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BARRIERS OF BUILDING INFORMATION MODELLING (BIM) IMPLEMENTATION: CURRENT PERSPECTIVES OF CONSTRUCTION STAKEHOLDERS IN JOHOR, MALAYSIA

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Abstract — Building Information Modelling (BIM) is an innovative approach within the architectural, engineering, and construction (AEC) industry that has been globally adopted. Despite Malaysia's construction industry experiencing substantial growth and technological advancements, a significant proportion of AEC firms remain uninterested in BIM due to anticipated challenges. This study aims to explore the hurdles hindering BIM implementation specifically within the Johor region of Malaysia's AEC construction sector. Data were gathered through a survey and analyzed using the Average Index method. The findings highlight several key factors impeding BIM adoption, notably a lack of awareness regarding its benefits among stakeholders, inadequate standardization in government regulations, and the high costs associated with software licenses. Addressing these barriers is crucial for stakeholders to devise effective strategies for overcoming obstacles and fostering the adoption of BIM in construction practices.

***Keywords*:** building information modelling, sustainable, construction, stakeholder, barrier

1.0 INTRODUCTION

Building Information Modelling (BIM) presents a groundbreaking technology with the potential to enhance various aspects of construction firms. However, alongside its benefits, there exist numerous challenges and barriers to its implementation, such as the costs associated with training and the need to adapt existing business practices. Griffith et al. [1], O'Brien [2], and Whyte and Bouchlaghem [3] argue that the resistance to adopting modern information technology (IT) within the construction sector primarily stems from technical difficulties rather than societal factors, citing issues like lack of technical expertise, system complexity, and inadequate support structures. Conversely, Ruikar et al. [4] and Rojas and Locsin [5] propose a different viewpoint, emphasizing that human factors pose significant obstacles to the integration of modern technology in construction. According to Martinko et al. [6], the challenge lies in changing people's behaviors to effectively utilize digital tools, which they identify as the most influential factor hindering the adoption of new technologies.

In Malaysia, the barriers to implement BIM in the country can be categorized into three main factors, which are people, processes and technology [7]. The first factor is 'people'. People have been comfortable with traditional methods ever since the first construction project was built in Malaysia. Thus, most of them refuse to change conventional methods, as it will be difficult for them to adapt to new ones. Next, the lack of skills and knowledge to implement BIM is also an issue, as most construction firms do not expose the usage of BIM to their employees. This shows that BIM is still new in Malaysia, as most construction players are still learning to understand fully BIM [7].

The second factor is the processes. There are no proper BIM guidelines or any specific models that could assist construction players in implementing BIM in their daily usage in the construction field. The third factor is technology. The tools for applying BIM are expensive to most contractors [7]. Additionally, the continual advancement of BIM hardware necessitates frequent updates, which often translates to significant costs for most construction industry stakeholders. Moreover, in order to apply BIM, construction players are required to undergo trainings to better understand BIM. But the training is expensive, and some companies cannot afford to pay for all of their workers [8].

Even though several studies were conducted on the barriers to BIM implementation towards the building industry in Malaysia, such as Zuhairi et al. [9], Ibrahim et al. [10] and Memon et al. [11], a clear understanding of these obstacles remains elusive. Moreover, the investigations mentioned above cover Malaysia as a whole, and do focusing on a particular region. Therefore, this study aims to investigate the barriers of BIM implementation in the construction industry, particularly focusing on construction projects in Johor.

1.1. Barriers of BIM Implementation

1.1.1. People

This category encompasses barriers related to human resources, skills, and workforce readiness for BIM adoption. Items under this category include factors such as the availability of well-trained personnel, employee skill levels, and training programs focused on BIM proficiency. These barriers reflect challenges associated with the readiness of individuals within organizations to embrace BIM technology and processes effectively. BIM is strongly reliant on people in order to be implemented. To ensure the success of BIM deployment, employees should be equipped with BIM knowledge and training [12]. Among the barriers identified are lack of knowledge and understanding on BIM [8, 13]; lack of awareness [11, 14, 15], lack of BIM expertise [8], lack of training [11–14]; resistance to change [14]; lack of communication [14]; and fear of outcomes [14].

