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Legal and Regulatory Challenges of BIM in Malaysian Construction Law

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Abstract

Building Information Modelling (BIM) is increasingly recognized as a transformative technology in the global construction industry, enabling enhanced project visualization, improved collaboration, and greater accuracy in design and execution. However, the adoption of BIM in Malaysia's construction sector is accompanied by a complex array of legal and regulatory challenges. This study critically examines these challenges, focusing on key areas such as intellectual property rights, data ownership, contract management, and the integration of BIM within existing legal frameworks and construction regulations in Malaysia. The research delves into the implications of BIM on contract formation, dispute resolution, and liability issues, considering the traditional legal structures that may not fully accommodate BIM's collaborative and data-intensive nature. Additionally, the study explores the regulatory environment, assessing how current laws and regulations align with or hinder the adoption of BIM. Through a combination of legal analysis and case studies, this research identifies gaps and proposes recommendations for legal reforms and regulatory adjustments necessary to support the widespread implementation of BIM in Malaysia. The findings provide valuable insights for policymakers, legal practitioners, and construction professionals, guiding them towards a more robust legal framework that facilitates the effective and legally sound integration of BIM into the Malaysian construction industry.

Keywords: *Building Information Modelling, Legal, Challenges, Contract Management, Sustainable Building.*

Introduction

Building Information Modelling (BIM) has emerged as a transformative technology in the construction industry, offering numerous benefits such as improved collaboration, design accuracy, and project efficiency. Integrating Building Information Modelling (BIM) into Malaysia's construction industry has enhanced project management, design, and collaboration. However, it also presents significant legal and contractual challenges. One major issue is the absence of a clear contractual framework that defines the legal obligations of designers in a BIM environment. Lee et al. [1] emphasize the need for re-evaluating existing contracts to clarify roles, responsibilities, and liabilities to minimize disputes. Traditional contracts are often inadequate for addressing BIM complexities, especially regarding data ownership, model management, and the responsibilities of each project participant, Jamil and Syazli Fathi [2]. Khawaja and Mustapha [3] highlight that increased BIM use can lead to disputes over intellectual property rights (IPR) and data management, suggesting the development of guidelines on data sharing and dispute resolution mechanisms. The Malaysian legal landscape surrounding BIM is further complicated by the absence of specific legislation to govern BIM practices. Teoh et al. [4] call

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for more detailed legal guidelines and contract requirements to align with BIM technology. Intellectual property issues also arise, particularly over the ownership and usage rights of BIM models, as discussed by Baharom et al. [5]. Their study stresses the need for clear contracts to protect intellectual property. To address these challenges, the study aims to analyze the current legal framework, identify gaps, and propose reforms to support BIM adoption in Malaysia's construction industry.

The adoption of Building Information Modelling (BIM) in the Malaysian construction industry promises to improve collaboration, accuracy, and efficiency, but faces significant legal, contractual, and operational challenges. Disputes in construction are common, often arising from unclear contracts, poor communication, and differing project interpretations [6, 7]. In BIM projects, these issues can be exacerbated by the collaborative nature of the technology, where multiple stakeholders contribute to and rely on a shared digital model. Yates [8] highlights that conflicts often stem from inadequate conflict management practices and the lack of clear legal frameworks tailored to new technologies like BIM, which can lead to costly legal disputes. In Malaysia, time and cost overruns remain a persistent issue in construction projects [9, 10], and BIM could exacerbate these challenges without appropriate legal safeguards. The lack of tailored contracts for BIM projects can create ambiguities in roles, responsibilities, and liabilities, leading to project delays and increased costs. Furthermore, predictive models for managing BIM-related disputes, like boosted decision trees, are underdeveloped in Malaysia, making it difficult to forecast dispute outcomes and devise effective resolution strategies [11, 12].

Given these challenges, this research aims to address the legal and regulatory issues surrounding BIM adoption in Malaysia. The study will examine the factors contributing to disputes in BIM projects, evaluate existing contractual frameworks, and propose solutions to mitigate legal risks, ultimately contributing to the development of a more robust legal framework for BIM integration in the Malaysian construction sector.

Literature Review

Overview of Building Information Modelling

Definition and Evolution of BIM

Building Information Modelling (BIM) is defined as a process that involves the generation and management of digital representations of the physical and functional characteristics of a facility. These digital representations, often referred to as BIM models, serve as a shared knowledge resource for information about a facility, forming a reliable basis for decision-making throughout its lifecycle from the earliest conceptual stages, through design and construction, to operation and maintenance [13, 14]. The concept of BIM has evolved over several decades. Initially, computer-aided design (CAD) tools were used to create two-dimensional (2D) drawings, which were then enhanced by three-dimensional (3D) modeling capabilities. However, the limitations of CAD in terms of data integration and collaboration prompted the development of more advanced tools. BIM goes beyond 3D modeling by integrating additional dimensions time (4D), cost (5D), and more into the design and construction processes. This evolution has transformed BIM from a mere design tool into a comprehensive process that supports collaboration and coordination among all stakeholders involved in a construction project [15, 16].

Table 1: Comparison of Traditional Contractual Framework vs. BIM-Integrated Contractual Framework

Aspect	Traditional Contractual Frameworks	BIM-Integrated Contractual Frameworks
Project Workflow	Linear, with distinct phases and handoffs, Eastman [13]	Integrated, with simultaneous collaboration across phases, Lee et al. [1]
Responsibility and Liability	Clearly defined for each party, often isolated, Jamil and Syazli Fathi [2]	Shared responsibilities, the potential for overlapping liabilities, Baharom et al. [5]
Contractual Documents	Separate documents for design, construction, and management, Teoh et al. [4]	Centralized BIM model as a core contract document, Teoh et al. [4]

Dispute Resolution	Primarily litigation or arbitration, Cheung and Yiu [6]	Increased use of ADR methods and BIM-specific mechanisms, Khawaja and Mustapha [3]
Risk Allocation	Defined per party's role and contract, Jamil and Syazli Fathi [2]	More complex, requiring specific provisions for BIM-related risks, Teoh et al. [4]
IPR Management	Simple, with clear ownership of specific documents, Baharom et al. [5]	Complex due to the collaborative creation of the BIM model, Baharom et al. [5]

Key Features of BIM

BIM's key features distinguish it from traditional design and construction methods. These features include:

3D Modelling*:*

At its core, BIM is based on 3D modeling, which allows for a detailed and accurate digital representation of a building's physical and functional characteristics. Unlike traditional 2D drawings, BIM's 3D models provide a more intuitive and comprehensive view of the design, enabling stakeholders to visualize the project more effectively.

Information Integration

BIM models are not just visual representations; they are rich in data. Every element in a BIM model is embedded with detailed information, such as dimensions, materials, performance data, and relationships to other elements. This integration of data enables better decision-making, as all relevant information is accessible in one place.

Collaboration and Coordination

One of the most significant advantages of BIM is its ability to facilitate collaboration among the various stakeholders in a construction project. BIM enables architects, engineers, contractors, and clients to work together on a single, shared model, reducing the potential for misunderstandings and errors that can occur when using separate, non-integrated systems [17].

Clash Detection and Conflict Resolution

BIM includes tools for clash detection, which allow project teams to identify and resolve conflicts between different design elements before construction begins. For example, BIM can automatically detect when a structural element conflicts with a mechanical system, enabling the team to address the issue during the design phase rather than during construction, where it would be more costly to fix.

Lifecycle Management

BIM supports the entire lifecycle of a building, from design and construction to operation and maintenance. The model can be updated and used for facilities management, helping to optimize the building's performance throughout its lifespan. This lifecycle approach is a significant departure from traditional methods, where information is often lost or becomes inaccessible after the construction phase.

4D and 5D BIM

Beyond 3D modelling, BIM can incorporate the fourth dimension (time) and the fifth dimension (cost) into the model. 4D BIM enables the simulation of construction schedules, allowing project managers to visualize how the project will progress over time. 5D BIM integrates cost data, helping to monitor and control budgets more effectively by linking costs directly to the model components.

Benefits of BIM

BIM offers numerous benefits that have been widely documented in the literature. These benefits include:

Enhanced Collaboration and Communication

BIM's collaborative nature ensures that all stakeholders have access to the most up-to-date information, reducing the likelihood of errors and miscommunication. This shared platform fosters better teamwork and more coordinated efforts across different disciplines.

Improved Design Quality

The ability to visualize the project in 3D and simulate different scenarios allows for more informed design decisions. BIM helps identify potential design flaws early in the process, leading to higher quality outcomes and fewer changes during construction [15].

Cost and Time Savings

By improving accuracy in design and facilitating better coordination, BIM can lead to significant cost and time savings. The integration of 4D and 5D BIM further enhances the ability to manage schedules and budgets effectively, reducing the risk of overruns.

Risk Mitigation

BIM's clash detection capabilities and data integration help identify and address potential risks early in the project lifecycle. This proactive approach to risk management can prevent costly rework and delays, contributing to more successful project outcomes [17, 18].

Sustainability

BIM can also support sustainable design practices by providing tools for energy analysis, materials optimization, and lifecycle assessments. These capabilities enable designers to create more efficient and environmentally friendly buildings.

Facilities Management

Post-construction, BIM continues to add value by serving as a comprehensive repository of building information. Facilities managers can use the BIM model for maintenance, renovations, and operation of the building, ensuring that the building performs optimally throughout its lifecycle.

Challenges in BIM Adoption

Despite its many advantages, the adoption of BIM is not without challenges. These challenges can be broadly categorized into technological, organizational, and regulatory barriers.

Technological Challenges

Implementing BIM requires a significant investment in new software and hardware, as well as ongoing updates to keep pace with technological advancements. Additionally, the complexity of BIM software can be a barrier, requiring extensive training and expertise that may not be readily available in all firms, particularly smaller enterprises [15, 19].

Organizational Challenges

The shift from traditional methods to BIM necessitates changes in organizational workflows and practices. This shift can be met with resistance from stakeholders who are accustomed to established processes. Furthermore, the collaborative nature of BIM requires a cultural change within organizations to foster greater cooperation and information sharing, which can be difficult to achieve.

Regulatory Challenges

The regulatory environment often lags behind technological advancements, and this is true for BIM as well. In many regions, including Malaysia, there is a lack of comprehensive standards and regulations that govern BIM usage. This regulatory gap can create uncertainty and hinder the widespread adoption of BIM, as firms may be unsure of how to integrate BIM into existing legal and contractual frameworks [4, 20].

Cost Considerations

While BIM can lead to long-term cost savings, the initial investment required for implementation can be prohibitive, especially for smaller firms. The cost of software licenses, training, and the time required to transition to BIM can be significant barriers to adoption.

