Volume: 11 Issues: 81 [March, 2026] pp. 195 – 206
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118117

A PILOT STUDY ASSESSING THE RELIABILITY OF INTENTION TO ADOPT BIM MEASURES AMONG CONSTRUCTION SMES

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Article history
Received date : 19-2-2026
Revised date : 20-2-2026
Accepted date : 4-3-2026
Published date : 14-3-2026

To cite this document:
Ismail, E. D., Ismail, N. A. A., Kamaruddin, N., Sannagy, P. B., & Palaniappen, S. V. (2026). A pilot study assessing the reliability of intention to adopt BIM measures among construction SMEs**.** *Journal of Islamic, Social, Economics and Development (JISED),* 11 (81), 195 – 206.

Abstract*:* *The adoption of Building Information Modelling (BIM) among construction small and medium-sized enterprises (SMEs) remains limited despite its potential benefits in improving project efficiency and performance. Prior to conducting a full-scale empirical study, it is important to ensure that the research instrument used to measure BIM intention to adopt factors is reliable and suitable for the target respondents. Therefore, this study aims to conduct a pilot test to assess the reliability of the questionnaire items. A quantitative, survey based pilot study was carried out involving respondents from construction SMEs in Selangor, Malaysia. Data were collected using a structured questionnaire adapted from previous studies. Internal consistency reliability was evaluated using Cronbach's alpha and composite reliability. All constructs achieved reliability values above the recommended threshold, indicating satisfactory internal consistency and supporting the adequacy of the measurement items for the subsequent analysis in the main study. No item removal was required at this stage. Overall, this pilot study confirms that the research instrument is suitable for investigation on the BIM intention to adopt among construction SMEs. The finding provide basis for proceeding with the main study using a larger sample.*

Keywords*:* *Building Information Modelling, Construction SMEs, Pilot Study, Reliability Analysis, Technology Adoption*

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Introduction

The construction industry is experiencing a shift towards digital construction in line with national and global development agendas and one of which is the National Construction Policy (NCP 2030). The use of digital technologies in construction projects is increasingly encouraged to improve efficiency, reduce cost and enhance project delivery (Osunsanmi et al., 2020; Wuni et al., 2024) . One of the most widely discussed digital technologies in the construction sector is Building Information Modelling (BIM). BIM supports better coordination, visualization and information sharing throughout the Project lifecycle (Sarigul & Gunaydin, 2025; Tran & Nguyen, 2024).

Despite the potential benefits of BIM, its adoption remains uneven across organizations. Large construction firms tend to adopt BIM more actively due to stronger financial capacity, technical expertise and organizational support (Ismail et al., 2025; Saka et al., 2024; Tavallaei et al., 2022) In contrast, SMEs often face challenges such as limited resources, lack of skilled personnel and uncertainty about the benefits of technology (Ben Mahmoud et al., 2022; Miškić et al., 2025). These challenges have resulted in slower BIM adoption rate among construction SMEs compared to larger organizations

Understanding BIM adoption intention among construction SMEs requires a structured and reliable measurement instrument. Before conducting a full-scale empirical study, it is important to ensure that the questionnaire items used to measure the constructs are reliable and suitable for the target respondents (García-Corpas et al., 2014; Wong et al., 2012). Unreliable measurement items may lead to inaccurate findings and weaken the overall quality of the research (Ree & Carretta, 2006).

Although numerous studies examine BIM adoption determinants, limited research reports pilot validation of measurement instruments prior full-scale empirical testing, particularly within the Malaysia construction SMEs.

A pilot study plays an important role in the research process, particularly in testing the reliability and clarity of research instrument. Pilot studies are commonly conducted to identify potential issues related to questionnaire design, item wording and measurement consistency before proceeding with the main study (Nieuwenhuijsen, 2005; Ograjenšek, 2008). By conducting a pilot study, researchers can refine the research instrument and reduce the risk of problems during the main data collection phase. Therefore, this article aims to assess the reliability of the questionnaires items using Cronbach's alpha and composite reliability before conducting the main study

Purpose of the Pilot Study

A pilot study is a preliminary and small-scale version of a larger research project, conducted prior to the main study to test and refine research instruments and procedures. In quantitative research, pilot studies are primarily carried out to evaluate the reliability and validity of research instruments, such as questionnaires and surveys, and to identify potential issues that may affect the quality ot the man study (Hazzi & Maaldaon, 2015; Leon et al., 2011).

