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Integration of Building Information Modeling Adaptation for Industrialized Building System Projects

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ABSTRACT

This paper examines the integration of Building Information Modeling (BIM) adaptation into Industrialized Building System (IBS) projects to understand the current level of BIM adaptation and readiness among construction players, particularly IBS contractors, in WPKL and Selangor. It aims to evaluate the level of technological adaptation and the technology readiness index (TRI) for BIM-IBS projects and to uncover the relationship between technological adaptation and the TRI. Consequently, a comprehensive literature review and quantitative analysis were adopted to gather relevant information obtained through a questionnaire. The findings indicate a strong level of preparedness for BIM–IBS implementation across all aspects, with average scores typically ranging from 3.98 to 4.61. The financial readiness aspect achieves the highest average (M = 4.61, SD = 0.57). The normality test indicated a non-normal distribution; therefore, Spearman's rank correlation was appropriate for this analysis. The results collectively show that all five factors financial, organizational, technical, individual, and sustainability, demonstrate significant positive correlations with the TRI. Despite certain variations, especially regarding organizational and financial factors, the general findings indicate a solid groundwork for effective BIM–IBS implementation, as long as governance, training, and strategic alignment are consistently enhanced.

Keywords: Building Information Modeling, Industrialized Building System, Technological Adaptation, Technology Readiness Index.

1. INTRODUCTION

In the construction stage, problems frequently occur because of inadequate coordination, communication, and standardization. The implementation of Building Information Modeling (BIM) can assist in tackling these fundamental issues. BIM is a collaborative process that enables various participants in the construction sector to work together on a project [1]. It is viewed as a technology- oriented transformation that can greatly influence the construction sector. BIM transcends merely being an information technology rooted in databases; it integrates aspects of strategy and process [2]. BIM facilitates measurable project performance through the development of a smart virtual system that combines project data from planning to construction and utilization, serving as an alternative to conventional paper-based project design and management.

Moreover, Industrialized Building Systems (IBS) represents another cutting-edge technology that encompasses mass-manufactured construction methods within regulated settings like factories [3]. IBS comprises prefabricated installation elements that are systematically utilized and coordinated efficiently. The Malaysian government has worked to encourage BIM adoption in IBS

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construction initiatives, yet progress has been gradual.

2. LITERATURE REVIEW

2.1 Fourth Industrial Revolution (Industry 4.0)

The construction sector is essential to supporting numerous industries by building infrastructure and properties. Nonetheless, construction workers generally allocate just a limited amount of their time to core activities, while a significant part of their time is spent on tasks like running errands, arranging materials, and overseeing equipment. The Fourth Industrial Revolution (IR4.0), as described by [4], is the merging of IT systems with physical systems to form cyber-physical systems (CPS) that connect the tangible and digital realms, aiming to revolutionize the construction industry.

At present, the construction sector falls short compared to others in automation and digital technologies, even though it has undergone three major transformations in the past that enhanced operations and efficiency. The third transformation was characterized by major computerization, and now, with IR 4.0, intelligence will lead the industry's development. [5] state that IR 4.0 signifies a merging of technologies that integrates the physical, digital, and biological domains. Since its introduction in 2011 [6], the concept of IR4.0 has generated considerable debate, yet a widely accepted definition remains lacking. It is commonly seen as the combination of sophisticated machines, connected sensors, and software, designed to enhance business results and value chain management throughout the product lifecycle [7].

Essential elements of IR 4.0 consist of Cyber-Physical Systems (CPS), the Internet of Things (IoT), the Internet of Services (IoS), and smart entities. Significantly, machine-to-machine (M2M) communication is included in IoT, whereas smart products are categorized under CPS. Utilizing these technologies can enhance productivity and generate employment, thereby driving consumer demand and increasing revenue (the compensation effect). Nonetheless, the emergence of new technologies can result in job loss (redundancy effect), raising concerns about future technological unemployment [8].

