basis for policymakers and industry practitioners to develop more effective strategies for enhancing BIM adoption in construction safety management.

FUTURE RESEARCH RECOMMENDATION

Future research is recommended to explore BIM integration from a broader industry perspective, including small- and medium-sized contractors, consultants, and regulatory agencies. Longitudinal studies might also be conducted to investigate the long-term effects of adopting BIM on safety performance at various stages of the construction project. Additionally, future studies may focus on developing and validating BIM-based safety frameworks, integrating emerging technologies such as artificial intelligence and digital twins, and assessing the effectiveness of structured BIM training programmes. Expanding the scope of research to include comparative studies across regions or countries would further enhance understanding of BIM adoption dynamics and contribute to the development of globally applicable safety management strategies.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Nur Zulaika Mohd Fauzi conceptualised the research idea, designed the methodology, conducted the investigation, collected and analysed the data. Dr Wan Faida Wan Mohd Azmi supervised the manuscript development, reviewed and refined the content, and approved the final submission as the corresponding author. Sr Dr Wan Norizan Wan Ismail and Assoc Prof Sr Dr Mohd Saidin Misnan contribute to the critical review, commentary and refinement of the manuscript based on their expertise respectively. Mothilal Muniandy contributed as an industry expert by providing professional insights related to the current BIM implementation practices in the construction industry.

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