ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIII, Issue XII, December 2024

Bridging the Gap: Strategies to Enhance Building Information Modelling (BIM) Integration in Klang Valley, Malaysia's Construction Industry

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DOI : https://doi.org/10.51583/IJLTEMAS.2024.131213

Received: 02 December 2024; Accepted: 14 December 2024; Published: 09 January 2025

Abstract: The adoption of Building Information Modelling (BIM) has transformed the architecture, engineering, and construction (AEC) industry by providing a digital platform for integrating project lifecycle information. While BIM has been widely recognised for improving project efficiency, reducing costs, and enhancing communication, its implementation faces persistent challenges that hinder its full adoption, particularly in Malaysia. This study aims to identify the challenges of BIM implementation in construction projects within Klang Valley and to recommend strategies for improving its adoption in construction projects. A mixed-method approach was employed, involving a questionnaire survey distributed to 55 AEC professionals and in-depth interviews with three key stakeholders. The findings highlight that high costs, skill gaps, time constraints, preference for conventional practices, and limited awareness and training are the primary challenges hindering BIM adoption in construction projects, underscoring the need for financial support, capacity-building initiatives, cultural shifts, and improved education to foster wider acceptance and implementation. These challenges highlight the need for targeted initiatives to bridge knowledge gaps, enhance training programmes, and promote the value of BIM to stakeholders. Addressing these issues is crucial to ensuring the successful integration of BIM across construction projects, enabling the industry to maximise its potential benefits. Effective BIM adoption in construction projects requires a combination of comprehensive training, phased implementation, government support, standardisation, and technological advancements, underpinned by national strategies to address challenges, enhance education, and demonstrate BIM's tangible benefits. This study aims to provide insights that can guide policymakers, industry leaders, and practitioners in overcoming the barriers to BIM adoption, paving the way for a more advanced and efficient construction sector.

Keywords: Building Information Modelling (BIM), architecture, engineering and construction (AEC) industry, construction project, challenges of BIM, BIM adoption strategies

I. Introduction

Building Information Modelling (BIM) has evolved into a cornerstone technology in the architecture, engineering, and construction (AEC) industry, reshaping traditional project management and design practices. Since its conceptual introduction in the 1980s and formalisation through Autodesk's 2002 white paper, BIM has been widely recognised as a digital platform for integrating physical and functional characteristics of a facility throughout its lifecycle (Autodesk, 2002). Its capabilities extend beyond three-dimensional modelling to include time (4D) and cost (5D) dimensions, enabling enhanced collaboration, efficiency, and decision-making across project stakeholders (US National BIM Standard Project Committee, 2007).

Globally, countries such as the United Kingdom and Canada have embraced BIM as part of their digital transformation strategies, with annual adoption rates reflecting its growing impact (NBS, 2016). In Malaysia, BIM adoption commenced in 2007 with the Public Works Department's implementation in government projects, including the National Cancer Institute (Ahmad Latiffi et al., 2016). Subsequently, initiatives such as the Construction Industry Transformation Plan (CITP 2016–2020) and the Construction 4.0 Strategic Plan have driven awareness and implementation efforts. Despite these initiatives, the adoption of BIM remains limited, with many stakeholders reporting insufficient knowledge, high costs, and resistance to change as significant barriers (Haron et al., 2017).

The necessity for BIM in Malaysia's construction sector, particularly in the Klang Valley, is underscored by the region's high volume of infrastructure projects. However, challenges persist, such as technical constraints, lack of training, and reluctance to shift from conventional methods. While BIM offers numerous benefits—improving planning, coordination, and project outcomes—its potential remains underutilised due to these barriers (CIDB, 2016; Zakaria et al., 2013).

This study aims to examine the challenges hindering BIM adoption in the Klang Valley and to propose strategies for its enhancement. By examining BIM adoption in this region, the research provides valuable insights into the key determinants affecting its successful integration into the construction industry. Additionally, the study highlights the importance of developing targeted strategies to address these determinants, ensuring a more effective and sustainable implementation process. The findings serve as a foundation for stakeholders to better understand BIM dynamics and work toward its optimization in Klang Valley's construction sector.

II. Literature Review

Building Information Modelling (BIM) has emerged as a transformative tool in the architecture, engineering, and construction (AEC) sector, promising improved collaboration, efficiency, and project outcomes. While globally recognized as a game-changer, its adoption in Malaysia remains in developmental stages, requiring a conducive environment and proactive collaboration among industry stakeholders. Introduced by the Public Works Department (PWD) in 2007, BIM has showcased its potential through projects such as the National Cancer Institute. However, barriers like high implementation costs, limited expertise, and low client demand continue to impede progress.