1.1.2. Government

The government category encompasses barriers related to regulatory frameworks, standards, and policies that impact BIM implementation. Items under this category include factors such as the availability of BIM standards, regulatory support for BIM adoption, and accessibility of government resources for BIM initiatives. These barriers highlight the importance of supportive government policies and regulations in facilitating the widespread adoption of BIM within the construction industry.

The Malaysian government makes little effort to encourage the use of BIM in general. To achieve widespread acceptance, the government should take the lead in encouraging BIM implementation in the Malaysian construction industry. Despite a considerable roadblock during implementation, it is clear that the private sector is leading the push in implementing BIM. According to Zuhairi et al. [9], this is a good sign for BIM deployment in the Malaysian construction sector, since it assures that new construction technology is successfully implemented.

Organizational culture is also one of the major barriers, according to Ibrahim et al. [10], as the majority of respondents were indifferent when it came to the organization's stance. This is because it is connected to the top management's desire to change and their opinions on BIM. The cost that relates to BIM adoption in the construction sector requires a significant upfront investment in terms of software, hardware, and personnel training. Changes in work flow and procedure are costly when new technologies are implemented. Most service providers will not make such an investment unless they see long-term benefits for their company, and if the owner subsidizes the training expenditures [11].

Client demands are also among the barriers of BIM implementation, as many stakeholders are concerned about change. Clients believe that changing contract requirements to allow for the use of 3D or BIM models reduce the number of competitive bids received. This will narrow their pool of possible bidders, and, as a result, raise the project's overall price. This might be due to the fact that clients are unaware of new technology and its advantages. Thus, there is a reluctance to adopt BIM. In reality, implementing BIM in the construction business is difficult without client demand [11].

1.1.3. Technology-related task

This category encompasses barriers related to technological aspects of BIM implementation, such as software costs, compatibility issues, and technological infrastructure requirements. Items under this category include factors such as the affordability of BIM software licenses, technological challenges in software integration, and the availability of adequate technological resources for BIM implementation. These barriers underscore the importance of addressing technological constraints to ensure smooth BIM adoption and integration into construction workflows.

A technology-related concern is the lack of BIM standards for model integration and management by various teams. To combine multidisciplinary information in a single BIM model, multi-user access to the BIM model is crucial. Protocols must be created throughout the project programming process to preserve consistency in the information context and formatting standards. Since no common protocols were available at the time, each organization developed its own. This might lead to model errors, which, if not addressed, could result in an inaccurate and inconsistent BIM model [16].

2.0 MATERIALS AND METHODS

A literature review of publications in academic journals, proceedings and books published between the years 2000 and 2021 was used to determine the variables of awareness and barriers of BIM implementation. Following that, relevant data was selected and compiled based on the identification of BIM implementation barriers at construction sites. The questionnaire was created by including the four parties that influence the building site, which are contractor, consultant, architect, and client.

The questionnaire was then evaluated by three expert panels to ensure that it was valid and reliable in terms of content. The specialists were chosen from among individuals with more than five years of expertise in construction sites. Before being distributed to the targeted respondents, the questionnaire was revised multiple times in terms of the value of the collected qualities. The researchers gathered information from a variety of construction projects around Johor. The data from the survey was analysed using average index analysis and SPSS software to determine the significant barrier to BIM implementation in the construction industry.