2.2 Construction Technology

The construction sector significantly influences the economy, environment, and society by shaping our everyday experiences through the built environment, including residences, offices, and transport systems. Still, the sector has frequently fallen behind in technological advancements relative to others, remaining fairly unchanged over the last fifty years [9]. Construction workers rely significantly on specific skills and expertise, which complicates automation efforts. Over the past 20 years, construction productivity has significantly lagged that of the manufacturing industry, which experienced a 34.1% increase in productivity, compared to 27.1% in other sectors [10].

Although they are different sectors, construction and manufacturing rely on each other. Automation, access to digital data, and connectivity embody the potential for digitalization in construction, facilitating enhanced data gathering and processing throughout the value chain. Cutting-edge technologies develop self-sufficient systems, whereas digital accessibility means connecting via internet-capable devices, aiding budget oversight through electronic purchasing, which can lower expenses by approximately 5% to 10% in competitive environments [11].

The Fourth Industrial Revolution (IR4.0), marked by cutting-edge technologies such as the Internet of Things (IoT), automation, artificial intelligence (AI), and data analytics, holds the promise to revolutionize the construction sector, particularly when combined with Building

Information Modeling (BIM) and Industrialized Building Systems (IBS). This integration improves decision-making, increases efficiency, and lowers risks by leveraging data from BIM models, sensors, and building systems.

IR4.0, when integrated with IBS, enhances prefabrication methods and decreases construction duration through automation and robotics, while BIM can organize prefabricated parts to reduce mistakes. AI-driven tools can enhance scheduling and workflows, thereby boosting productivity and project management. Additionally, merging IoT with BIM enables the development of intelligent buildings that collect real-time data to improve energy efficiency and boost occupant convenience. This integration promotes sustainable design, resulting in eco-friendly structures.

Finally, IR 4.0 technologies facilitate comprehensive lifecycle management of structures, from design to maintenance, by leveraging digital twins and predictive analytics to enhance asset management and minimize operational expenses. In conclusion, utilizing IR 4.0 alongside BIM and IBS presents substantial potential for advancing the construction industry by optimizing processes to be more efficient, sustainable, and data-oriented, resulting in improved project outcomes and superior built environments.

2.3 Technology Readiness Index (TRI)

The Technology Readiness Index (TRI) provides a structure to assess the readiness of a technology for deployment in a particular sector or setting, like Building Information Modeling (BIM) technology for Industrialized Building Systems (IBS) projects. With the growing complexity of technological products, it is crucial to comprehend user preparedness.

TRI, as described by [12], refers to a person's general disposition toward technology, taking into account individual variations in receptiveness to emerging technologies. It consists of four main elements, as described by [13]: action enablers that encourage technology use; discomfort, signifying anxiety about new technologies; insecurity, related to trustworthiness and potential risks; and inhibitors, which obstruct adaptation.

The TRI can evaluate BIM's preparedness for IBS projects through various methods, including stakeholder awareness of BIM technology, the sufficiency of technological infrastructure (like internet connectivity and hardware compatibility), stakeholders' willingness to adapt BIM, and the essential skills for successful implementation. Additionally, it assesses the effectiveness of BIM in aligning with current practices and systems within the IBS sector. By examining these dimensions, TRI offers significant insights into the preparedness and potential obstacles to implementing BIM in IBS projects, aiding stakeholders in prioritizing actions and making well-informed choices.

A study by [14] indicates that TRI has been incorporated into the Technology Acceptance Model (TAM) within the realm of e-HRM. [15] examined the impact of technology readiness on mobile shopping intention, highlighting perceived usefulness and usability as mediating factors. Additionally, research indicated that decision-makers possessing greater innovative characteristics are more inclined to adopt data standards. Therefore, incorporating TRI into this project, it will help better understand the readiness for BIM implementation in IBS projects.

3. METHODOLOGY

In this section, the questionnaire design and responses were reviewed. A questionnaire survey was employed to collect data using a quantitative research approach, which is widely adopted in construction management and BIM-related studies [16, 17]. The probability sampling method used in this research is cluster sampling. A cluster sample is a sampling technique in which the researcher separates the total population into distinct groups, or clusters. Every observation within the selected clusters is part of the sample. This approach is generally employed when the population is extensive, scattered, and hard to reach. The clusters were ideally meant to reflect the traits of the entire population. Accordingly, the questionnaire was developed following a comprehensive review of the existing literature on the adaptation of Building Information Modeling (BIM) for Industrialized Building System (IBS) projects [18]. Figure 1 shows the methodological flow used throughout this study.