On a global scale, countries such as the United States, the United Kingdom, and Scandinavian nations have demonstrated how strategic government initiatives and structured frameworks can facilitate widespread BIM adoption. For instance, the US has leveraged government mandates to promote BIM use in federal projects, while the UK's unified framework for BIM implementation in public infrastructure has become a benchmark. Similarly, Norway and Singapore have emphasized integrating BIM into national policies, underscoring the importance of structured policies, technical support, and collaborative frameworks.

Despite these success stories, Malaysia faces multifaceted challenges. High initial costs, particularly for software, hardware, and training, deter many stakeholders from adopting BIM (Haron et al., 2017). A lack of technical expertise and resistance to change further exacerbates the issue, with many industry players hesitant to transition from traditional methods (Anuar et al., 2015). Compounded by limited awareness of BIM's benefits, these challenges restrict its integration into workflows (Mamter, 2017). Technological barriers, such as interoperability issues and inadequate infrastructure, particularly among small and medium-sized enterprises (SMEs), also play a significant role (Smith & Tardif, 2009; Shang & Shen, 2014).

In infrastructure projects, the complexity and scale of operations magnify these challenges. Robust data management systems are often lacking, complicating the handling of extensive datasets (Radzia et al., 2024). Additionally, legal ambiguities surrounding data ownership and liability, coupled with the absence of national BIM standards, hinder consistent application (Olatunji & Sher, 2010). These gaps highlight the pressing need for regulatory frameworks and standardization in Malaysia's construction industry.

Recent developments indicate a positive shift towards greater BIM adoption in Malaysia. Between 2021 and 2024, the Public Works Department (JKR) implemented BIM technology in 455 construction projects across various stages of planning, design, and construction (The Edge Malaysia, 2024). Furthermore, starting August 2024, Malaysia mandated the use of BIM for all major construction projects valued at RM10 million and above, marking a significant move towards digital methods in the construction sector (PlanRadar, 2024).

To address the challenges of BIM adoption, Malaysia has implemented several strategic initiatives aimed at fostering integration and utilization within the construction sector. The Construction Industry Development Board (CIDB) has introduced comprehensive policy and regulatory frameworks, such as the BIM Guide 5, to standardize and promote BIM usage across the industry (CIDB, 2019). These guidelines provide a structured roadmap for addressing key challenges like interoperability and implementation best practices. Additionally, CIDB-led efforts focus on training programs to bridge the skills gap and equipping professionals with the expertise needed for effective BIM implementation. Financial incentives and grants have been introduced to mitigate high initial costs, particularly benefiting small and medium-sized enterprises (SMEs). Together, these measures create a supportive environment for BIM adoption, enabling the construction industry to overcome barriers and align with global standards for improved efficiency, collaboration, and sustainability.

Collaborations between government agencies and educational institutions have been established to provide training programs that enhance technical expertise in BIM.

Financial Incentives: Programs offering financial support to offset the high initial costs associated with BIM implementation have been introduced to encourage adoption among SMEs.

By learning from global best practices and implementing these targeted initiatives, Malaysia aims to overcome existing barriers and fully realize the benefits of BIM in its construction and infrastructure sectors.

III. Methodology

The study employs a purposive sampling technique, where respondents are deliberately chosen based on their direct involvement in the construction industry and experience with Building Information Modelling (BIM) implementation. This method ensures the selection of participants with relevant expertise and knowledge, allowing them to provide meaningful insights into the study's research questions. Following Creswell's (2014) methodology, purposive sampling focuses on identifying individuals who are most likely to contribute rich, relevant, and diverse information. This approach allows for an in-depth examination of the specific experiences and perspectives of BIM practitioners, leading to a more nuanced understanding of the challenges and opportunities associated with BIM adoption. The study's sample comprises 55 experts from various fields, including architecture, engineering, construction, and specialist roles, all involved in BIM projects within Malaysia's Klang Valley region.

Data collection involved semi-structured interviews using open-ended questions, a consent letter, and a voice recorder to gather qualitative insights. Most interviews have lasted approximately 30 minutes, with the shortest interview lasting 20 minutes and the

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIII, Issue XII, December 2024

longest about 30 minutes. Three individuals from different backgrounds and groups in the construction industry participated in interviews, explicitly representing the architecture, engineering, and construction management sectors. Participants were informed of the research objectives, and their consent was obtained before the discussions began. The semi-structured format allowed for flexibility, enabling the interviewer to ask follow-up questions and prompting participants to elaborate on their perspectives. As highlighted by Bryman and Bell (2015), semi-structured interviews encourage personalised responses, leading to richer data. Rapport was established at the beginning of each session, creating a comfortable environment for participants to share their thoughts freely. The use of recordings ensured the accuracy and reliability of the responses, which are essential for formulating practical and actionable strategies.