Interoperability Issues

BIM relies on the integration of data from various disciplines and software platforms. However, interoperability between different BIM tools and systems is not always seamless, leading to challenges in data exchange and collaboration across different teams.

Legal and Contractual Issues

BIM's collaborative approach raises questions about intellectual property rights, data ownership, and liability. Without clear contractual agreements that address these issues, disputes can arise, complicating the use of BIM in projects [5, 10].

Table 2: Summary of Legal and Contractual Challenges in BIM Adoption

Challenge	Description	Key References
Inadequate Contractual Frameworks	Traditional contracts do not accommodate collaborative BIM processes.	Lee et al. [1] and Jamil and Syazli Fathi [2]
Intellectual Property Rights (IPR)	Complex ownership issues due to shared creation of the BIM model.	Baharom et al. [5]
Responsibility and Liability	Difficult to allocate liability in a collaborative environment.	Jamil and Syazli Fathi [2]
Dispute Resolution	Traditional methods may not be suitable for BIM-specific disputes.	Cheung and Yiu [6] and Khawaja and Mustapha [3]
Risk Allocation	Requires new strategies to allocate risks fairly among stakeholders.	Teoh, et al. [4]

Global Trends in BIM Adoption

Globally, BIM adoption has been propelled by government mandates, industry standards, and the recognition of its benefits. In the UK, the government required BIM on all public sector projects, beginning with Level 2 BIM, setting a global precedent for its use. Singapore's Building and Construction Authority (BCA) also played a key role, implementing mandatory BIM submission for certain projects and offering extensive training programs, positioning Singapore as a leader in BIM adoption. In the United States, BIM adoption has been primarily driven by the private sector, with large construction firms leveraging its competitive advantages. The US government has supported BIM through initiatives like the National BIM Standard (NBIMS-US), providing implementation guidelines.

BIM in the Malaysian Context

In Malaysia, BIM adoption has been gaining momentum, but it is still in the early stages compared to more developed markets. The Construction Industry Development Board (CIDB) has been a key player in promoting BIM through initiatives like the Construction Industry Transformation Programme (CITP) 2016-2020. The CITP identified BIM as a critical technology for improving productivity, quality, and safety in the Malaysian construction industry.

Despite these efforts, several challenges remain in achieving widespread BIM adoption in Malaysia. These include the high cost of implementation, the lack of skilled personnel, and the need for greater awareness of BIM's benefits among industry stakeholders. Additionally, the regulatory environment in Malaysia is still evolving, and there is a need for more comprehensive guidelines and standards to support BIM implementation across the industry [4, 21].

Legal and Contractual Challenges

The adoption of Building Information Modelling (BIM) within the construction industry has introduced a paradigm shift in how projects are planned, designed, and executed. However, alongside the technological advancements and collaborative opportunities offered by BIM, significant legal and contractual challenges have emerged. These challenges stem from the fundamental differences between traditional construction practices and the integrated, data-driven processes that BIM facilitates. This section explores the key legal and contractual issues associated with BIM, focusing on the inadequacy of existing contractual frameworks, the complexities of intellectual property rights (IPR), and the allocation of responsibilities and liabilities among project participants.

Contractual Frameworks and Obligations

Traditional construction contracts are based on a linear process with clearly defined responsibilities, but BIM disrupts this by enabling simultaneous contributions from multiple stakeholders throughout the project lifecycle. Lee et al. [1] argue that BIM's collaborative nature requires contracts that accommodate integrated workflows and data sharing, which traditional contracts often fail to address. These contracts typically do not clarify roles in managing and modifying the digital model, leading to disputes over model accuracy, data integrity, and liability for errors or omissions.

Additionally, the legal status of the BIM model itself poses challenges. Jamil and Syazli Fathi [2] note that without clear contractual provisions, conflicts may arise regarding whether the BIM model or traditional documents take precedence in case of discrepancies. Another issue is determining ownership and control of the BIM model. In traditional projects, design documents are owned by the architect or designer, but in a BIM environment, where multiple parties contribute, ownership is more complex. Contracts need to clearly specify ownership, modification rights, and responsibility for maintaining the integrity of the BIM model throughout the project.

Intellectual Property Rights (IPR)

The collaborative nature of BIM creates challenges in managing intellectual property rights (IPR), as the digital model results from contributions by various stakeholders. In traditional construction, IPR resides with the creators of specific design elements, but in BIM, ownership and usage rights become complex. Baharom et al. [5] highlight that existing IPR frameworks struggle to address these complexities, especially regarding ownership of the BIM model and its data. Clear contractual definitions are necessary to avoid disputes over who can use, modify, or distribute the model and to protect proprietary information.

As the BIM model evolves with contributions from architects, engineers, contractors, and others, each party may claim rights over their modifications, complicating the allocation of ownership and usage rights. Contracts must address not only the final ownership of the BIM model but also the rights tied to each incremental contribution. Furthermore, the commercial exploitation of BIM data such as for facilities management or future projects poses another legal challenge. Without explicit contractual provisions, disputes may arise over the right to commercialize the model and how profits should be shared. Baharom et al. [5] recommends including clauses that define the rights to reuse, license, or sell BIM data in contracts.

Allocation of Responsibilities and Liabilities

The integration of BIM into construction projects necessitates a redefinition of responsibilities and liabilities, as traditional roles become less clear in a collaborative BIM environment. In traditional contracts, responsibilities are divided among participants (e.g., designers for design accuracy, contractors for construction), but with BIM, multiple parties contribute to a shared model, blurring these lines. One key issue is allocating liability for errors or omissions in the model, such as when an incorrectly designed structural element causes a defect. Jamil and Syazli Fathi [2] suggest that contracts must clearly define liability, potentially using shared or joint liability arrangements.

Another challenge is the responsibility for maintaining and updating the BIM model throughout the project. As the model evolves, clear definitions are needed regarding who is responsible for ensuring its accuracy and keeping it up-to-date, especially when multiple parties make concurrent changes. Additionally, the use of BIM introduces uncertainties regarding the standard of care expected from each party. Unlike traditional projects, where industry norms establish the standard, BIM's new technologies and processes may not yet be fully standardized, leading to ambiguity over the required level of care. Contracts must therefore explicitly define the expected standard of care, accounting for BIM's specific demands and risks.

Dispute Resolution and Risk Management

The adoption of Building Information Modelling (BIM) has been heralded as a game-changer in the construction industry, particularly for its potential to streamline processes, improve collaboration, and enhance project outcomes. However, the integration of BIM into construction projects also introduces new complexities that can give rise to disputes and increase the need for effective risk management strategies. This section delves into the literature on dispute resolution mechanisms suitable for BIM-based projects and explores how BIM can be utilized to manage and mitigate risks throughout the project lifecycle.

Dispute Resolution in BIM Projects

Disputes are common in construction projects due to their complexity and the involvement of multiple stakeholders with differing interests. Cheung and Yiu [6] note that factors like unclear contractual terms and miscommunication often lead to disputes. The introduction of BIM adds complexity, with potential issues arising over model accuracy, responsibility for errors, and data interpretation. Traditional dispute resolution methods may not be suitable for BIM's technical and collaborative aspects, leading Khawaja and Mustapha [3] to advocate for tailored mechanisms, such as specialized arbitration panels or technical adjudication, to handle these disputes.

BIM can also play a proactive role in dispute prevention. Gould et al. [22] highlight how BIM's real-time data sharing and visualization capabilities allow early detection of issues, reducing misunderstandings. Additionally, BIM provides a clear audit trail, aiding in dispute resolution. However, disputes remain possible, necessitating contract provisions for BIM-specific resolution methods. Alternative dispute resolution (ADR) methods, like mediation and arbitration, are recommended, as they are more flexible and quicker than traditional litigation. Multi-tiered dispute resolution clauses, which encourage early negotiation or mediation before escalating to arbitration, can further enhance collaboration in BIM projects and preserve relationships [22, 23].

Risk Management and BIM

Risk management is crucial in construction, involving the identification and mitigation of risks that could impact project success. Memon et al. [9] note that in Malaysia, poor risk management has led to time and cost overruns, challenges that BIM can address by improving risk identification and mitigation. BIM's capabilities, such as clash detection and 4D modeling, enable teams to anticipate risks and resolve issues before construction begins, reducing costly rework and delays.

However, BIM introduces new risks, particularly concerning the reliability and accuracy of the model. Errors in the model, compounded by the collaborative nature of BIM, can have widespread consequences. If responsibilities for maintaining model accuracy are unclear, disputes and liability issues can arise [4, 24]. The allocation of risks in BIM contracts is also critical, as traditional methods may not suffice in a collaborative BIM environment. Contracts must explicitly define risk allocation for model accuracy, data integrity, and information management.

Teoh et al. [4] argue for regulatory reforms to address BIM-specific risks and support effective risk management. BIM can also be a proactive tool in managing risks, such as using 4D and 5D BIM to identify schedule and cost-related risks. However, effective risk management through BIM depends on stakeholder training and cooperation to fully realize its potential benefits.

BIM Project and Performance in Malaysia

The adoption of Building Information Modelling (BIM) in the construction industry has been recognized globally for its potential to improve project outcomes in terms of time, cost, quality, and overall efficiency. In Malaysia, the Construction Industry Development Board (CIDB) has been actively promoting BIM as part of its broader efforts to modernize the construction sector, particularly through initiatives like the Construction Industry Transformation Programme (CITP) 2016-2020. Despite these efforts, the integration of BIM into Malaysian construction practices has faced numerous challenges, which in turn affect the performance of projects utilizing BIM. This section reviews the literature on the impact of BIM adoption on project performance in Malaysia, focusing on time, cost, quality, and the factors that influence the successful implementation of BIM.

Impact of BIM on Time Performance

BIM offers significant potential to improve time performance in construction projects, particularly in Malaysia, where time overruns are common due to scheduling delays, poor planning, and unforeseen changes [9]. BIM enhances project planning and scheduling using 4D BIM, which integrates time-related data with the 3D model, enabling more accurate planning. Studies show that BIM reduces delays by improving coordination among stakeholders. Clash detection tools within BIM help identify design conflicts early, preventing costly rework and schedule disruptions. Additionally, BIM's ability to simulate construction sequences allows project managers to optimize workflows and spot potential bottlenecks [15].

However, the effectiveness of BIM in improving time performance depends on factors such as BIM maturity, team competency, and the integration of BIM into project management strategies. Teoh et al.

[4] highlight that while BIM can enhance time performance, its full potential is often limited by a lack of BIM expertise and insufficient integration with traditional management practices. This underscores the importance of ongoing training and capacity building to enable project teams to fully leverage BIM's time-saving benefits.