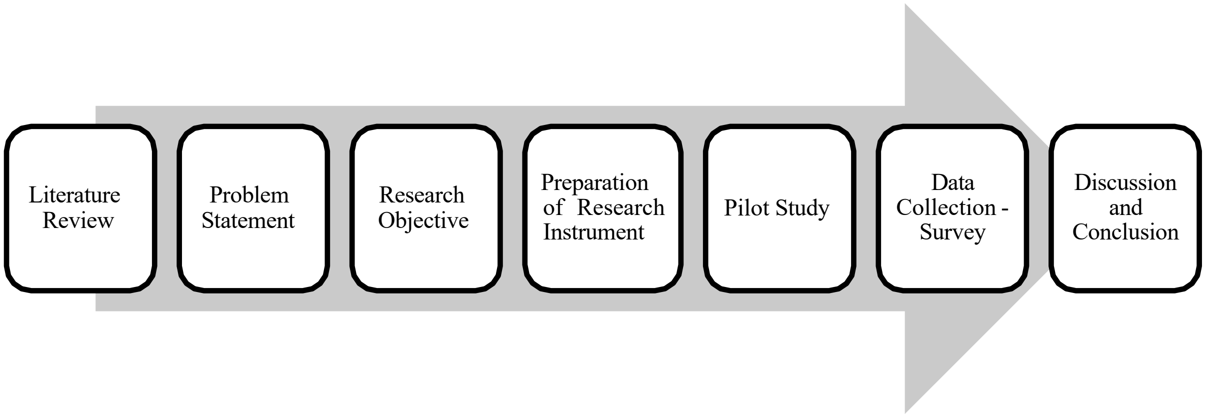

Figure 1: Flowchart of the method.

Table 1: Respondents' Demographic Profile (n=98).

Demographic Profile	Frequency	Percentage (%)
Years of Working Experiences in Construction Industry		
Less than or equal to 3 years	14	14.29
4-6 years	31	31.63
7-9 years	27	27.55
More than or equal to 10 years	26	26.53
Gender		
Male	74	75.5
Female	24	24.5
Education		
Certificate	1	1.02
Diploma	14	14.29
Degree	70	71.43
Master	12	12.24
PhD	1	1.02
CIDB Grade		
G4	6	6.12
G5	20	20.41
G6	16	16.33
G7	56	57.14
State of Organization		
WPKL	36	36.73
Selangor	62	63.27

A set of questionnaires was developed to achieve the research objectives, and a pilot study involving 30 participants was conducted. The respondents' feedback was used to refine the questionnaire items further. Conducting a pilot study is essential for improving question reliability and minimizing ambiguity before full-scale data collection [19]. Based on the pilot study outcomes, the questionnaire was finalized. The final questionnaire consists of three main sections: (a) general information of the respondents, (b) research Objective 1, and (c) research Objective 2. For Parts B and C, a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used to measure the key factors influencing BIM adoption in IBS projects. The Likert scale is commonly used in BIM-related studies due to its effectiveness in capturing subjective judgments and behavioral tendencies [20].

Table 1 shows the demographic profile of the respondents, including years of working experience in the construction industry, gender, education level, and CIDB grade.

The profile highlights a workforce that is mainly male (74) and includes 24 females, exhibiting a strong educational background: 70 possess a degree, 14 have a diploma, 12 hold a master, 1 has a certificate, and 1 has a PhD. CIDB qualifications indicate a majority at G7 (56), with 20 at G5, 16 at G6, and 6 at G4. Experience is biased towards mid to senior levels, with 31 in the (4 to 6-year range), 27 in the (7 to 9-year range), 26 in the 10 years or more range, and 14 with 3 years or less. In terms of geography, 62 participants are from Selangor and 36 from Wilayah Persekutuan Kuala Lumpur (WPKL). There are 98 participants in total. In general, the data indicate a well-qualified, nearly senior group with strong CIDB qualifications, focused in certain areas, while also revealing chances to enhance gender diversity, ensure a continuous flow of younger talent, and synchronize training and succession strategies with regional market trends.