The findings from these interviews will guide recommendations tailored to overcoming specific challenges and fostering broader acceptance of BIM technologies within architecture, engineering, and construction management sectors.

IV. Data Analysis Method

The research adopts both quantitative and qualitative analysis methods to examine BIM implementation in Klang Valley construction projects. The research approach distinguishes the objectives of qualitative and quantitative data collection. Quantitative data focuses on identifying the challenges associated with BIM adoption through structured surveys and statistical analysis. On the other hand, the qualitative data, gathered through semi-structured interviews, is specifically aimed at formulating strategies for improving BIM adoption based on industry insights.

The qualitative data from semi-structured interviews were analysed using thematic analysis to uncover meaningful insights into strategies for improving BIM adoption in construction projects. This process provided a structured approach to identify, organise, and interpret key themes relevant to the research objectives. To ensure the accurate representation of participants' responses, all recorded interviews were transcribed verbatim. The transcripts were then thoroughly reviewed to familiarise the researchers with the data and understand the context of participants' perspectives. This initial stage set the foundation for a systematic analysis process. The analysis followed Patton's (1987) methodology, which involves organising, summarising, categorising, and examining data for patterns and themes. Codes were generated from the raw data, representing key ideas or recurring points highlighted by participants. These codes were systematically grouped into broader categories to identify overarching themes. Powers and Knapp (2006) emphasise the importance of content analysis in identifying recurring themes and patterns. This step facilitated a deeper understanding of stakeholders' viewpoints on BIM adoption challenges and enhancement strategies. Themes were refined and categorised based on their relevance to the research questions, ensuring that the analysis captured both the barriers to BIM adoption and actionable recommendations for improvement.

The insights gained from thematic analysis were integrated into the overall research findings. This ensured a comprehensive exploration of the challenges and strategies for BIM adoption, complementing the quantitative data. For example, if quantitative results identified "lack of training" as a major challenge, qualitative insights provided details on specific training approaches recommended by industry professionals.

V. Results and Discussion

The Challenges of Bim Implementation in Construction Projects

Table 1: Survey's Result

Item	SD	D	N	A	SA
High cost of the BIM technology, software and training, are the main factors that obstruct stakeholders from adopting the technology.	7.28	0.00	16.36	36.36	40.00
Lack of competency among the team members and lack of time to implement another challenge to implement BIM technology.	3.63	0.00	20.00	43.64	32.73
Reluctant to venture into new technology and assumption that conventional methods are easier than new processes are other challenges to implement BIM.	1.82	3.64	16.36	60.00	18.18
Low exposure and education on BIM knowledge among stakeholders and players in construction industry cause the adoption rate is still lower in Malaysia.	0.00	8.90	8.90	60.00	22.20

Note: SA= Strongly Agree; A= Agree; Neutral; D= Disagree; SD= Strongly Disagree

Cost Implications of Bim Adoption

The data reveals that financial constraints are the most significant challenge, with 40.00% of respondents strongly agreeing and 36.36% agreeing that the high cost of BIM technology, software, and training obstructs adoption. These percentages underscore

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIII, Issue XII, December 2024

the widespread consensus on the financial burden associated with implementing BIM. Respondent 2 highlighted budget constraints, specifically pointing out that the cost of staff training and software acquisition creates significant hurdles for consultants. Respondent 3 echoed these concerns, emphasising that the initial cost of BIM software is prohibitively high, and the associated training expenses add to the financial strain. Respondent 1, although not directly mentioning cost, alluded to the broader financial implications by associating these challenges with industry-wide limitations. These findings align with previous research. Elmualim and Gilder (2014) identified that insufficient capital and the perception that BIM benefits do not outweigh implementation costs are critical barriers to BIM adoption. Similarly, Siebelink et al. (2020) observed that financial constraints, such as the high costs of software and training, significantly hinder BIM implementation at various organisational levels.

The convergence of quantitative data, interview insights, and existing literature confirms that financial constraints are the primary barrier to BIM adoption. The high costs associated with technology and training limit accessibility and deter stakeholders from embracing BIM as a standard practice in the construction industry. Addressing these financial barriers is crucial to fostering wider adoption.

Skill Gaps and Time Constraints in Bim Integration

The integration of Building Information Modelling (BIM) in construction projects is significantly hindered by skill gaps among team members and insufficient time for implementation. Quantitative data indicates that 43.64% of respondents agree, and 32.73% strongly agree, that these factors are major obstacles to effective BIM adoption.