Pilot studies allow researchers to assess the feasibility of the research design, examine the clarity and relevance of questionnaire items and evaluate whether the study procedures are workable within the intended research context (Janghorban et al., 2014; Vazzoler - Mendonça et al., 2024). Through this process, unclear or ambiguous items can be identified and revised,

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thereby improving the overall quality and consistency of the measurement instrument (Suzuki et al., 2025). In addition, pilot testing helps ensures that the instrument adequately captures the constructs it is intended to measure and supports more reliable data collection in the main study (Hazzi & Maaldaon, 2015).

Furthermore, pilot studies may provide preliminary insights that assist researchers in refining research questions, measurement approaches and analytical strategies for the full-scale study (Blythe LaGasse, 2013). Overall, conducting a pilot study is an important methodological step that strengthens the rigor of quantitative research and increases the likelihood of a successful and well-designed main study.

Methodology

A proposed framework is developed based on a review of previous literature, as illustrate in Figure 1. This study adopts the Technology Organization Environment (TOE) framework as its underpinning theoretical framework. The TOE framework was introduced by Tornatzky and Fleisher in 1990 to explain organizational adoption of technological innovation by considering technological, organizational and environmental factors (Amini & Jahanbakhsh Javid, 2023; Prakash, 2025). Since the unit of analysis of this study is organization, the TOE framework is considered appropriate, as it is specifically designed to examine technology adoption at the organizational level.

The TOE framework has been widely used in intention to adopt and adoption technology studies across various sectors, including construction and SMEs (Zhong et al., 2025). One of the key strengths of TOE framework is its ability to capture both organizational conditions and external environmental influences that affect adoption decisions. By categorizing adoption factors into three distinct contexts, the framework provides a clear and structural approach to understanding organizational intention to adopt new technologies such as BIM.

In this study, the technological context includes relative advantage and complexity, which reflects SMEs' perceptions of the benefits of BIM and the level of difficulty associated with its implementation (Elghdban et al., 2023; Zhao et al., 2023). The organizational context comprises organizational readiness and organizational resistance, representing internal capabilities, preparedness, and resistance to change that may influence BIM adoption decisions (Abdullah et al., 2024; Tayib et al., 2022). The environmental context consists of competitive pressure and technology vendor support, which capture external forces and support mechanisms that may encourage or hinder BIM adoption among construction SMEs (Ling et al., 2023; Wan Mohammad et al., 2018).

Intention to adopt BIM is positioned as the dependent variable, as this study focuses on SME's willingness to adopt BIM rather than actual implementation. This focus is appropriate, as intention is commonly viewed as a key precursor to actual adoption behaviour (Arkorful et al., 2022; Nakhonchaigul & Siriyota, 2024). Firm size and firm age are included as control variables to account the differences in organizational characteristics that may influence adoption intention. Overall the proposed framework provides a systematic and integrated approach to examining the factors influencing BIM adoption intention with the construction SME context.

