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Integrating Critical Risk Identification and BIM Strategies for Enhanced IBS Project Management

Noorul Amilin Saipudin[1,2,*], Nurfadzillah Ishak[1]

[1]Faculty of Civil Engineering & Technology, Universiti Malaysia Perlis (UniMAP), Perlis, Malaysia.
[2]Politeknik Tuanku Sultanah Bahiyah, Kulim Hi-Tech, Kulim, Kedah

KEYWORDS

Building Information Modelling (BIM)
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Risk Management

ABSTRACT

The integration of Building Information Modelling (BIM) strategies with critical risk identification processes is essential for enhancing project management in Industrialised Building System (IBS) projects. This study aims to measure the levels of potential critical risks, assess BIM application strategies, examine their relationship, and propose a framework for effective integration. The methodology employed a mixed-methods approach, incorporating quantitative data from structured surveys analyzed using IBM SPSS for descriptive and correlation analysis, and qualitative data from semi-structured interviews and focus group discussions to gather in-depth insights. Results indicated a significant correlation between comprehensive BIM application and the reduction of critical risks, showcasing BIM's value in risk visualization and mitigation. The qualitative analysis highlighted the importance of targeted training, stakeholder collaboration, and addressing barriers such as resource limitations and steep learning curves. These findings align with existing literature and emphasize that while BIM offers substantial benefits for risk management, practical implementation challenges must be addressed. The developed framework provides a structured approach for integrating BIM and risk identification strategies, guiding construction professionals in improving project outcomes. This research contributes to the body of knowledge by presenting a practical framework that enhances IBS project management through BIM, with recommendations for future studies to explore practical implementations and long-term evaluations for validation.

1. INTRODUCTION

The Industrialised Building System (IBS) has become a pivotal approach within the Malaysian construction industry due to its potential for improving productivity, reducing construction time, and enhancing overall project efficiency(Hashim et al., 2024). However, despite these advantages, IBS projects are not without challenges, particularly in managing project risks effectively. Recent studies have emphasized the need for robust risk identification and management strategies to support IBS implementation ((Romli et al., 2024). The integration of Building Information Modelling (BIM) with traditional risk management processes has been identified as a promising avenue to enhance risk visibility, streamline decision-making, and foster proactive responses in IBS project management(Abideen et al., 2022).

Building Information Modelling (BIM) has shown its utility beyond design and visualization, encompassing risk management and operational planning in construction projects (Ismail, 2020). BIM enables stakeholders to simulate construction phases, identify potential risks, and develop mitigative strategies well in advance (Abkar et al., 2024). The integration of BIM with risk management practices facilitates a comprehensive view of project parameters, which can mitigate common challenges such as coordination issues and material waste (Ang Soon Ern et al., 2022). This technological synergy enhances the accuracy of risk prediction and promotes a more adaptive project management framework, crucial for the successful execution of IBS projects.

Despite its benefits, awareness and adoption of BIM-integrated risk management remain limited. Findings indicate a lack of comprehensive training and professional interaction as barriers to effective implementation (Hashim et al., 2024). Addressing these gaps requires targeted initiatives that promote understanding and integration of BIM strategies in risk management, ensuring that IBS projects achieve their intended outcomes with minimal disruptions. This paper explores these intersections, aiming to provide an in-depth analysis of how BIM can transform risk identification and management, thereby improving IBS project performance in Malaysia.

2. METHODOLOGY

The research methodology for this study is structured across four comprehensive stages to ensure a systematic and effective approach to achieving the research objectives. The flow of this methodology is visually represented in Figure 1, and each stage is detailed below.

*Corresponding author: amilin_saipudin@yahoo.com

Stage 1: Problem Identification and Objective Formation

The initial stage involves the identification of the problem statement, formulation of research questions, and establishment of clear research objectives (RO1, RO2, RO3, RO4). This stage sets the foundation for the study by defining the key issues related to critical risk identification and the integration of Building Information Modelling (BIM) in Industrialised Building System (IBS) projects.

Stage 2: Literature Review

In Stage 2, an in-depth literature review is conducted to gather and synthesize existing knowledge on construction issues, IBS, and BIM. This review forms the basis for understanding the current challenges and gaps in integrating BIM with risk identification processes. The review is sourced from journals, books, and other reliable references, ensuring a comprehensive understanding of the subject matter.