The insights provided by Respondents 1, 2, and 3 collectively highlight significant barriers to the effective adoption of Building Information Modelling (BIM). These challenges, centred around technical skill deficiencies, reliance on conventional methods, and the steep learning curve for contractors and subcontractors, underline the complexity of integrating BIM into the construction industry.

However, these barriers are not insurmountable. While Respondent 1 points to insufficient technical expertise, this can be mitigated through targeted training and professional development, as supported by Ullah et al. (2019), who identified a lack of skilled personnel as a key barrier to BIM adoption. Respondent 2's observation about the reliance on conventional methods underscores the need for cultural and systemic shifts to encourage collaboration and standardisation, echoing findings from Sardroud et al. (2018), who noted that traditional workflows and cultural issues slow down BIM implementation. Finally, the steep learning curve highlighted by Respondent 3 reveals the importance of phased implementation and accessible training programs, aligning with Siebelink et al. (2020), who emphasised the need for skill development and capacity building at all organisational levels.

These findings, when viewed collectively, suggest that addressing BIM adoption challenges requires a multi-pronged approach, combining individual capacity building with systemic reforms. Investments in training, incentives for adoption, and the establishment of industry-wide standards are essential to overcoming these barriers and enabling widespread and effective use of BIM in construction projects.

Preference For Conventional Practices

The adoption of Building Information Modelling (BIM) in the construction industry faces challenges due to a preference for conventional methods and reluctance to embrace new technologies. Quantitative data indicates that while 60.00% of respondents agreed with this sentiment, only 18.18% strongly agreed, suggesting that although recognised, this issue is less critical compared to cost and skill-related barriers.

Respondent 2 noted that some consultants favour traditional methods because of their familiarity and perceived simplicity. Respondent 3 attributed resistance to change to a lack of confidence and knowledge about BIM, aligning with the quantitative data. Respondent 1 implied that resistance to change is a broader industry cultural issue, though not directly linked to conventional methods. These insights are consistent with existing literature. Elmualim and Gilder (2014) identified unwillingness to adopt new workflows as a significant barrier to BIM implementation. Similarly, Rekve (2023) emphasised that organisational resistance to change is a critical factor hindering BIM adoption. Additionally, a study by Vital Consulting (2023) highlighted that professionals accustomed to traditional project management methods often view BIM as an overly complex addition to their workflow.

Limited Awareness and Training in Bim

60.00% of respondents agree, and 22.20% strongly agree, that insufficient BIM knowledge contributes to the low adoption rate. Respondent 1 highlighted a lack of technical skills, directly linked to insufficient BIM education. Respondent 2 emphasised the necessity for enhanced training and education to boost adoption rates. Respondent 3 noted that low awareness and knowledge among contractors and subcontractors exacerbate the slow adoption rate.

These insights align with existing literature. Mamter et al. (2019) identified that educational institutions play a crucial role in building the human capital required for BIM adoption, and a lack of adequately trained personnel is a major barrier. Munianday et al. (2023) found that the most significant impediments to BIM adoption include the appraisal of time and finances, as well as the tolerance of changes in approach, suggesting that collaborative training and BIM education are essential solutions. Taat et al. (2022) reported that the lack of training and education is one of the significant barriers to BIM adoption. Ismail and Kamal (2023) highlighted that numerous research studies identify the lack of professional skills in BIM application as a primary reason for the slow adoption of BIM in industries.

Insufficient education and training present significant challenges to improving BIM adoption in Malaysia's construction industry. Addressing these issues through enhanced educational programs and industry collaboration is essential for increasing the adoption rate.

Table 2: The Ranking Analysis

Item	A	SA	Agree + SA	Rank
Low exposure and education on BIM knowledge	60	22.2	82.2	1
Reluctant to venture into new technology	60	18.18	78.18	2
Lack of competency among team members	43.64	32.73	76.37	3
High cost of the BIM technology	36.36	40	76.36	4

Note: SA= Strongly Agree; A= Agree

The ranking analysis highlights that low exposure and education on BIM knowledge is the most critical barrier to adoption, underscoring the urgent need for structured training programs and awareness initiatives. Reluctance to adopt new technology ranks second, driven by resistance to change and reliance on traditional methods, which can be mitigated through effective change management and incentives. The lack of competency among team members and time constraints is another significant hurdle, requiring targeted skill development and phased implementation strategies. Lastly, the high cost of BIM technology, software, and training remains a prominent barrier, necessitating financial support mechanisms such as subsidies and cost-sharing. Addressing these challenges in a prioritised manner can foster wider and more effective adoption of BIM in the construction industry.