Impact of BIM on Cost Performance

BIM can significantly enhance cost performance in construction projects, particularly in Malaysia, where cost overruns are common due to inaccurate estimates, scope changes, and inefficiencies [9]. The integration of cost data with 3D models in 5D BIM allows for more accurate, real-time cost estimates throughout the project lifecycle. BIM's ability to generate detailed quantity take-offs and simulate design options with associated costs supports informed decision-making, reducing the likelihood of budget overruns [17].

However, challenges remain in fully realizing BIM’s cost-saving potential in Malaysia. The initial costs of BIM implementation such as software acquisition, staff training, and workflow adjustments can be prohibitive, especially for small and medium-sized enterprises (SMEs). Additionally, resistance to change from stakeholders accustomed to traditional cost estimation methods can hinder adoption [9]. Another challenge is the integration of BIM with existing cost management systems. Many firms still rely on traditional tools that may not be compatible with BIM, leading to inefficiencies and data discrepancies. Teoh et al. [4] suggest that for BIM to improve cost performance, it must be seamlessly integrated with financial management systems to enable real-time cost monitoring and control.

Impact of BIM on Quality Performance

BIM has the potential to significantly improve quality performance in construction by enhancing design accuracy, reducing errors, and fostering better communication among stakeholders. Its ability to provide a detailed digital representation of a project allows for early detection and correction of design flaws, ensuring adherence to specifications and client expectations. In Malaysia, the construction industry faces challenges in quality due to poor workmanship, inadequate supervision, and insufficient quality control [9]. BIM addresses these issues by facilitating an integrated approach to quality management, such as using clash detection to identify design conflicts and maintaining a comprehensive record of project decisions to ensure consistent quality standards [15].

However, the effectiveness of BIM in enhancing quality performance depends on the level of adoption and the commitment of project teams. Teoh et al. [4] argue that while BIM can improve quality, its impact is limited by the lack of standardized BIM implementation across the industry. This inconsistency can result in varying quality management practices. To address this, greater standardization of BIM processes and enhanced collaboration among stakeholders are needed to ensure consistent quality improvements across Malaysian construction projects.

Factors Influencing the Successful Implementation of BIM

The successful implementation of BIM in Malaysia's construction industry is influenced by factors such as BIM adoption levels, the availability of skilled personnel, the regulatory environment, and stakeholder willingness to embrace change. Despite BIM's recognized potential, its adoption in Malaysia has been slower compared to other countries due to these challenges.

A key factor is the uneven level of BIM adoption among industry stakeholders. While large firms and government agencies have adopted BIM, smaller firms face barriers such as high implementation costs and a lack of awareness of its benefits. This uneven adoption hampers the full potential of BIM, as its benefits are best realized when all project participants are involved [4].

Another challenge is the shortage of skilled BIM professionals in Malaysia. Effective BIM implementation requires not only proficiency in BIM software but also the integration of BIM processes into traditional workflows. To address this gap, there is a need for greater investment in training and education [15]. The regulatory environment also impacts BIM adoption. While initiatives like the CITP have been introduced, the regulatory framework is still developing. Clear guidelines and standards are needed to address legal and contractual uncertainties [4]. Finally, overcoming resistance to change is essential, and demonstrating BIM’s tangible benefits through pilot projects can help encourage adoption [9].

Regulatory Environment and BIM

The successful adoption and implementation of Building Information Modelling (BIM) in the construction industry depend significantly on the regulatory environment in which it operates. Regulations, standards, and legal frameworks provide the necessary guidelines for how BIM should be used, ensuring that its integration into construction processes is smooth, consistent, and legally sound. In Malaysia, the regulatory environment surrounding BIM is still evolving, and while there have been significant strides in promoting BIM adoption, several gaps and challenges remain. This section reviews the existing regulatory frameworks related to BIM in Malaysia, discusses the challenges faced in creating a supportive regulatory environment, and explores the need for further development of regulations to facilitate effective BIM implementation.

Current Regulatory Frameworks for BIM in Malaysia

Malaysia has recognized BIM's potential to transform the construction industry, prompting various government initiatives to promote its adoption. The Construction Industry Development Board (CIDB) has played a key role, particularly through the Construction Industry Transformation Programme (CITP) 2016-2020. The CITP outlines goals for improving productivity, quality, safety, and sustainability, with BIM as a central technology to achieve these objectives. As part of the CITP, the CIDB introduced the BIM Roadmap 2014-2020, which guides the industry through BIM adoption stages, from awareness to full implementation. This roadmap includes initiatives such as developing BIM standards, offering training programs, and establishing a BIM library. Additionally, the Malaysian government has made BIM mandatory for certain public sector projects, especially complex infrastructure.

However, the regulatory framework for BIM in Malaysia remains fragmented and underdeveloped. Unlike countries like the UK, which have established comprehensive BIM standards and mandates (e.g., the UK BIM Framework and Level 2 BIM requirement for government projects), Malaysia's regulatory approach is still evolving. This lack of a centralized, mandatory BIM standard results in varied implementation practices, leading to inconsistencies in BIM adoption and outcomes [4].

Challenges in the Regulatory Environment for BIM

One of the main challenges in the regulatory environment for BIM in Malaysia is the lack of standardized guidelines and protocols for its implementation. While the BIM Roadmap and CIDB initiatives offer general direction, there is no binding national standard that mandates how BIM should be used across all projects. This lack of standardization leads to varying levels of BIM adoption, with some projects employing advanced practices and others sticking to basic usage, creating inconsistencies that can hinder collaboration, data sharing, and the overall effectiveness of BIM in improving project outcomes [15].

Moreover, Malaysia's existing legal frameworks do not adequately address specific issues arising from BIM, such as intellectual property rights (IPR), data ownership, and liability. BIM’s collaborative nature, where multiple parties contribute and modify the model, complicates determining ownership and liability. Without clear legal guidelines, these uncertainties can lead to disputes that traditional construction law struggles to resolve, potentially discouraging full BIM adoption [5].

The slow pace of regulatory reform is another challenge. Despite the recognition of the need for BIM-specific regulations, the process has been sluggish due to bureaucratic inertia, inter-agency coordination challenges, and balancing industry interests. This delay has led to a regulatory framework that has not kept up with the rapid evolution of BIM technology, resulting in gaps that undermine effective adoption [4]. Furthermore, enforcement of existing regulations is weak, risking superficial BIM adoption that fails to harness its full potential [22].

The Need for Comprehensive BIM Regulations and Standards

To fully harness BIM's potential in Malaysia's construction industry, comprehensive and standardized regulations are essential. These regulations should address legal, technical, and operational challenges, providing clear guidelines for BIM implementation. Key areas requiring regulation include the standardization of practices, with national BIM standards like the UK's PAS 1192 or ISO 19650, ensuring consistency and effective collaboration across projects [4]. Legal reforms are also needed to clarify intellectual property, data ownership, and liability in the BIM environment [5]. Additionally, capacity building through training programs and certifications is crucial to address the skills gap [15]. Finally, strong enforcement mechanisms, including penalties and audits, are necessary to ensure widespread and effective BIM adoption, improving industry competitiveness [22].

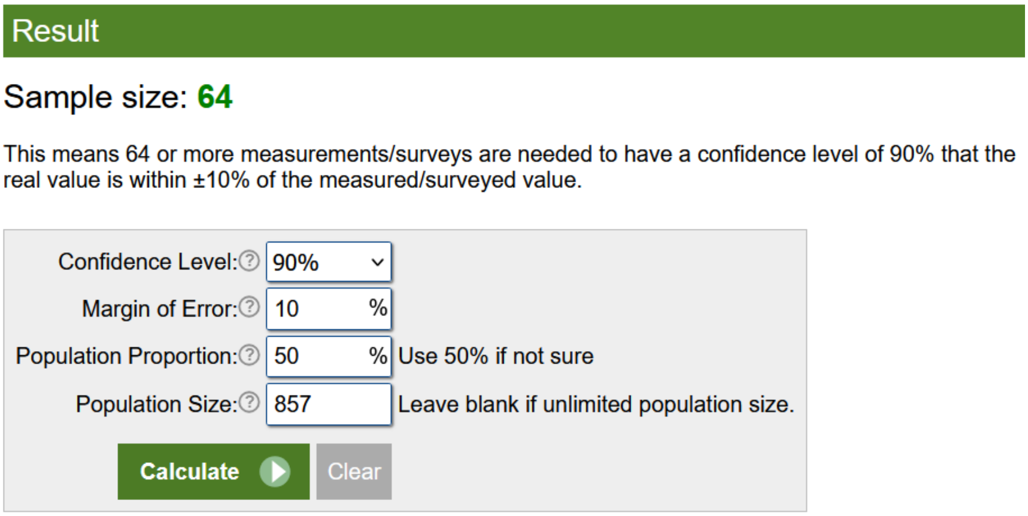
International Comparisons and Best Practices

International best practices offer valuable insights for Malaysia to improve its BIM regulatory framework. Countries like the UK, Singapore, and Australia lead in BIM adoption with strong regulations. For instance, the UK mandates Level 2 BIM for all government projects, driving standardization, while Singapore's BCA enforces mandatory BIM submissions and offers extensive training. These examples emphasize the role of government leadership in BIM adoption, highlighting the need for standardization, legal reforms, and capacity building. Malaysia can draw on these practices to develop a more effective and comprehensive BIM framework.

Research Methodology

This study used the quantitative research design, which aimed at empirically assessing the impact of BIM adoption on project performance and quantifying stakeholders' perceptions of the legal and regulatory challenges they face. A structured survey will be distributed to a stratified random sample of construction professionals, focusing on project performance metrics and perceptions of legal and contractual frameworks supporting BIM. Likert scales and closed-ended questions will gather quantifiable data for statistical analysis [25]. The survey data sent through Google Form was analyzed using descriptive statistics, correlation, and regression analysis to identify patterns and relationships between variables [26]. This study targets construction professionals in Malaysia, with a target population of 857 and a minimum sample size of 64, determined by using the sample size calculator. This sample is deemed sufficient to provide reliable insights into the legal and regulatory challenges of BIM in Malaysian construction law, balancing statistical power with practical data collection constraints. The total respondents received after the four-week duration was 120, which exceeds the minimum number of respondents required.

Figure 1: Sample Size (Sources: Calculator.net



Data Analysis

This study explores the perceptions and experiences of 120 respondents regarding the legal challenges of Building Information Modelling (BIM) in Malaysian construction law. The questionnaire is divided into four sections. The first section gathers background information on respondents, including their professional roles, years of experience, and firm size, offering insights into how different backgrounds may affect perspectives on BIM's legal challenges.