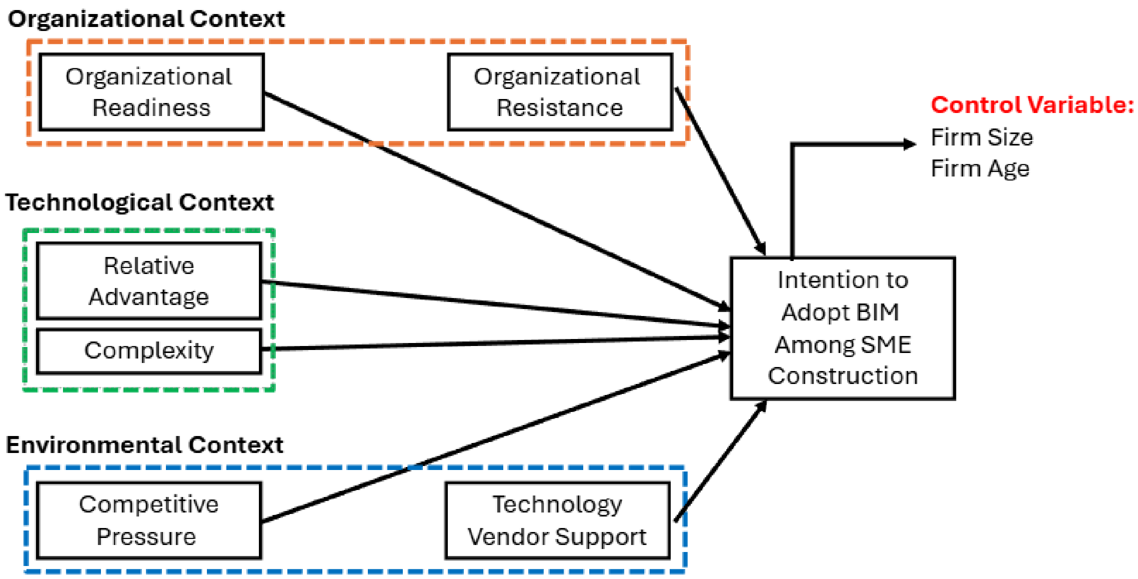

Figure 1: Research Framework

In this study, the sampling of respondents was based on purposive sampling. The purposive sampling was chosen because the respondents selected were considered to be in the best position to provide relevant information related to BIM intention to adopt at the organizational level. The sample consisted of respondents from construction SMEs. Respondents were selected based on the following criteria: (1) the firm must fall under SME category (G1 – G5) and (2) the respondent must be involved in organizational decision-making or have sufficient knowledge related to technology adoption within the firm.

A pre-test was conducted prior to the pilot test to identify potential issues related to the questionnaire design and item clarity. Pre-testing is an important step to ensure that the questionnaire items are clearly understood by respondents and appropriately reflect the study context (Grimm, 2010). The purpose of the pre-test was to identify unclear wording, ambiguous statements and any weaknesses in the questionnaire before administering it to the pilot study respondents.

The pre-test involved a small group of subject matter experts and industry practitioners with experience in construction and digital technology adoption. These experts were requested to review the questionnaire items and provide feedback on content relevance, clarity, and suitability to the construction SME context. Based on the feedback received, minor revisions were made to improve the wording and clarity of several items. According to the experts comments and feedback, two items were identified as less suitable for inclusion in the final measurement instrument and were therefore omitted.

The first item, related to organizational readiness, which was deemed too broad and overlapping with general financial considerations rather than reflecting readiness at the operational level. The second item, related to technology vendor support, was considered less relevant to the construction SMEs context, as expert feedback indicated that vendor incentives are not a primary driver of BIM adoption decision among SMEs. This process helped to enhance the face and content validity of the questionnaire and reduce potential response bias. Following these

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revisions, the remaining items were retained as they were considered clear, relevant and appropriate for measuring the intended constructs. The refined instrument was then used for the pilot study and subsequent reliability analysis.

All items used in this study were adapted and adopted from previous literature related to technology and organizational studies. The questionnaire was divided into several sections. One section captured the background information of the respondents and their organizations. The remaining sections measured the study constructs related to technological, organizational and environmental contexts, as well as intention to adopt BIM. A close-ended questionnaire format was used, where respondents selected their responses from a set of predefined options.

The measurement items were assessed using Likert scales. Two types of Likert scale points were used consist of a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) and a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). This scales were chosen as it allows respondents to express varying degrees of agreement and is commonly used in technology adoption research. Care was taken to ensure that all questionnaire items were short, simple and easy to understand. Statements were kept concise to reduce ambiguity and ensure consistency in responses.

The pilot test was conducted over a short period of time to evaluate the data collection process and the reliability of the questionnaire. Data were collected using an online survey platform. The survey link was distributed to potential respondents through professional networks and online communication channels. Respondents were informed that participation was voluntary and that their responses would be kept confidential. Only completed questionnaires were retained for analysis. The data collected from the pilot study were then used to assess the reliability of the measurement items before proceeding to the main data collection of the study.

Furthermore, the online questionnaire link was distributed using multiple channels. Some of the survey links were personally sent through social media communication mediums to potential respondents from construction SME's. This approach was adopted to reach respondents directly involved in the organizational decision-making related to technology adoption. The data collection process took approximately seven weeks to compile responses.