Strategies For Improving Bim Adoption in Construction Projects

Comprehensive Training Programs and Career Development

Comprehensive training programs are crucial for building BIM proficiency across construction teams. Respondent 1 emphasised team-wide training for shared understanding, while Respondent 2 highlighted career-linked training as a driver for participation and knowledge transfer. Mamter et al. (2019) stressed collaboration between educational institutions and industry for BIM-specific curriculums, and Sardroud et al. (2018) pointed to continuous training as key to addressing skill gaps and accelerating adoption.

Phased implementation, as noted by Respondent 3, allows organisations to integrate BIM gradually, minimising disruptions. Rekve (2023) supported this, advocating for initial consultant-led stages to reduce resistance, with Munianday et al. (2023) recommending ongoing training for long-term sustainability.

Advanced technologies like AI and AR/VR enhance BIM training by improving predictive analytics and creating immersive learning experiences. Respondent 2’s insights align with Taat et al. (2022), who found these tools significantly improve training outcomes and workflow efficiency.

Phased Implementation Approach

Introducing BIM incrementally, with initial support from consultants and leveraging cloud-based coordination tools, provides a smooth transition for organisations. Respondent 3 highlighted the efficacy of this method, particularly during early adoption phases. Munianday et al. (2023) supported this, finding that gradual adoption minimises disruptions and improves long-term adaptability. Similarly, Rekve (2023) emphasised that phased implementation allows organisations to address resistance incrementally, increasing acceptance and efficiency over time. This approach aligns with industry best practices, enabling stakeholders to manage learning curves and operational changes effectively.

Government Support and Incentives

Financial barriers remain a primary challenge to BIM adoption, as noted by respondents advocating for tax breaks and subsidies to alleviate training costs. Mamter et al. (2019) reinforced this perspective, highlighting the need for government-backed financial assistance and policy frameworks to encourage adoption. Furthermore, Sardroud et al. (2018) emphasised that sustained government support through education initiatives and incentives can accelerate BIM adoption. National efforts, such as subsidised training and funding for pilot projects, can create a more enabling environment for stakeholders.

Standardisation And Collaboration

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIII, Issue XII, December 2024

Developing industry-wide BIM protocols and central repositories of best practices fosters collaboration and enhances adoption. Respondent 3 recommended centralised knowledge-sharing initiatives, while Taat et al. (2022) identified the importance of standardised processes for improving coordination and reducing inefficiencies. Alsofiani (2024) suggested that shared digital platforms can enhance integration across project teams, aligning practices and improving project outcomes.

Leveraging Technological Advancements

Emerging technologies such as AI, AR/VR, blockchain, and cloud computing have transformative potential for BIM workflows. Respondents highlighted that these tools improve predictive analytics, decision-making, and secure data sharing. Rekve (2023) and Taat et al. (2022) noted that such advancements not only enhance operational efficiency but also simplify complex processes, making BIM adoption more accessible.

A national BIM program could provide a unified strategy for addressing barriers, promoting education, and improving digital maturity in construction. The National Institute of Building Sciences (2022) stressed the value of such initiatives in driving adoption and improving standardisation. Furthermore, addressing resistance to change through clear demonstrations of BIM's business value is critical, as highlighted by Sardroud et al. (2018).

VI. Conclusion

In conclusion, the adoption of Building Information Modelling (BIM) in construction projects faces significant challenges, with financial constraints, skill gaps, resistance to change, and limited education emerging as critical barriers. Ranking analysis identifies low exposure and education as the most pressing issue, necessitating structured training and awareness programs, followed by reluctance to adopt new technology and reliance on conventional practices. Strategies for improving BIM adoption include comprehensive training initiatives linked to career development, phased implementation approaches to minimise disruptions, government incentives to alleviate financial burdens, and industry-wide standardisation to foster collaboration. Leveraging emerging technologies such as AI, AR/VR, blockchain, and cloud computing further enhances BIM workflows and adoption potential. Future research should explore the impact of national BIM programs, incorporating advanced technologies, and quantifying the return on investment for BIM implementation. Additionally, assessing the long-term effectiveness of phased approaches and government-supported initiatives could provide actionable insights for policymakers and industry stakeholders.

Acknowledgement

The authors wish to express their gratitude to all individuals and organisations that supported this study in various capacities, although these contributions are not covered under the author contribution or funding sections. All authors contributed equally to the conceptualisation and design of this research, reflecting a collaborative effort throughout the process.

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