The next sections focus on respondents' experiences with BIM, splitting them into two groups: those with BIM experience and those without. This comparison aims to identify adoption patterns, usage behaviors, and barriers related to BIM's legal and regulatory issues. The final section invites open-ended feedback from all respondents about the current legal frameworks governing BIM and suggestions for improvement. By combining quantitative data with qualitative insights, the study aims to comprehensively address the legal challenges of BIM adoption in Malaysia. The findings are expected to inform policy development and industry practices, helping to bridge regulatory gaps and support more effective BIM adoption across the Malaysian construction industry.

Demographic Profile of Respondents

This section is answered by a total of 120 respondents.

Table 3: Roles in the construction industry

No.	Description	Amount	Percentage
1	Quantity Surveyor	43	36.4%
2	Project Manager	33	27.3%
3	Engineer	22	18.2%
4	Architect	22	18.2%

* This question only allows one selected answer.

Figure 2: Roles in the Construction Industry

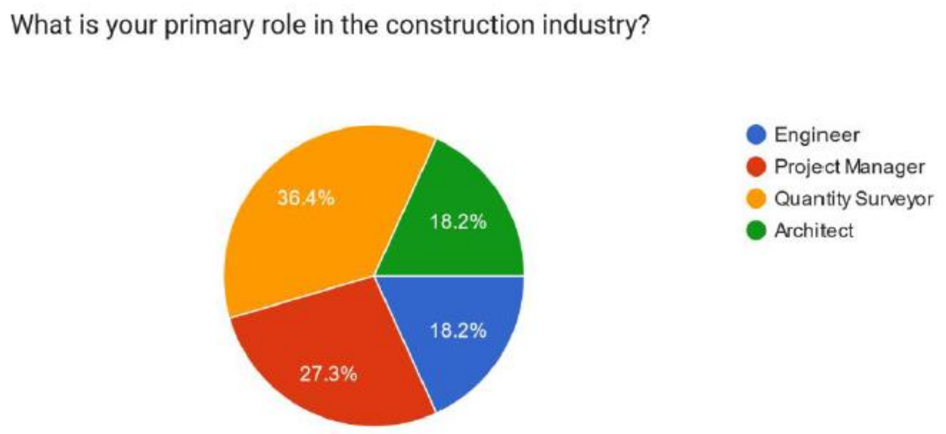


Table 3 indicates a diverse representation of roles within the construction industry, with Quantity Surveyors being the largest group at 36.4%, followed by Project Managers at 27.3%. Engineers and Architects each make up 18.2% of respondents. This distribution highlights strong participation from professionals directly involved in project planning, cost management, and design implementation. Such a range of perspectives provides valuable insights into BIM's legal and regulatory challenges from the viewpoint of key construction roles, emphasizing the comprehensive nature of the survey's demographic reach.

Table 4: Working experience of respondents

No.	Description	Amount	Percentage
1	Less than 5 years	54	45.5%
2	5 – 10 years	33	27.3%
3	10 – 15 years	22	18.2%
4	More than 15 years	11	9.1%

* This question only allows one selected answer.

Figure 3: Working experience of respondents

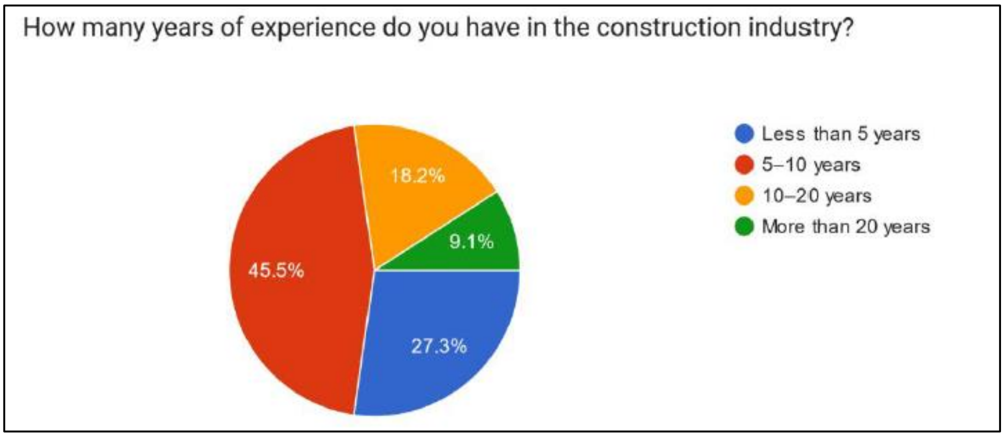


Table 4 on respondents' working experience reveals that nearly half (45.5%) of the participants have less than 5 years of experience, followed by 27.3% with 5 to 10 years. Respondents with 10 to 15 years comprise 18.2%, while only 9.1% have over 15 years of experience. This distribution suggests a workforce primarily consisting of early- to mid-career professionals, providing perspectives that are likely shaped by recent training and evolving BIM practices. The varied experience levels offer a balanced view of the industry's challenges with BIM adoption and regulatory concerns.

Table 5: Size of Firm of Respondent

No.	Description	Amount	Percentage
1	Medium (51–200 employees)	65	54.5%
2	Small (1–50 employees)	33	27.3%
3	Large (more than 200 employees)	22	18.2%

* This question only allows one selected answer.

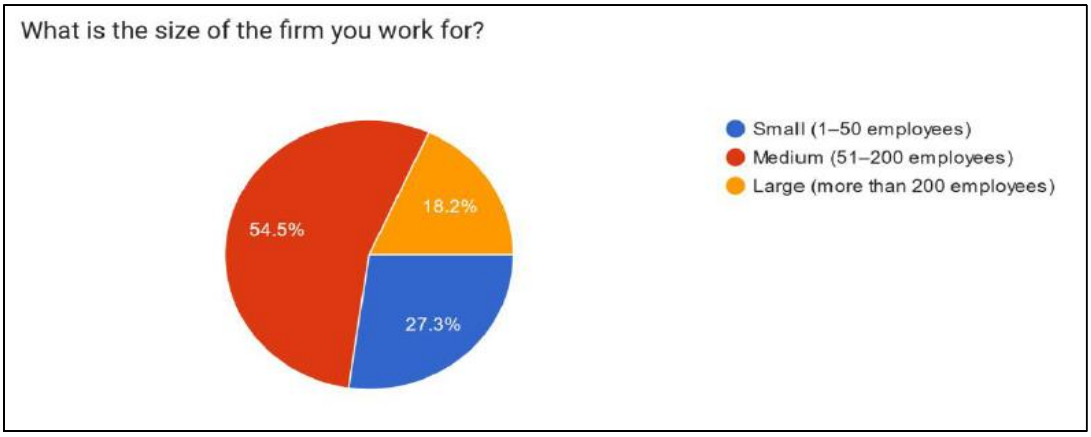


Table 5 reveals the distribution of respondents by firm size, with medium-sized firms (51–200 employees) comprising the majority at 54.5%, followed by small firms (1–50 employees) at 27.3%, and large firms (more than 200 employees) at 18.2%. This distribution suggests that medium-sized firms play a substantial role in the sample, offering perspectives that balance resource limitations and scalability issues often faced in BIM adoption. The smaller representation of large firms reflects the industry's typical size structure in Malaysia, where SMEs predominate but face challenges in BIM implementation due to financial and technical constraints.

Table 6: Familiarity in Using BIM

No.	Description	Amount	Percentage
1	Moderately familiar	54	45.5%
2	Expert user	22	18.2%
3	Slightly familiar	22	18.2%
4	Very familiar	11	9.1%
5	Not familiar	11	9.1%

* This question only allows one selected answer.

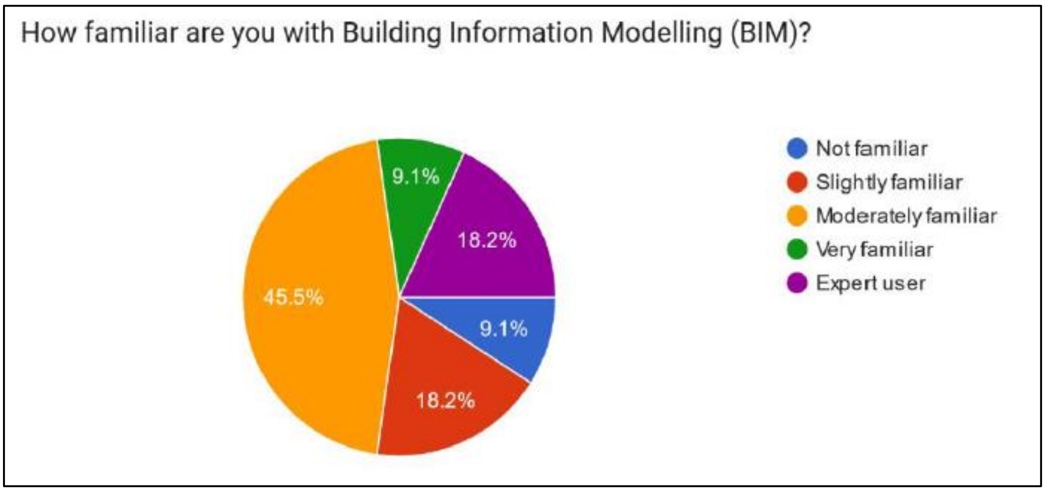


Figure 4: Familiarity in using BIM

Table 6 displays respondents' familiarity with BIM. The largest group, 45.5%, is moderately familiar, suggesting a foundational understanding but with limited expertise in advanced functions. Expert users account for 18.2%, while slightly familiar and very familiar users represent 18.2% and 9.1%, respectively. Another 9.1% indicated no familiarity with BIM. This spread shows moderate familiarity overall, but with fewer users highly skilled in BIM. This highlights the potential need for expanded training to increase proficiency levels across all user groups.

The demographic data supports a comprehensive analysis, showing that BIM-related challenges are relevant across diverse roles, experience levels, and firm sizes. This variety allows for a nuanced understanding of BIM adoption in Malaysia, especially in identifying how different firm sizes and experience levels perceive the associated legal and regulatory issues.

BIM Adoption in the Industry

This section is answered by a total of 120 respondents.

Table 7: BIM Adoption in Company

No.	Description	Amount	Percentage
1	Yes	54	45.5%
2	Planning to adopt	44	36.4%
3	No	22	18.2%

* This question only allows one selected answer.