3.1 Validity

Validity research refers to the process of assessing the accuracy and appropriateness of a research study's findings, conclusions, and interpretations. The study employs assessment techniques that validate its intended measurements and produce results that accurately reflect the studied population. Data validity indicates how accurately it represents actual academic research [21]. Validity exists because it protects researchers from measuring things they did not intend to study [22].

Face validity, content validity, criterion validity, and construct validity establish four different types of validity. Face validity and content validity function as qualitative assessment methods that measure actual face validity. The study used both face validity testing and content validity testing to conduct its qualitative research because these methods provide a straightforward assessment. Expert panels determine the authenticity of image content by evaluating survey appearance, survey utility and representative elements. The expert panel consists of people with expertise in a specific area. The instrument performs the measurement.

The relationship between the questions asked and the measured variables begins with face validity and content validity as primary validation steps. The selection of two university lecturers to conduct the preliminary examination and evaluation of the applications ensures the validity of the study from the perspective of [23]. These lecturers were selected because they are college researchers and construction experts with extensive experience related to IBS and BIM. The participants had sufficient time to evaluate all comprehension questions that required their specialized knowledge in their respective fields.

Some questions were revised because it was discovered that certain items contained errors and that two questions had almost identical meanings. In addition, several terms required amendment because respondents found the questions difficult to understand. Existing survey questions were removed as they did not meet the study objectives, and new questions were introduced to replace them. These revisions ensured that the questionnaire adequately addressed the intended scope of the research. The lecturers provided suggestions to conducting the pilot study, including methods for analyzing and answering questions after the questionnaire was distributed. It confirmed that all components of the theoretical construct required measurement through their assessment process. All ideas and recommendations were included in the questions, which enabled them to conduct the pilot test.

3.2 Reliability

Table 2 shows the scale of reliability and Cronbach's alpha coefficient. Cronbach's alpha coefficient is usually used to determine whether measurement items in a questionnaire maintain internal consistency and assessment reliability.

Table 2: Scale of Reliability and Cronbach's Alpha Coefficient [24].

Cronbach's Alpha Coefficient, α	Level of Reliability
< 0.50	Unacceptable
0.50 – 0.59	Poor
0.60 – 0.69	Questionable
0.70 – 0.79	Acceptable
0.80 – 0.89	Good
≥ 0.90	Excellent

Based on Table 2, the alpha value needs to be 0.50 or higher, as lower values indicate that the items fail to measure the same construct and require modification or elimination. The range of 0.50 to 0.59 indicates a poor rating because it shows the items do not maintain sufficient consistency. The alpha range of 0.60 to 0.69 is questionable, as the scale needs development to improve reliability. The alpha value in the 0.70-0.79 range indicates acceptable reliability, as research purposes require consistent item measurement. The range of 0.80 to 0.89 indicates good reliability, as all items exhibit high internal consistency. The alpha value of 0.90 or higher demonstrates excellent reliability because it shows extreme consistency, which allows researchers to trust that their measurement instruments accurately assess the intended construct.

Table 3 shows the Cronbach's alpha coefficient for five adaptation factors, which include financial, organizational, technical, individual, and sustainability, for BIM-IBS projects. The internal consistency of the measurement items was assessed through the application of Cronbach's alpha coefficients. The overall reliability score for all 20 items is 0.844, which falls within the good reliability range, indicating that the instrument is reliable and suitable for further analysis.

Table 3: Reliability Coefficient of the Variables Factors.

Variables	No. of Original Items	α Coefficient	Scale	Rating
Financial Factor	4	0.905	≥ 0.90	Excellent
Organization Factor	4	0.718	0.70 – 0.79	Acceptable
Technical Factor	4	0.833	0.80 – 0.89	Good
Individual Factor	4	0.729	0.70 – 0.79	Acceptable
Sustainability Factor	4	0.740	0.70 – 0.79	Acceptable
Total	20	0.844		

The financial factor had a Cronbach's alpha of 0.905, indicating excellent reliability. The result demonstrates that financial-readiness measurement items, including investment capability and cost considerations, show high consistency, effectively measuring the financial element of BIM-IBS adaptation.