Throughout the data collection period, follow-up messages were sent to encourage participation and improve the response rate. By clicking the survey link, respondents were informed that their participation was voluntary and that completing the questionnaire would take approximately eight to ten minutes. Prior to the main distribution, the researcher tested the survey distribution process to ensure that the link could be accessed properly and that the questionnaire could be completed within the expected time.

In total, 89 responses were received. After data screening, only 70 valid responses were retained and used for further analysis. The omitted responses did not comply with study's inclusion criteria.

Results and Discussions

The 70 data were analyzed using SPSS 29 (Statistic Package for the Social Science) and SmartPLS. Frequency test was used to analyze the information that was gathered from the respondents. The majority of the respondents held senior positions within their organizations, with 57.3% serving as Owner/CEO , followed by Project Managers (23.2%) and Managing

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Directors (8.5%). This indicates that most respondents were directly involved in organizational decision-making.

In terms of organizational experience, 36.6% of the firms had been operating for 5-10 years while 30.5% had more than 15 years of experience. Firms with less than 5 years of operation accounted for 20.7% and 12.2% had been in operation for 11-15 years, reflecting a mix of young and well-established construction SMEs.

Table 1: Respondent Demographic Profile (Pilot Study, n = 70).

Demographic	Frequency	Percentage (%)
Position		
Owner/CEO	47	57.3
Project Manager	19	23.2
Managing Director	7	8.5
Others	9	11.0
Years of Operation		
Less than 5 years	17	20.7
5–10 years	30	36.6
11–15 years	10	12.2
More than 15 years	25	30.5
CIDB Contractor Grade (G1–G5)		
G1	30	42.9
G2	15	21.4
G3	3	4.3
G4	8	11.4
G5	14	20.0
Annual Revenue		
Less than RM300,000	41	50.0
RM300,001 – RM2.99 million	28	34.1
RM3 million – RM20 million	4	4.9
More than RM20 million	9	11.0
Main Role in Construction Projects		
Main Contractor	38	46.3
Subcontractor	9	11.0
Mixed / Specialist Roles	23	32.7

With respect to contractor registration, the respondents were primarily registered under CIDB grade G1 to G5. The largest proportion of firms were classified as G1 (42.9%) while G3 represented the smallest proportion (4.3%). Regarding the annual revenue, 50% of the firms reported revenue of less than RM300,000 while 34.1% earned between RM300,001 and RM2.99 annually. A smaller proportion of firms reported revenue between RM3 million and RM20 million (4.9%) and 11% reported revenue exceeding RM20 million. This further supports the SME profile of the respondents.

In terms of organizational role in construction projects, 46.3% of the firms operated primarily as the main contractor, while 11% functioned as subcontractors. The remaining 32.7% reported mixed or specialist roles, highlighting the diverse operational nature of construction SMEs.

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Table 2 Measurement Instrument and Scale Sources

Construct	Items
Relative Advantage (RA) (Premkumar & Ramamurthy, 1995)	BIM technology will allow us to better communicate with our project stakeholders. BIM technology will allow us to cut costs in our project operations. Implementing BIM technology will increase the profitability of our projects. Adoption of BIM technology will provide timely information for decision making in our projects.
Complexity (CX) (Maroufkhani et al., 2020)	We perceive learning to use BIM technology is difficult for our employees in the company. We perceive BIM technology is difficult to maintain in our company. We perceive BIM technology is difficult to operate in our company.
Organizational Readiness (OR) (Ngah et al., 2017)	Our organization provides staff with formal explanation regarding BIM technology. Our organization has the financial resources necessary to adopt BIM technology. Our organization has knowledgeable staff to adopt BIM technology.
Organizational Resistance (ORT) (Hong & Kim, 2002)	We have been resisting the implementation of BIM technology. We sometimes blame BIM for the business problems we face. We still use traditional construction practices even though BIM changes the way of conducting business. We sometimes do not respond to requests from the BIM project team. Some people in our company hope BIM implementation will fail.
Competitive Pressure (CP) (Maroufkhani et al., 2020)	Our choice to adopt BIM technology is strongly influenced by what competitors in the industry are doing. Our firm is under pressure from competitors to adopt BIM technology. Our firm would adopt BIM technology in response to what competitors are doing.
Technology Vendor Support (TVS) (Premkumar & Ramamurthy, 1995)	The availability of BIM technology vendors that provide technical support encourages our organization to consider adopting BIM technology. Training and guidance provided by BIM technology vendors influence our intention to adopt BIM. Active marketing efforts by BIM vendors, including incentive offerings, positively influence our intention to adopt BIM. Free training sessions offered by BIM technology vendors enhance our confidence and willingness to adopt BIM.
Intention to Adopt BIM (INT) (Senarathna et al., 2018)	Our organization intends to adopt BIM technology. Our organization feels that organizational needs can be met by BIM technology. Our organization will take steps to adopt BIM technology in the future. Our organization will adopt BIM technology within the next twelve months.