2.1. Questionnaire Development

Table 1 Factors of Barriers in BIM Implementation

Group	Code	Key barrier
People	P1	Lack of BIM knowledge
	P2	Lack of awareness of BIM benefits
	P3	Lack of BIM expertise
	P4	Reluctance to change to BIM
	P5	Fear of the unknown outcomes
	P6	Lack of collaboration among parties
	P7	Lack of well trained workers
	P8	Lack of support from top management
	P9	High cost of training program
Government	G1	Clients are reluctant to spend on BIM adoption
	G2	Lack of standardization
	G3	Lack of national agenda
	G4	Lack of governmental legislation
	G5	Lack of support and motivation
	G6	Lack of BIM demand among clients and most company
Technology-related task	T1	Expensive cost of software license
	T2	Some software only in English progress
	T3	Complexity of BIM technologies (software) compare with conventional method
	T4	Requirement of high-spec computers
	T5	Improper interoperability between traditional methods and BIM

A questionnaire was used to collect data on the perspectives of numerous construction groups at constructionsites, allowing for an objective and cost-effective analysis. To begin, a complete list of barriers factors was screened in a pilot research to confirm that all of the questionnaire items are valid, reliable, and meaningful. The categorization of barriers into “people”, "government," and "technology-related tasks" categories was based on previous studies and expert judgment (content validation). While factor analysis can provide valuable insights into the underlying structure of survey data, our study focused on descriptive analyses to identify and prioritize key barriers to BIM implementation based on respondent perceptions. There were three parts to the survey. The first part looked into the respondents' backgrounds. The second part looked into the 26 barriers factors of BIM, which are indicated in Table 1. These are the variables that may influence the deployment of BIM on construction sites. Likert scores ranging from 1 (strongly disagree) to 5 (strongly agree) were used in the questionnaire.

2.2. Population and Sampling

The survey targeted construction stakeholders directly involved in building projects across the Johor state. It was administered voluntarily and anonymously, with the support and collaboration of project owners. A total of 65 responses were collected from a diverse range of industry practitioners, including architects, contractors, clients, and consultants. The selection criteria ensured that respondents held managerial positions or higher within their respective organizations, ensuring a comprehensive insight into industry perspectives. The data collection process faced notable challenges due to the Movement Control Order (MCO) imposed by the government amid the pandemic situation, which limited physical interactions and access to potential participants. Although online surveys have a low response rate [17], the study adopted the method because of the COVID-19 restrictions on movement, low administration costs and flexibility of displaying questions. For instance, Chigara and Movo [18] conducted a study in construction industry in Zimbabwe during Covid-19, and their study received 27% response rate. This challenge is common in construction research during the pandemic [19]. Additionally, the total responses exceeded the minimum threshold of 30 respondents, therefore considered acceptable and sufficient for statistical analysis [17]. Table 2 presents the breakdown of respondent details.

Table 2 Details of Respondents

Description	**Percentage (%)**
Respondents' organisation	
Architect	28
Contractor	29
Client	25
Consultant	18
Working experience (years)	
Less than 1 year	8
1 to 3 years	26
4 to 6 years	22
7 to 9 years	17
More than 10 years	28

2.3. Measure for Data Analysis

After data collection, non-parametric approaches were used to analyse the major barriers towards BIM implementation in the construction industry once the data was collected. The reliability test was conducted using the Statistical Package for the Social Sciences (SPSS) software application. Then, the data was analysed for Average Index Analysis to obtain the average index value for the factors of awareness and barriers of BIM among respondents from the construction industry.

A reliability study was performed to ensure the accuracy of the results and the general consistency of the survey. The Cronbach's Alpha was used to evaluate the reliability of the system, that is its internal consistency. Alpha values exceeding 0.6 generally indicate acceptable reliability [20]. A decent alpha value typically starts at 0.70 and increases from there, indicating strong internal consistency [21]. The result of Cronbach's Alpha score for this study was 0.978, suggesting a high level of consistencies of the survey instrument. Next, the Average Index Analysis was used to compute the mean score of major factors impacting BIM implementation. Table 3 shows the average index ratings that indicate acceptable categorization, as indicated by Majid et al. [22].

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Table 3 Average Index Rating

Likert scale	Score value
Strongly disagree	1.00 ≤ Average Value ≤ 1.50
Disagree	1.50 ≤ Average Value ≤ 2.50
Moderately agree	2.50 ≤ Average Value ≤ 3.50
Agree	3.50 ≤ Average Value ≤ 4.50
Strongly agree	4.50 ≤ Average Value ≤ 5.00

3.0 RESULTS AND DISCUSSION

3.1. Average Index Analysis of the Barriers of BIM Implementation

With the supplied scale suggested by the respondents, an average index analysis was performed to examine the strongest agreement for the awareness and barriers of BIM implementation in building construction in the Johor area. Table 4 illustrates the results of Average Index Analysis towards barriers of BIM implementation based on respondents.