The organizational factor achieved a Cronbach's alpha of 0.718, which is considered acceptable reliability. The measurement items for management support and organizational structure, along with organizational policies, successfully measure organizational readiness, according to this finding. The technical factor showed a Cronbach's alpha of 0.833, indicating good reliability. The items that measure technical infrastructure, software availability, and system integration demonstrate reliable performance that accurately reflects their intended purpose.

The individual factor obtained a Cronbach's Alpha value of 0.729, which also falls within the acceptable reliability range. The items that measure workforce skills, knowledge, and willingness to adapt to BIM-IBS show consistent performance in line with this finding. The sustainability factor achieved a Cronbach's alpha of 0.740, indicating acceptable reliability. The assessment items that evaluate environmental, economic and long-term sustainability factors demonstrate consistent measurement results.

Additionally, Table 4 presents the reliability analysis of the four (4) technology readiness dimensions: optimism, innovativeness, discomfort, and insecurity. The total Cronbach's alpha for all 20 items is 0.803, indicating good overall reliability and confirming that the instrument is suitable for measuring technology readiness among respondents.

Table 4: Reliability Coefficient of the Variables of TRI.

Variables	No. of Original Items	α Coefficient	Scale	Rating
Optimism	4	0.825	≥ 0.90	Good
Innovativeness	4	0.860	0.70 – 0.79	Good
Discomfort	4	0.877	0.80 – 0.89	Good
Insecurity	4	0.906	0.70 – 0.79	Excellent
Total	20	0.803		

The optimism dimension had a Cronbach's alpha of 0.825, indicating good reliability. This shows that the items that assess positive beliefs about technology benefits and efficiency improvements present internal consistency. The innovativeness dimension achieved a Cronbach's alpha of 0.860, indicating good reliability. The results show that the items successfully measure respondents' readiness to adopt new technologies, including BIM-IBS. The discomfort dimension had a Cronbach's alpha of 0.877, indicating good reliability. The items that assess feelings of being overwhelmed or lacking control during new technology use demonstrate consistent measurement. The insecurity dimension achieved a Cronbach's alpha of 0.906, indicating excellent reliability. The results demonstrate that items assessing data security concerns, system reliability, and trust in technology show extremely high internal consistency.

4. RESULTS AND DISCUSSION

Table 5 presents descriptive statistics for the primary variables used to assess the extent of technological adaptation and the Technology Readiness Index (TRI) for BIM–IBS implementation by contractors in Malaysia's Central Region. The average values for each variable are above 3.9, suggesting strong consensus among respondents regarding the factors affecting BIM adaptation and their preparedness to use the technology. This indicates that contractors typically view the implementation of BIM–IBS favorably and recognize its significance in the construction sector.

Table 5: Mean and Standard Deviation of Variables.

Variables	Mean	Std. Deviation	Rank
Adaptation Factors			
Financial	4.6148	0.57007	1
Organization	4.1352	0.65327	2
Technical	4.0357	0.05317	4
Individual (Workforce)	4.0587	0.05240	3
Sustainability	3.9821	0.05028	5
TRI			
Optimism	4.2372	0.05528	1
Innovativeness	4.0944	0.58714	3
Discomfort	4.0867	0.60507	4
Insecurity	4.1811	0.62978	2

The financial factor has the highest average value (M = 4.6148, SD = 0.57007), indicating that financial capacity, software and hardware investment, and cost-related factors are viewed as the key drivers of adaptation to BIM–IBS. Even though the standard deviation is slightly higher than for other variables, it still shows a fairly stable viewpoint among respondents, suggesting that while the majority of contractors see financial readiness as crucial, there are some moderate variations in their financial capabilities and investment priorities.

The organizational component (M = 4.1352, SD = 0.65327) indicates a high level of consensus regarding the importance of management backing, organizational culture, internal regulations, and strategic dedication in promoting BIM adaptation. The increased standard deviation indicates variability among organizations, which could be due to differences in company size, leadership dedication, and maturity in digital transformation.