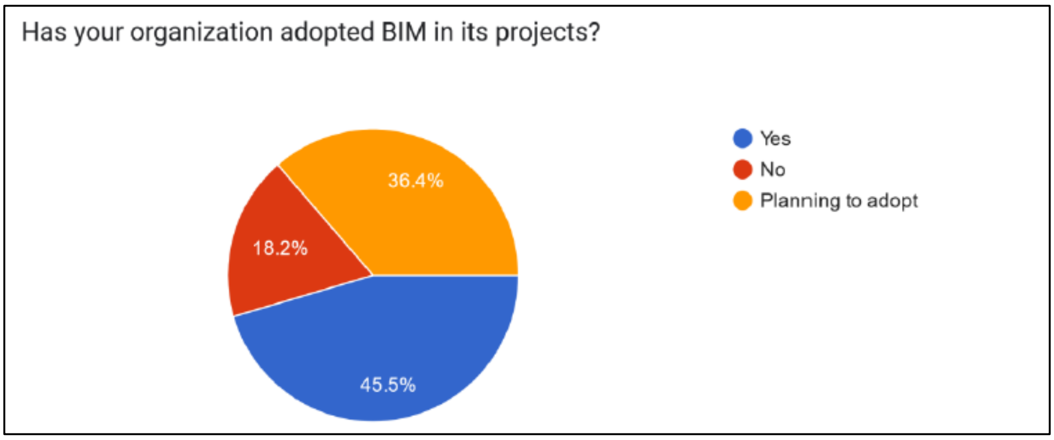


Figure 5: BIM Adoption in Company

Table 7 shows BIM adoption trends among companies, where 45.5% have already adopted BIM, and an additional 36.4% plan to adopt it. These findings support the conclusions of Jamil and Syazli Fathi [2], who noted that BIM adoption is growing but is often slowed by resource constraints, especially in smaller firms. The 18.2% of companies not planning adoption mirrors issues highlighted by Teoh et al. [4], who cited financial and training barriers as deterrents, indicating that targeted support for adoption remains crucial in the Malaysian context.

Table 8: Stages of the Project Lifecycle Where BIM Is Used

No.	Description	Amount	Percentage
1	Design Stage	76	63.6%
2	Construction Stage	65	54.5%
3	Operation and Maintenance Stage	54	45.5%
4	Entire Project Lifecycle	22	18.2%
5	None	22	18.2%

* This question is allowed to have Multiple choices.

Figure 6: Stages of Project Lifecycle that BIM is Used

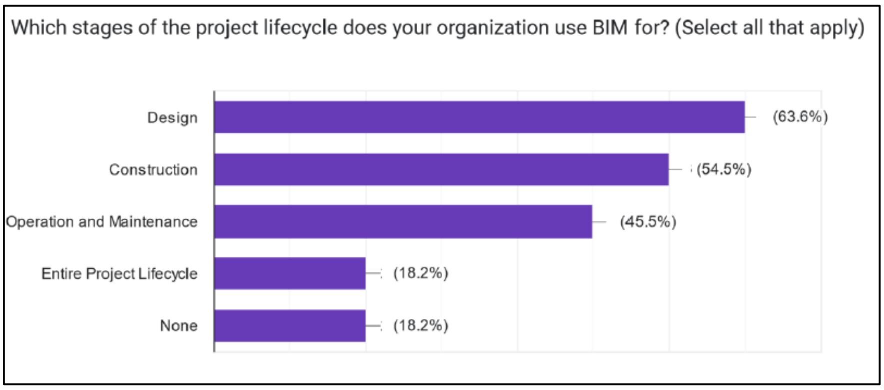


Table 8 reveals the stages of the project lifecycle where BIM is applied, with 63.6% of respondents using it in the design stage, 54.5% during construction, and 45.5% in operation and maintenance. Only 18.2% use BIM throughout the entire project lifecycle, and another 18.2% do not use it at all. This pattern aligns with Eastman [13], who observed BIM's primary value in design and construction, yet it underscores gaps in lifecycle integration. The limited use across all phases suggests a need for legal and regulatory support to facilitate BIM's broader application, particularly in operation and maintenance [4].

Table 9: Primary Reasons for Adopting BIM into Projects

No.	Description	Amount	Percentage
1	Faster Project Completion	87	72.7%
2	Enhanced Design Accuracy	76	63.6%

3	Reduced Costs	54	45.5%
4	Improved Project Collaboration	43	36.4%
5	Client Requirements	22	18.2%
6	Reduced Time for Tendering Process	11	9.1%

* This question is allowed to have Multiple choices.

Figure 7: Primary Reasons for Adopting BIM into Projects

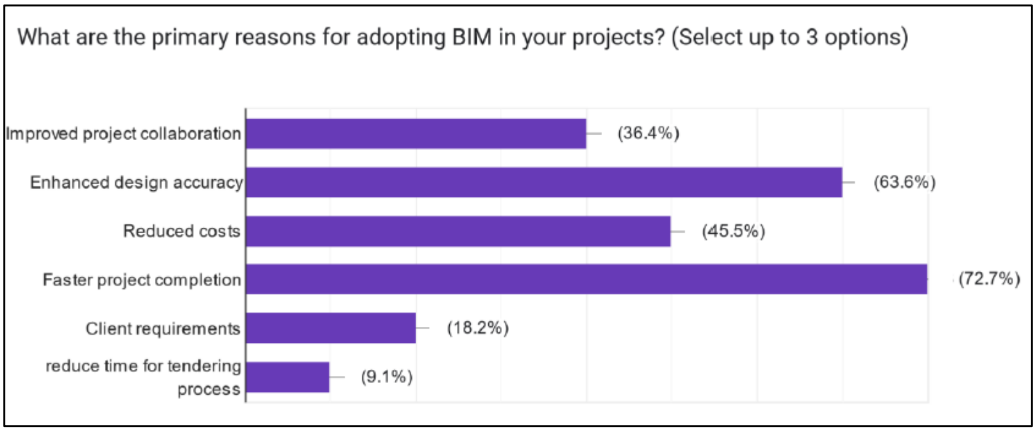


Table 9 highlights the primary reasons for adopting BIM in projects, with 72.7% of respondents citing faster project completion, followed by enhanced design accuracy at 63.6%. Reduced costs were important for 45.5% of respondents, while improved collaboration was noted by 36.4%. Client requirements accounted for 18.2%, and reduced tendering time was least common at 9.1%. This aligns with Memon et al. [9], who found that BIM adoption frequently aims to optimize timelines and accuracy, reflecting BIM's potential for improving efficiency in construction processes.

Table 30: Main Challenge of BIM Adoption

No.	Description	Amount	Percentage
1	High Implementation Costs	76	63.6%
2	Lack of Skilled Personnel	65	54.5%
3	Resistance to Change	43	36.4%
4	Lack of Legal Frameworks	22	18.2%
5	Intellectual Property Concerns	22	18.2%
6	Other Consultants Not Willing to Use	11	9.1%

* This question is allowed to have Multiple choices.

Figure 8: Main Challenge of BIM Adoption

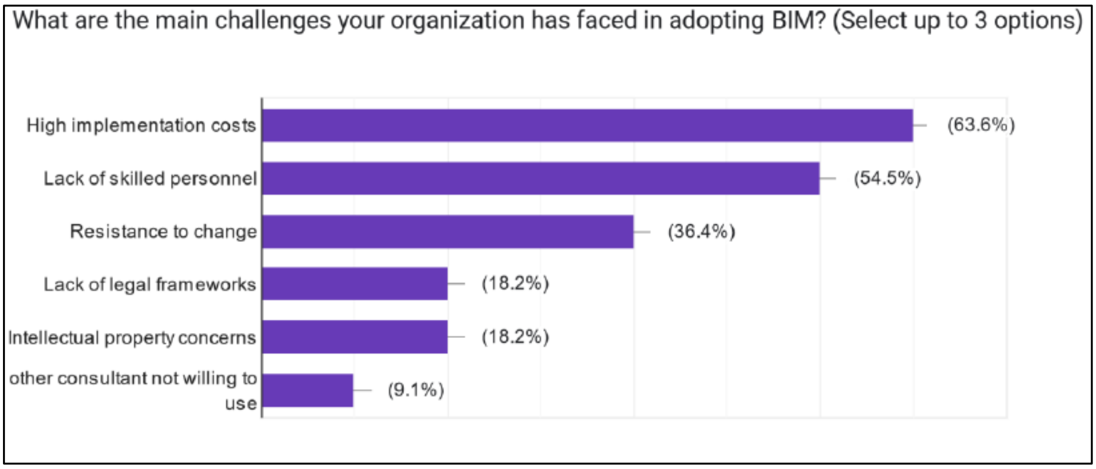


Table 10 identifies the primary challenges of BIM adoption, with 63.6% of respondents indicating high implementation costs as the most significant obstacle. This is followed by a lack of skilled personnel at 54.5% and resistance to change at 36.4%. Legal framework gaps and intellectual property concerns were noted by 18.2% each, while 9.1% cited the reluctance of other consultants to adopt BIM. These findings align with Baharom et al. [5], who highlighted financial, legal, and skill-related barriers as substantial hurdles to widespread BIM adoption.

While BIM is increasingly adopted, its application primarily in the design phase restricts its broader benefits, such as efficiency in construction and long-term asset management. The high costs and technical requirements remain substantial barriers, particularly for SMEs, indicating that industry support, such as subsidies or accessible training, may be necessary to enable smaller firms to participate more fully in BIM's digital ecosystem.

Legal and Contractual Challenges in BIM

This section is answered by a total of 120 respondents.

Table 41: Clarity of Current Contracts

No.	Description	Amount	Percentage
1	Neutral	65	54.5%
2	Clear	33	27.3%
3	Very Clear	11	9.1%
4	Very Unclear	11	9.1%
5	Unclear	0	0%

* This question only allows one selected answer.