According to Table 4, the contractor team has the highest mean rating score when compared to the other groups of construction teams. Meanwhile, the average of all groups viewed question P7 in the category of people, question G2 in the category of government, question T1 in the category of technology-related-task, and question P5 in the category of process, as the barriers of BIM implementation at construction sites. Referring to Table 4, the significant barriers to BIM implementation at construction sites were lack of well-trained people (P7) (3.89), lack of standards (G2) (3.75), high costs of software license (T1) (3.78), and difficulty of changing present management processes (P5) (3.77). Based on all 4 significant barriers between all categories, the highest average mean that was summed up by all construction teams was P7, with the score of 3.89, which was lack of well-trained people.

Table 4 Barriers of BIM Implementation Based on Group of Respondents

	Contractor	Consultant	Architect	Client	Mean
			People		
P1	4.16*	3.67	3.44	3.38**	3.66
P2	4.00*	3.67	3.44**	3.50	3.65
P3	4.11*	3.50**	3.56	3.75	3.73
P4	4.11*	3.67	3.44 **	3.50	3.68
P5	3.84*	3.58**	3.61	3.63	3.67
P6	4.11*	3.83	3.67	3.56 **	3.79
P7	4.32*	3.67**	3.78	3.81	3.89***
P8	4.32*	3.58	3.50**	3.88	3.82
P9	4.26*	3.67	3.67	3.63 **	3.81
			Governmental		
G1	4.00*	3.58	3.56	3.13**	3.57
G2	3.89	4.17 *	3.50	3.44**	3.75***
G3	3.95*	3.75	3.22**	3.31	3.56
G4	3.84*	3.67	3.11**	3.50	3.53
G5	3.95	4.00*	3.56	3.44**	3.74
G6	3.95	4.00*	3.39	3.44**	3.69
			Technology-related task		
T1	3.89*	3.83	3.72	3.69 **	3.78 ***
T2	3.58	3.50	3.61 *	3.50**	3.55
T3	4.00*	3.42**	3.56	3.56	3.63
T4	4.11*	3.17**	3.56	3.94	3.69
T5	3.58	3.58	3.67*	3.56**	3.60

Based on the results, most of the highest value barriers were scored by the contractors. This appears to be proportionate to their reluctance to implement BIM. According to Zuhairi et al. [9], contractors are one of the parties that engaged in construction projects who are hesitant to implement BIM in their projects due to the lack of knowledge of the benefits of BIM in terms of the operation and maintenance phase of the project's life cycle.

For ‘People’ factor, ‘lack of trained workers’ was the highest perceived barriers to implement BIM. According to Oraee et al. [23], employees received BIM training that focused solely on software platforms and not on the BIM process itself. This is in line with studies by Elhendawi et al. [24] and Zhou et al. [25] that stated that the lack of BIM specialists is one of the barriers on BIM implementation [24]. Furthermore, Wan Mohammad et al. postulated that lack of experience and skilled workers in an organization as the top challenge in BIM implementation [26].

Meanwhile for the ‘Government’ factor, ‘lack of standardization’ was ranked as the highest ranked barrier. Othman et al. stated that BIM model and collaboration standards are not adequately accessible, emphasizing the role of having access to such information [25, 27]. This statement is supported by Gamil et al. [13], which stated that lack of standardization is listed as one of the challenges on BIM implementation.

Next, the highest ranked barrier for ‘Technology-related’ group is ‘expensive cost of software license’. According to Risto [28], companies encounter challenges with costs of acquired technology while racing to excellence in BIM adoption. Currently, all applicable modelling software is extremely costly, costing three times or more than standard 2D CAD software [25]. Similarly, Georgiadou [29] findings expressed that there is widespread of BIM awareness in the UK but financial barrier remains one of the main setbacks in acquiring digital infrastructures that will facilitate BIM adoption, especially for small- and medium-sized enterprises.