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Reliability refers to the degree to which measurement items consistently measure a construct (Hair et al., 2014). Reliability is considered a necessary condition for validity (Cooper et al., 2003). Therefore, the reliability of the measurement instrument should be assessed prior to evaluating its validity. In this study, the internal consistency of the measurement scales was assessed using Cronbach's alpha, which is one of the most widely used statistical methods for evaluating construct reliability in social science research. An alpha value of 0.70 or higher is generally regarded as an acceptable threshold for reliability (Cortina, 1993).

The reliability analysis indicates that the Cronbach's alpha values for all constructs ranged from 0.701 to 0.930. TVS recorded the highest alpha value (0.930), followed by RA (0.912) and INT (0.886), demonstrating strong internal consistency. All items exceeded the recommended threshold of 0.70. Overall, the results confirm that all measurement scales demonstrate acceptable to excellent internal consistency reliability.

The composite reliability value ranged from 0.707 to 0.959, further supporting the internal consistency of the constructs. TVS achieved the highest CR value. ORT obtained the lowest CR value which remain acceptable. These findings demonstrate that all constructs exhibit satisfactory composite reliability, confirming the robustness of the measurement model. Therefore, further refinement or removal of items to improve reliability was not required at this stage. Based on the Cronbach's alpha and composite reliability results, the questionnaire was deemed reliable and suitable for use in the main study. Table below presents Cronbach's alpha and composite reliability values for all constructs.

Table 3: Internal Consistency Reliability Results

Construct	Number of Items	Cronbach's Alpha	Composite Reliability
Relative Advantage (RA)	4	0.912	0.935
Complexity (CX)	3	0.844	0.915
Organizational Readiness (OR)	3	0.822	0.892
Organizational Resistance (ORT)	4	0.701	0.707
Competitive Pressure (CP)	3	0.823	0.885
Technology Vendor Support (TVS)	4	0.930	0.950
Intention to Adopt (INT)	4	0.886	0.923

Conclusions

The pilot study undertaken is an important step prior to conducting the main study on the intention to adopt BIM among construction SMEs in Selangor, Malaysia. It contributes methodologically by strengthening measurement rigor in BIM adoption research through structured pilot validation. The findings form the reliability analysis confirmed that the measurement instrument achieved acceptable levels of internal consistency, with all constructs recording Cronbach's alpha and composite reliability values above the recommended threshold. This outcome indicates that the questionnaire is reliable and suitable for use in the subsequent main study.

In addition, the pilot study demonstrated that the online survey approach, including personal distribution through messaging platforms, was effective for reaching construction SME respondents and collecting usable data. The positive response obtained during the pilot study confirmed that the refined measurement items were clear and appropriate for the target respondents. Importantly, the research objective of assessing the reliability of the measurement instrument was successfully achieved, as no further item refinement was required at this stage.

Overall, the pilot study highlights the importance of conducting preliminary testing to improve research design and instrument quality. The study confirms that the refined questionnaire is suitable for examining BIM adoption intention among construction SMEs in the main study. This paper therefore underscores the value of pilot studies in strengthening methodological rigor and contribute to best practices in BIM and construction technology adoption research.

Acknowledgements

1. The authors would like to express sincere appreciation to the Faculty of Built Environment, Universiti Teknologi MARA for its continuous academic support, research guidance, and provision of an enabling environment that facilitated the completion of this study.
2. The authors also gratefully acknowledge the financial and institutional support provided by the Ministry of Higher Education Malaysia (MOHE), which significantly contributed to the successful execution of this research.

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Journal website: academicinspired.com/jised
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