Figure 9: Clarity of Current Contracts

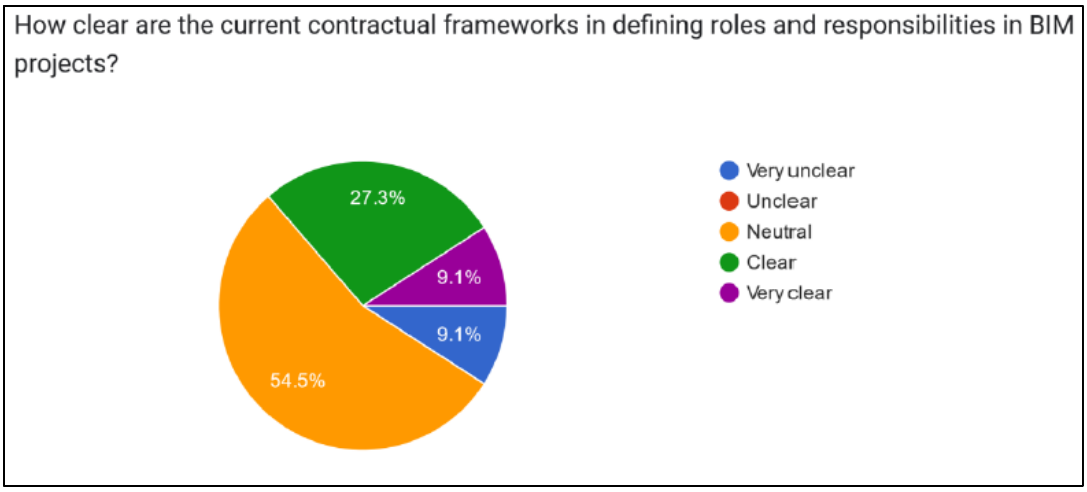


Table 11 illustrates perceptions of contract clarity in BIM projects. The majority, 54.5%, viewed current contracts as "neutral" in clarity, while 27.3% found them "clear" and 9.1% "very clear." Meanwhile, 9.1% rated them as "very unclear," with no respondents marking them as simply "unclear." This mixed response highlights a significant gap in BIM-specific contract clarity, echoing concerns in studies like Teoh et al. [4], which point to the need for standardized BIM contract terms to address ambiguities in roles and responsibilities.

Table 52: Intellectual Property Concerns

No.	Description	Amount	Percentage
1	Architect	43	36.4%
2	Shared ownership among stakeholders	33	27.3%
3	Consultants	33	27.3%
4	Clients	11	9.1%

* This question only allows one selected answer.

Figure 10: Intellectual Property Concerns

Who, in your opinion, should own the intellectual property rights of the BIM model?

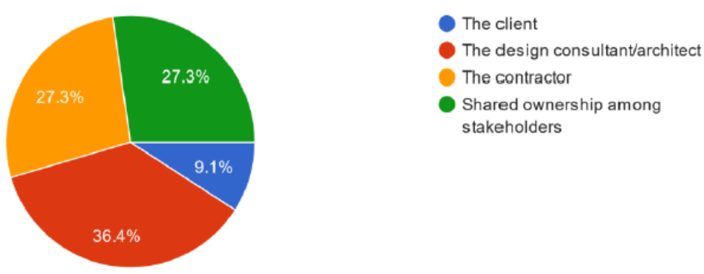


Table 12 presents respondents' perspectives on intellectual property (IP) ownership in BIM. Architects were seen as primary IP holders by 36.4% of respondents, while 27.3% supported shared ownership among stakeholders and another 27.3% favoured consultants. Only 9.1% indicated clients as primary IP owners. This distribution highlights BIM's collaborative nature and the associated complexity in assigning IP rights, supporting findings by Baharom et al. [5] who noted that BIM's multi-stakeholder contributions create challenges in defining clear IP ownership within construction projects.

Table 63: Risk and Liability Management

No.	Description	Amount	Percentage
1	Effective	65	54.5%
2	Neutral	43	36.4%
3	Very Effective	11	9.1%
4	Very Ineffective	11	9.1%
5	Ineffective	0	0%

* This question only allows one selected answer.

Figure 11: Risk and Liability Management

How effective are current contracts in managing risks and liabilities associated with BIM implementation?

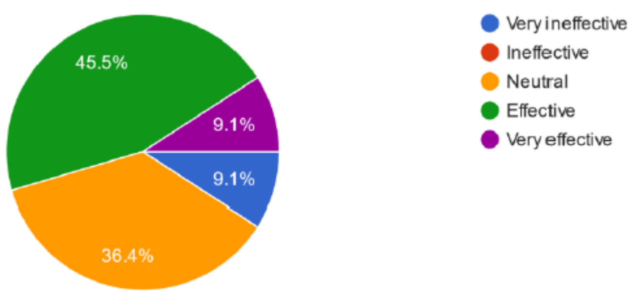


Table 13 provides insights into perceptions of risk and liability management within BIM projects. The majority of respondents (54.5%) rated it as "effective," while 36.4% viewed it neutrally, and only a small portion found it "very effective" (9.1%) or "very ineffective" (9.1%). Notably, none found it simply "ineffective." The study highlights mixed perceptions regarding the management of risks and liabilities within BIM, suggesting some confidence but also areas needing improvement. Neutral responses point to ambiguities in liability and responsibility, echoing Baharom et al. [5] findings on the need for clearer contractual language specific to BIM. This issue is particularly critical due to BIM's collaborative nature, where role-based responsibilities can be complex.

Additionally, Khawaja and Mustapha [3] emphasize the absence of standardized risk management frameworks tailored for BIM in Malaysia, which complicates risk allocation and can lead to disputes. A standardized approach to defining liabilities is essential, especially in multi-stakeholder projects, to enhance clarity and foster collaboration. The study also identifies significant gaps in Malaysia's contractual frameworks, particularly concerning intellectual property (IP) rights and liability. The preference for shared ownership indicates an understanding of BIM's collaborative nature but highlights the need for clear, legally binding terms. Developing BIM-specific contracts, as suggested by Teoh et al. [4], could help mitigate these risks and support more efficient project execution.

Impact of BIM on Project Performance

This section is answered by a total of 120 respondents.

Table 7: Time Performance

No.	Description	Amount	Percentage
1	Faster Project Completion	65	54.5%
2	No Impact on Time	33	27.3%
3	Some Delay	22	18.2%
4	Significant Delay	0	0%
5	Significantly Faster Project Completion	0	0%

* This question only allows one selected answer.

Figure 12: Time Performance

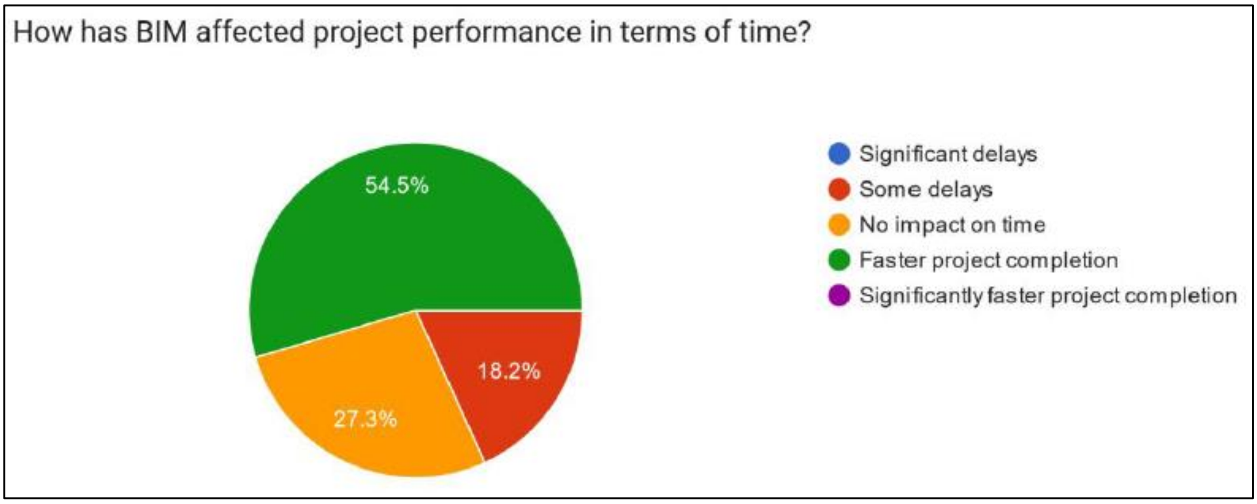


Table 14 examines BIM's impact on time performance in projects. A majority of respondents (54.5%) reported faster project completion due to BIM, while 27.3% observed no significant effect on timelines, and 18.2% experienced some delays. Notably, none reported significant delays or a significantly faster completion. These results suggest that, while BIM generally contributes to time savings, its impact may vary based on factors such as experience and training. This finding aligns with Memon et al. [9], who highlighted that BIM can enhance efficiency by minimizing rework through early clash detection. However, as some respondents noted no impact or delays, this implies that achieving optimal time benefits with BIM requires adequate user expertise and familiarity. These variations underscore the need for comprehensive training to maximize BIM's time-related advantages across all project stages.

Table 85: Cost Performance

No.	Description	Amount	Percentage
1	Reduced Costs Slightly	76	63.3%

2	No Impact on Costs	33	27.3%
3	Slightly Increased Costs	11	9.1%
4	Increased Costs Significantly	0	0%
5	Significantly Reduced Costs	0	0%

* This question only allows one selected answer.

Figure 13: Cost Performance

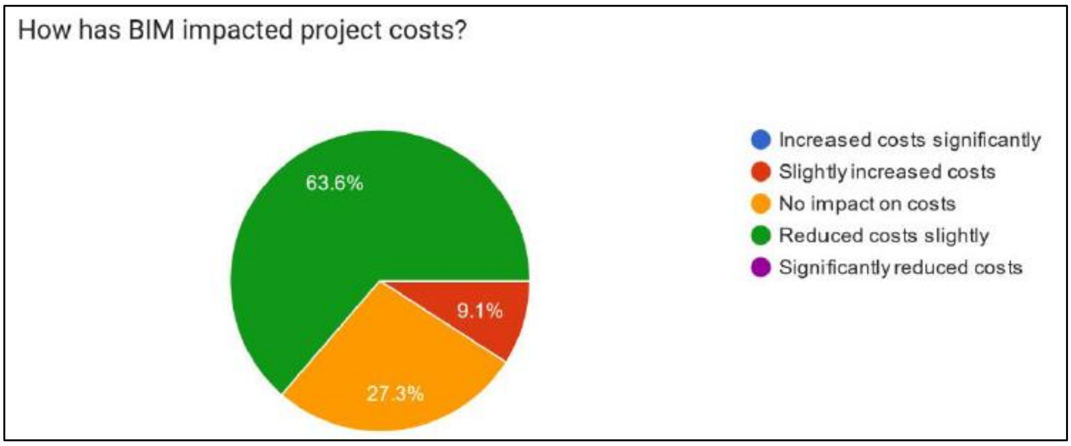


Table 15 analyses BIM's impact on project costs. A majority of respondents (63.3%) indicated that BIM slightly reduced costs, while 27.3% saw no impact on costs, and 9.1% experienced a slight increase. No respondents reported significant cost reductions or increases. These findings align with Memon et al. [9], who noted that BIM's detailed planning and clash detection can reduce rework and associated costs, yielding moderate savings. However, the lack of significant reductions suggests that initial setup costs and training requirements may counteract some cost savings, particularly for firms without established BIM practices.