The findings of this study hold significant implications for the construction industry. By identifying the key barriers to BIM implementation, stakeholders, including contractors, government agencies, and technology providers, gain valuable insights into areas that require attention and intervention.

The major barriers identified in this study offer valuable opportunities for enhancing BIM implementation in the construction industry. Addressing these barriers can lead to several improvements, such as:

- Enhanced training and skill development [30, 31]: By addressing the lack of well-trained personnel, organizations can invest in targeted training programs to equip employees with the necessary skills and competencies to effectively utilize BIM tools and processes. This can lead to improved workforce readiness and productivity.

- Standardization and knowledge sharing: Zhou et al. [25] postulated that the government and academic organizations could focus on determining legal liabilities within BIM projects and develop appropriate BIM contract templates or supplemental contractual provisions relating to BIM implementation. Overcoming barriers related to the lack of standards and access to information can foster greater standardization and knowledge sharing within the industry. Establishing common protocols and guidelines for BIM implementation can facilitate collaboration and interoperability among stakeholders, leading to smoother project workflows and reduced inefficiencies.

- Cost reduction and technology accessibility: Mitigating barriers associated with the high costs of software licenses can promote greater affordability and accessibility of BIM technology. This can be achieved through strategies such as negotiating bulk discounts, exploring open-source alternatives, or adopting subscription-based pricing models. Reducing barriers to technology adoption can democratize access to BIM tools and empower smaller firms to embrace innovation. Olanrewaju et al. [32] in their research proposed that collaboration among loan providers, government agencies, and relevant professional organizations could address financial aspects of BIM adoption. This collaboration would involve discussions with financial institutions about offering flexible loans to professionals seeking BIM software packages. Additionally, software vendors would be encouraged to provide flexible payment options or discounts to small-medium companies.

- Policy and regulatory support [30, 33]: Addressing barriers related to government standards and regulations can involve advocacy efforts to promote greater alignment between regulatory frameworks and industry needs. Engaging policymakers and regulatory bodies in dialogue can result in the development of supportive policies and incentives that encourage BIM adoption and compliance.

Addressing these barriers can facilitate smoother adoption and integration of BIM into construction practices, leading to improved project outcomes, cost efficiencies, and overall competitiveness. Furthermore, by highlighting the perspectives of different construction teams, the study offers a comprehensive understanding of the diverse challenges faced by industry practitioners, enabling targeted interventions and capacity-building efforts.

4.0 CONCLUSION

This study addresses the pressing need to understand the awareness and barriers associated with BIM implementation in the construction industry, particularly in Johor. BIM has emerged as a transformative technology in the construction sector, promising enhanced efficiency, collaboration, and project outcomes. Therefore, understanding the factors that influence BIM implementation is essential for stakeholders in the construction industry to navigate challenges effectively and capitalize on the benefits of BIM. Additionally, by focusing on Johor, the study provides localized insights that can inform decision-making and strategic planning tailored to the specific context of the region.

The present study presents findings from an experimental investigation examining the viewpoints of construction stakeholders—contractors, consultants, architects, and clients—regarding obstacles to implementing BIM on construction sites. Twenty-six impediments across three categories (people, government, and technology) were examined, and perspectives from stakeholder groups were analyzed. Notably, contractors garnered the highest average score across all categories.

The current study enriches the existing knowledge base of the construction industry by illustrating both the commonalities and discrepancies in the perspectives of stakeholders, particularly those involved in construction projects. While employing a strategy akin to prior research, this study offers a novel examination of the impediments to BIM implementation on building sites in the Johor region.

Consequently, future research endeavors could delve into enhancing strategies based on the assessments of each stakeholder group regarding the barriers to BIM implementation. This approach aims to identify pivotal obstacles, thereby fostering improvements in BIM implementation within the construction sector. Moreover, forthcoming research should broaden the study's scope and expand the respondent pool by incorporating data from other Malaysian states.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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