The technical factor (M = 4.0357, SD = 0.05317) shows a high average and a low standard deviation, indicating strong agreement among participants about the sufficiency and significance of technical infrastructure, including BIM software, hardware systems, and technical skills. This consistency indicates that technical preparedness is fairly uniform among contractors in the Central Region, likely due to greater industry exposure and regulatory support for BIM adoption.

Likewise, the individual (workforce) aspect (M = 4.0587, SD = 0.05240) shows a strong degree of workforce preparedness, exhibiting slight differences in replies. This suggests that employees' abilities, training, and readiness to use BIM technology are consistently deemed sufficient across organizations, highlighting increasing awareness and skill development efforts in the Malaysian construction industry.

The sustainability aspect (M = 3.9821, SD = 0.05028) is marginally lower than the other aspects but still reflects a favorable viewpoint. This indicates that contractors acknowledge BIM's contribution to improving sustainability results like minimizing waste, optimizing resource use, and enhancing the lifecycle performance of IBS projects. The small standard deviation indicates a strong consensus on BIM's role in sustainable construction methods.

Regarding TRI dimensions, optimism (M = 4.2372) and innovativeness (M = 4.0944) exhibit higher mean values, indicating contractors' favorable views of BIM's advantages and their readiness to adopt new technologies early. In contrast, discomfort (M = 4.0867) and insecurity (M = 4.1811) show similarly elevated mean scores, reflecting concerns about system complexity, data security, and dependence on technology. These results indicate that although contractors tend to be optimistic and innovative, concerns about BIM implementation persist and must be resolved through training, technical assistance, and explicit implementation guidelines. In general, Table 5 illustrates a significant yet complex degree of technological adaptation and preparedness, weighing optimistic perspectives against current implementation hurdles.

Table 6 presents the findings from the correlation analysis investigating the link between technological adaptation aspects and the TRI, aiming to understand contractors' preparedness for BIM technology in IBS projects in the Central Region of Malaysia. The results show that all analyzed factors demonstrate positive, statistically significant relationships with TRI ($p<0.01$), suggesting that technological adaptation advances correlate with higher levels of technology readiness.

Table 6: Correlation analysis of each factor and TRI.

Correlation analysis of each factor with TRI			
	r	**P**	**Findings**
Financial Factor	0.311	<0.002	
Organization Factor	0.501	<0.001	
Technical Factor	0.566	<0.001	Strong
Individual Factor	0.529	<0.001	
Sustainability Factor	0.516	<0.001	

The technical element shows the most significant correlation with TRI ($r = 0.566$, $p < 0.001$), highlighting a strong connection between technical skills and preparedness to implement BIM. This implies that contractors with improved access to BIM software, suitable hardware, and technical skills feel more confident and ready to adopt BIM in IBS projects. Technical competence directly diminishes perceived complexity and uncertainty, thereby boosting optimism and creativity while decreasing resistance to technology adaptation.

The workforce factor shows a significant positive correlation with TRI ($r = 0.529$, $p < 0.001$), underscoring the importance of employees' skills, experience, and adaptability in shaping readiness. A skilled, well-prepared workforce boosts confidence in BIM utilization, reduces unease, and alleviates insecurity, thereby enhancing overall technology preparedness. This underscores the importance of ongoing training and capacity-building initiatives to facilitate the execution of BIM-IBS.

The sustainability factor shows a significant positive correlation with TRI ($r = 0.516$, $p < 0.001$), suggesting that contractors who view BIM as a means to reach sustainability objectives are more prepared technologically. This discovery highlights the connection between BIM implementation and sustainable building methods, where ecological consciousness and long-term performance factors drive contractors to adapt innovative digital technologies.

The organizational element shows a robust and significant association with TRI ($r = 0.501$, $p < 0.001$). This suggests that organizations featuring encouraging leadership, well-defined BIM strategies, and organized workflows promote greater technology readiness among their personnel. A strong commitment from the organization supports resource allocation, promotes innovation, and reduces resistance to change, thereby improving preparedness for BIM implementation.