Table 96: Quality Performance

No.	Description	Amount	Percentage
1	Improved Quality	98	81.8%
2	No Change in Quality	22	18.2%
3	Significantly Improved Quality	0	0%
4	Decreased Quality	0	0%

* This question only allows one selected answer.

Figure 14: Quality Performance

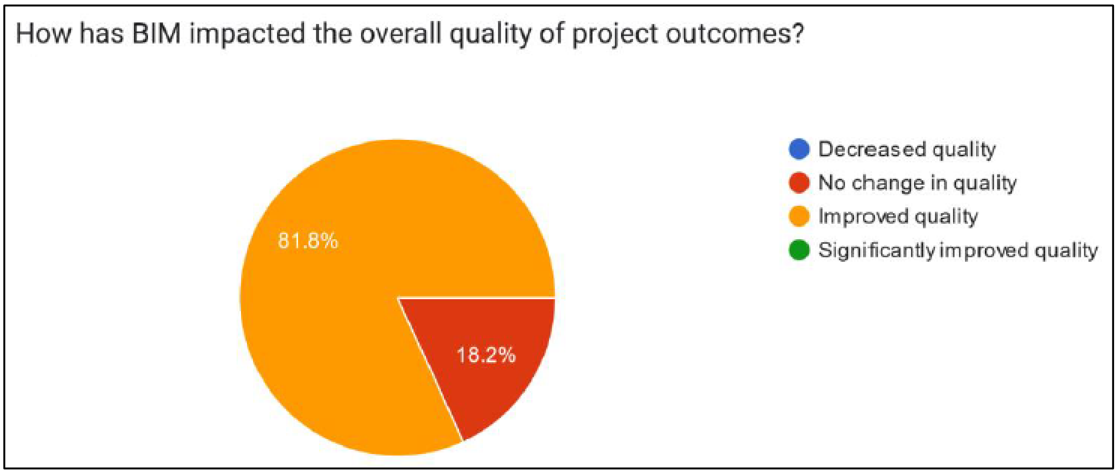


Table 16 highlights BIM's effect on project quality. A strong majority, 81.8% of respondents, reported an improvement in quality due to BIM, while 18.2% noted no change. No respondents observed a significant increase or decrease in quality.

Eastman [13] highlighting BIM's role in improving design accuracy and reducing errors through clash detection and coordinated modeling. While BIM positively impacts time and quality, its effect on cost is less clear due to high initial implementation costs, especially for smaller firms. However, the long-term benefits, including enhanced accuracy and reduced rework, suggest that with proper support, BIM could significantly improve project outcomes across the industry.

Dispute Resolution and Regulatory Needs

This section is answered by a total of 120 respondents.

Table 107: Dispute Occurrence

No.	Description	Amount	Percentage
1	No	65	54.5%
2	Unsure	33	27.3%
3	Yes	22	18.2%

* This question only allows one selected answer.

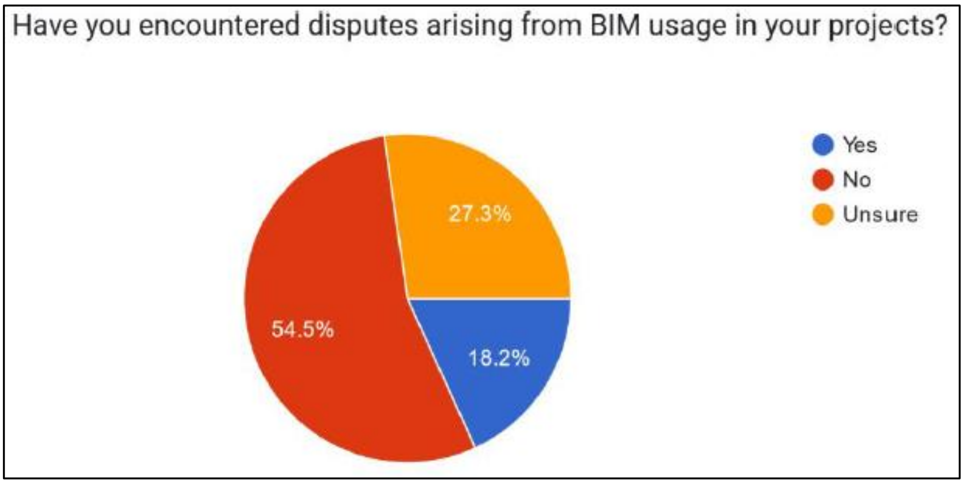


Figure 15: Disputes from BIM

Table 17 explores the occurrence of disputes in BIM projects. A majority of respondents (54.5%) reported no disputes, while 27.3% were unsure, and 18.2% confirmed experiencing disputes.

This aligns with findings by Khawaja and Mustapha [3], who noted that while BIM fosters collaboration, ambiguities in roles, intellectual property, and contractual terms can lead to disagreements if not carefully managed. The significant proportion of "unsure" responses may reflect unclear documentation or responsibilities within BIM projects, emphasizing the need for clearer contracts to reduce potential conflicts.

Table 118: Types of Disputes for BIM

No.	Description	Amount	Percentage
1	Intellectual Property Disputes	43	36.4%
2	Data Ownership Issues	43	36.4%
3	Design and Coordination Errors	33	27.3%
4	Liability for model inaccuracies	33	27.3%
5	Contractual Ambiguities	33	27.3%
6	None	33	27.3%

* This question is allowed to have Multiple choices.

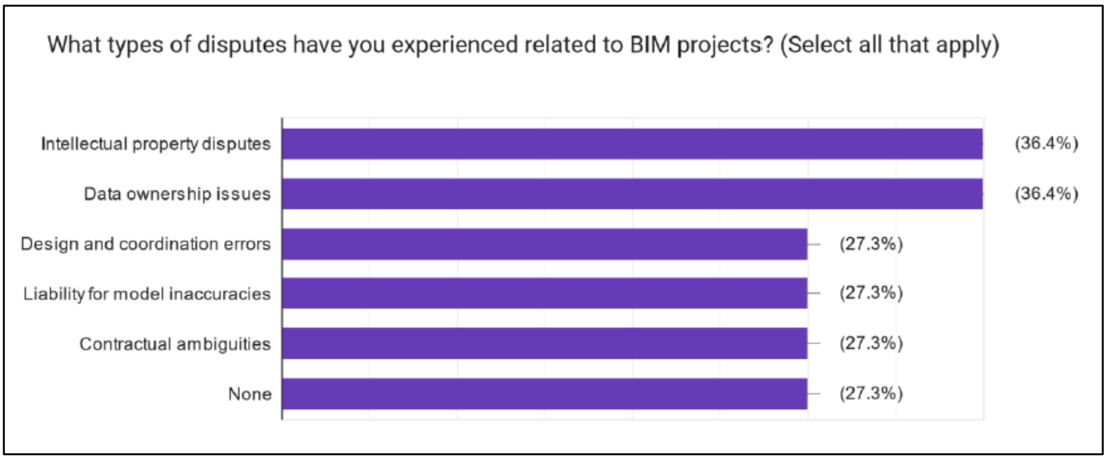


Figure 16: Types of Disputes for BIM

Table 18 reveals the types of legal challenges associated with BIM. Intellectual property (IP) disputes and data ownership issues were the most frequently cited, each selected by 36.4% of respondents. Design and coordination errors, liability for model inaccuracies, and contractual ambiguities were each noted by 27.3%. Additionally, 27.3% of respondents indicated no specific legal issues.

These findings echo Baharom et al. [5], who highlighted the complexity of IP and data ownership in BIM. The varied responses indicate the need for legal frameworks that address IP, data rights, and clear contractual terms to prevent disputes. The significant mention of design and liability issues suggests that BIM contracts should also delineate responsibilities clearly, as highlighted by Teoh et al. [4], to minimize project disputes.

Table 19: Suggested Reforms

No.	Description	Amount	Percentage
1	More Government Incentives for BIM Adoption	87	72.7%
2	Better Training and Education on BIM	87	72.7%
3	Reduction in BIM Software Costs	87	72.7%
4	Clearer Legal Framework and Standard Contracts	76	63.6%
5	More Client-Driven BIM Initiatives	65	54.5%

* This question is allowed to have Multiple choices.

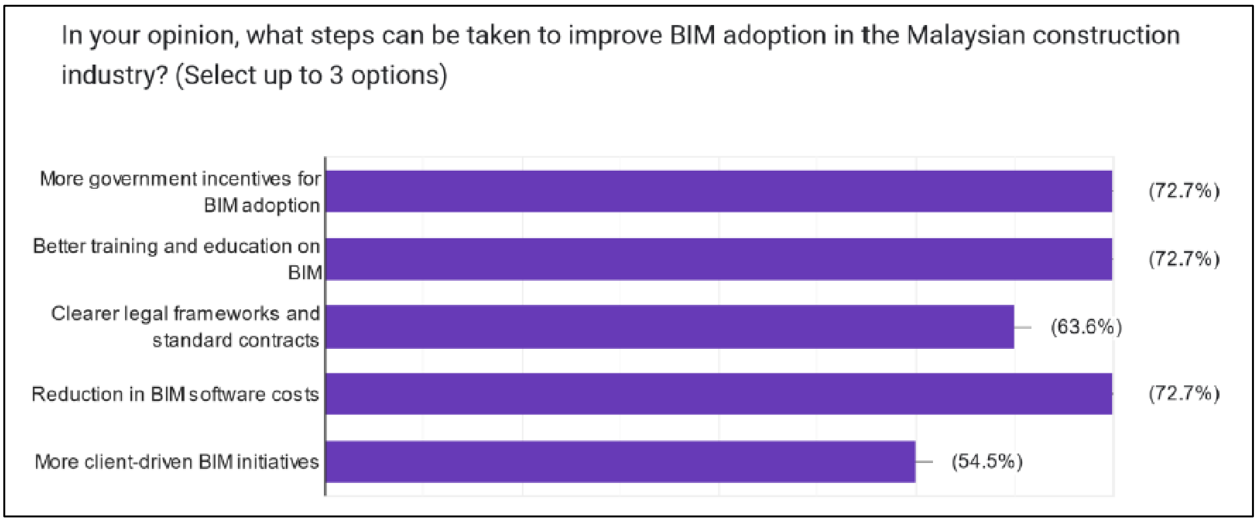


Figure 17: Suggested Reforms

Table 19 outlines the primary reforms suggested by respondents to facilitate BIM adoption. Three key areas government incentives, better training and education, and reduced BIM software costs each received strong support, with 72.7% of respondents selecting them. Additionally, 63.6% advocated for a clearer legal framework and standardized contracts, while 54.5% recommended more client-driven BIM initiatives.

Jamil and Syazli Fathi [2] emphasized the need for financial incentives and structured training to support BIM adoption, especially for SMEs. Baharom et al. [5] highlighting the importance of a clearer legal framework and standardized contracts to reduce disputes. Client-driven demand could further enhance BIM's value in planning, design, and efficiency. The high occurrence of disputes and legal gaps in Malaysia suggests a need for regulatory reform to facilitate smoother BIM integration.

Summary of Key Findings

Demographic Profile of Respondents

The survey includes a diverse range of professionals in the Malaysian construction industry, with Quantity Surveyors, Project Managers, Engineers, and Architects providing varied perspectives on BIM's technical and operational implications. Respondents' experience levels, from early-career to senior professionals, offer a nuanced analysis of BIM's impact across career stages. This diversity enables a comprehensive understanding of the regulatory and legal needs for BIM adoption, particularly in cost management, project planning, and design.

BIM Adoption and Usage Patterns

The data shows that 45.5% of firms have adopted BIM, with 36.4% planning to do so, while 18.2% have no adoption plans due to financial and technical barriers. BIM is most used in the design phase (63.6%), with less application in construction (54.5%) and operations (45.5%). Only 18.2% use BIM across the entire project lifecycle. This highlights a missed opportunity for broader adoption, suggesting the need for more regulatory support, training, and incentives.

Legal and Contractual Challenges in BIM Implementation

The study highlights legal and contractual barriers to BIM adoption, including unclear definitions of roles and responsibilities in existing contracts. Ambiguities in intellectual property (IP) rights and data ownership are significant concerns, with 36.4% of respondents reporting IP disputes. Liability issues, particularly regarding model inaccuracies, also pose challenges. These findings align with Baharom et al. [5], emphasizing the need for standardized contracts to address intellectual property, data ownership, and liability in collaborative BIM environments.

Impact of BIM on Project Performance

BIM adoption has positively impacted project performance in terms of time, cost, and quality, although benefits vary. 54.5% of respondents reported faster project completion due to improved coordination and clash detection, while 27.3% observed no impact, indicating that expertise plays a significant role.

63.3% noted slight cost reductions resulting from better design accuracy, although 9.1% experienced cost increases. Improvements in quality were substantial, with 81.8% citing enhanced design and coordination, consistent with Eastman [13]. Nonetheless, high initial costs remain a barrier, particularly for smaller firms.

Dispute Occurrence and Regulatory Needs

BIM adoption has generally reduced disputes, but conflicts still arise, particularly around intellectual property and data ownership. While 54.5% of respondents faced no disputes, 18.2% reported conflicts, and 27.3% were unsure, indicating a need for clearer documentation and defined responsibilities. Respondents strongly support clearer legal frameworks, reflecting [3] call for regulatory standards to address BIM's collaborative nature. Standardized contracts and dispute resolution processes would improve legal clarity and reduce conflicts, thereby enhancing project execution.

Suggested Reforms for BIM Adoption and Implementation

The survey identifies key reforms to boost BIM adoption in Malaysia, with 72.7% of respondents supporting government incentives, better training, and reduced software costs, which are crucial for SMEs facing high setup expenses. Additionally, 63.6% advocate for clearer legal frameworks and standardized contracts to reduce disputes. 54.5% recommend client-driven initiatives to enhance BIM adoption. These findings align with Jamil and Syazli Fathi [2], emphasizing the need for training, incentives, and structured support to foster innovation and collaboration.

Objectives and Key Findings

Objectives

The study was designed around three core objectives, each addressed through a combination of survey analysis and literature references.

Objective 1: Evaluate the Current Legal and Contractual Frameworks Governing BIM

The study highlights significant gaps in Malaysia's legal and contractual frameworks for BIM, particularly regarding role clarity, intellectual property (IP) rights, and liability management. Respondents noted ambiguity in contracts, with many failing to define responsibilities clearly. IP ownership and data control were also major concerns, given BIM's collaborative nature. These findings align with Baharom et al. [5], who emphasized the complexity of IP and ownership issues in BIM, underscoring the need for standardized, BIM-specific contracts.

Objective 2: Assess the Impact of BIM Adoption on Project Performance

BIM adoption positively affects project timelines, cost efficiency, and quality, though benefits vary. 54.5% of respondents reported faster project completion due to reduced rework and better coordination, while 27.3% saw no time impact, suggesting user expertise is crucial. Cost reductions were moderate, with 63.3% noting savings from improved design accuracy. Quality improvements were significant, with 81.8% reporting enhanced outcomes. These findings align with Memon et al. [9] and Eastman [13], highlighting BIM's efficiency, though initial costs remain a barrier for small firms.

Objective 3: Propose Recommendations for Improving Legal and Contractual Frameworks

The study captured industry support for legal reforms, with a strong emphasis on standardized contracts, IP clarity, and government-led incentives. Respondents highlighted the need for structured BIM guidelines, particularly in dispute resolution, to prevent conflicts over data ownership and model inaccuracies. Clearer IP definitions, standardized contracts, and financial incentives were widely recommended, aligning with recommendations from Teoh et al. [4]. By addressing these areas, Malaysia can foster an environment that supports collaborative BIM adoption, minimizes disputes, and provides legal clarity for stakeholders at each project phase.

Survey Findings in Comparison with Literature Review

The survey findings align with existing literature while offering unique insights into Malaysia's context. Similar to Jamil and Syazli Fathi [2], the survey identifies financial and technical barriers to BIM adoption for SMEs. Legal and contractual issues, particularly around IP and data ownership, echo Baharom et al. [5] findings, emphasizing the need for a clear legal framework. The study also supports Memon et al. [9] observations on BIM's positive impact, though initial costs remain a challenge. Regulatory gaps highlight the need for a Malaysian-specific BIM framework, similar to those in the UK and Singapore.

Limitations of the Study

Despite the valuable insights provided, this study has several limitations that may affect the generalizability and depth of the findings.

Sample Representation and Diversity: The study's sample primarily consisted of Quantity Surveyors, Engineers, Project Managers, and Architects, with limited input from other key stakeholders such as contractors, clients, and regulatory officials. This gap in representation may have resulted in an incomplete understanding of the legal and regulatory challenges specific to certain roles. Additionally, the sample size may not fully reflect the diversity of the Malaysian construction industry, particularly regarding geographic distribution and firm size.

Scope of Legal Issues Explored: The study focused on legal issues directly associated with BIM adoption, including intellectual property rights, contractual clarity, and dispute resolution. However, it did not cover broader or emerging legal concerns such as data security, privacy, and cybersecurity, which are increasingly relevant as BIM becomes more integrated with digital data exchange. As a result, the findings may not fully capture the scope of legal challenges that BIM users face in a digitally interconnected environment.

Limitations in Cross-Phase Analysis: While the study provides insights into BIM's use in design and construction phases, it offers limited analysis of BIM's application during the operational and maintenance phases. This restricts the study's ability to fully understand BIM's impact across the entire project lifecycle, especially in areas such as asset management and post-construction operations, where BIM's benefits could be significant but face unique regulatory challenges.

Potential Response and Role Bias: Responses may have been influenced by the specific professional roles and organizational contexts of the participants. For example, smaller firms with limited BIM experience may have different perceptions of legal challenges compared to larger firms with established BIM practices. Furthermore, role-specific experiences might have biased responses on issues like intellectual property and contract clarity, as these challenges can vary significantly between roles such as project managers and quantity surveyors.

Limited comparative context: The study focused solely on Malaysia, which limits the ability to compare findings with other countries that have mature BIM policies and regulatory frameworks. Such a comparison could have provided valuable insights into best practices and areas for improvement in Malaysia's BIM legal framework.

Recommendations for Future Research

Based on the limitations identified and the study's findings, future research could expand upon this study by addressing the following areas:

Broader inclusion of stakeholders and roles: Future studies should include a wider range of respondents, including contractors, clients, and government regulators. By capturing the perspectives of these stakeholders, researchers could develop a more comprehensive understanding of BIM's legal and regulatory challenges across the entire construction ecosystem. This broader inclusion would also allow for a more nuanced understanding of BIM-related challenges specific to different roles and project phases.

Exploration of Data Privacy and Cybersecurity in BIM: As BIM increasingly relies on digital models and data sharing, future research should examine issues related to data privacy, cybersecurity, and the protection of sensitive project data. With potential vulnerabilities in digital exchanges, studies could explore the specific legal implications of data security in BIM, as well as ways to protect sensitive data against cyber threats. This research would help stakeholders understand additional legal protections that may be required in a digitally interconnected construction environment.

Lifecycle and phase-specific BIM challenges: Future research could focus on the challenges and legal implications of BIM across the entire project lifecycle, from design to construction, and into the operation and maintenance stages. By examining each phase separately, researchers can identify phase-specific legal and regulatory needs, including asset management and long-term data ownership issues. Such studies would provide a more comprehensive understanding of the regulatory challenges and legal risks unique to each project phase.

Comparative analysis with BIM-mature countries: Conducting comparative research between Malaysia and countries with established BIM mandates, such as the UK, Singapore, or the United States, could yield insights into best practices in legal frameworks, IP management, and dispute resolution. By analyzing how these countries have structured their BIM regulatory frameworks, researchers could identify successful strategies that Malaysia might adapt to improve its own policies and enhance BIM adoption.

Cost-Benefit Analysis Specific to Small and Medium Enterprises (SMEs): Given the financial challenges identified in this study, future research could focus on a cost-benefit analysis for SMEs, examining the economic feasibility of BIM adoption for smaller firms. This analysis could evaluate potential cost savings, training expenses, and the long-term return on investment from BIM implementation. Such research would offer valuable insights into how financial support or government incentives could mitigate BIM’s initial costs, making it more accessible and encouraging broader adoption across the industry.

Evaluation of standardized contract models: Given the high demand for clearer contracts and standardized BIM frameworks, future research could focus on assessing or developing standardized BIM contract models suited for the Malaysian context. Researchers could examine which contract elements most effectively address issues of IP ownership, data responsibility, and risk allocation, and test these models in pilot projects to evaluate their impact on reducing disputes and enhancing project collaboration.

Conclusion

The research identified key barriers to BIM adoption in Malaysia, including high implementation costs, unclear legal frameworks, intellectual property issues, and inconsistent risk management practices. Comparison with prior literature emphasized the need for tailored regulatory support, government incentives, and structured training. It also stresses the importance of standardized contracts, clearer IP regulations, and client-driven initiatives for BIM integration. Future research should address broader stakeholder inclusion, explore data security, and conduct comparative analyses with BIM-mature countries, laying the groundwork for stronger legal and regulatory frameworks in Malaysia's construction sector.

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