Although the financial factor showed the lowest correlation coefficient ($r = 0.311$, $p < 0.002$), it remains statistically significant, suggesting a moderate yet important relationship with TRI. This implies that although financial resources matter, the willingness to implement BIM is not exclusively reliant on financial means. Contractors can show significant preparedness to robust technical assistance, a talented workforce, and organizational dedication, even in the face of financial limitations.

In conclusion, Table 6 verifies that factors related to technological adaptation are significant indicators of technology readiness for BIM implementation in IBS projects. The findings highlight that technical skills, workforce expertise, sustainability focus, and organizational backing have a stronger impact than financial factors alone. These results provide empirical support for strategic efforts emphasizing technical training, workforce development, and organizational change to improve BIM preparedness in Malaysia's construction sector.

5. CONCLUSION

From the demographic profile and statistical analyses, several key conclusions can be drawn regarding preparedness and technology-related perspectives in the construction sector. The respondents were predominantly experienced professionals, with most having more than 4 years of work experience, indicating that the findings reflect informed opinions from individuals well acquainted with construction practices and technological requirements. The workforce was largely male, which is consistent with the traditional gender composition of the construction industry reported in prior studies. In terms of educational background, the majority of respondents held at least a degree, suggesting a relatively high level of cognitive and technical readiness to understand and adapt to advanced digital technologies. Furthermore, a large proportion of respondents were from higher CIDB-grade organizations, particularly G7 firms, and were mainly located in Selangor and WPKL, reflecting participation from well-established and economically active construction regions, where technology adaptation is typically more advanced.

The descriptive analysis of the key variables indicates consistently high mean values across all factors, reflecting a positive overall perception of technology readiness for BIM-IBS adaptation. The financial factor recorded the highest mean score, suggesting that financial strength and investment capability are perceived as critical enablers of technology adaptation in construction projects. Similarly, organizational, technical, and individual (workforce) factors demonstrated high mean values, indicating that management support, technical infrastructure, and employee competencies are relatively well developed, aligning with findings from previous BIM and digital construction studies. In addition, the Technology Readiness Index (TRI) dimensions optimism, innovativeness, discomfort, and insecurity also showed elevated mean scores, suggesting that respondents are generally optimistic and open to innovation. However, some level of concern and uncertainty toward technology use persists. The sustainability factor also recorded a high mean value, reflecting growing awareness and acceptance of sustainable construction practices and the role of digital technologies in supporting sustainability goals.

The correlation analysis further strengthens these findings by revealing statistically significant and positive relationships between all examined factors and the Technology Readiness Index (TRI). Technical, individual, organizational, and sustainability factors showed strong correlations with TRI, indicating that improvements in technological infrastructure, workforce capability, organizational support, and sustainability orientation are closely associated with higher levels of technology readiness. Although the financial factor exhibited a comparatively weaker relationship, it still demonstrated a significant positive correlation with TRI, confirming its essential role in enabling and sustaining technological adaptation. Overall, these findings suggest that technology readiness in the construction sector is shaped by a combined influence of organizational commitment, technical capability, employee preparedness, and sustainability focus. Therefore, to enhance TRI and achieve successful technology adaptation, industry stakeholders should adopt a holistic strategy that simultaneously strengthens financial resources, organizational structures, technical systems, human capital development, and sustainability initiatives.

The construction industry benefits from Building Information Modeling (BIM) and Industrialized Building System (IBS) project integration because it delivers better design results through enhanced design visualization, accurate cost estimation, and material waste reduction. The system delivers productivity improvements through its automated clash detection system and its efficient on-site assembly process, and its enhanced stakeholder collaboration tools, which produce faster project completion times and improved project quality and environmental sustainability results. In terms of efficiency and productivity, BIM streamlines the design and construction process, resulting in higher productivity across all projects. Detailed 3D models provide a complete understanding of the design, which helps all parties to communicate and work together more effectively. BIM provides organizations with improved tools for estimating costs, developing budgets, and tracking cash flow. It helps to shorten project timelines while decreasing total expenses.

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