Stage 3: Research Design and Data Collection

The third stage involves designing the research methodology, which includes both primary and secondary data collection.

i) Primary Data Collection:

   a. Quantitative Approach: This approach targets the research objectives RO1, RO2, and RO3. Data is collected through structured questionnaires distributed to relevant respondents within the construction industry. Descriptive and correlation analyses are conducted using IBM SPSS software to analyze the collected data.
   b. Qualitative Approach: For RO4, a qualitative method is employed through semi-structured interviews and focus group discussions. This approach provides deeper insights and validates the findings from the quantitative analysis.

ii) Secondary Data Collection:

   Secondary data is obtained from journals, books, and other authoritative sources to supplement the primary data and strengthen the research.

Stage 4: Data Analysis and Framework Development

The final stage focuses on analyzing the data to establish findings aligned with the research objectives. Quantitative data is processed using descriptive and correlation analyses, while qualitative insights are gathered through expert validation and focus group recommendations.

The outcomes from both data types contribute to the development of a comprehensive framework that integrates critical risk identification with BIM strategies for enhanced IBS project management.

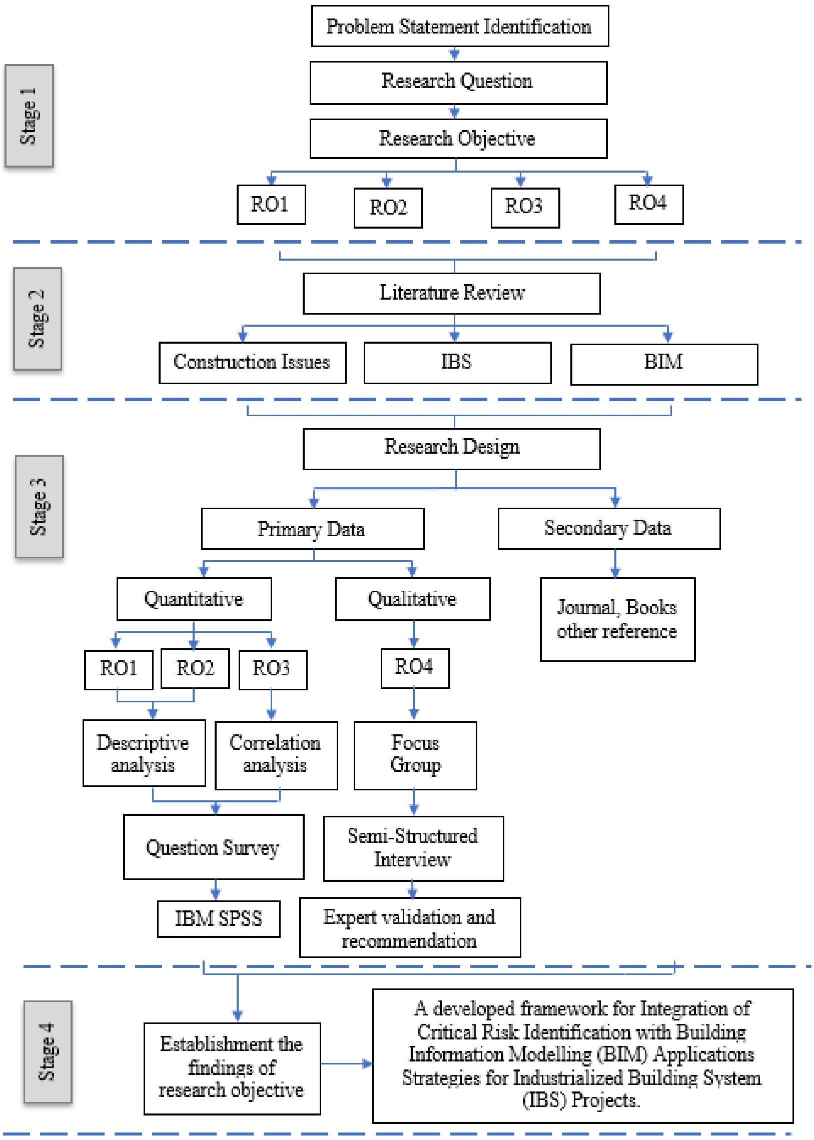

Figure 1. Research Methodology Flowchart.

3. RESULTS AND DISCUSSION

3.1 Quantitative Analysis Results

The quantitative data collected through the structured questionnaires were analyzed using IBM SPSS software. The descriptive analysis provided insights into the respondents' demographics and their understanding of potential critical risks and BIM application strategies in IBS projects. Results from the correlation analysis indicated significant relationships between the levels of identified risks and BIM application strategies. Notably, the findings demonstrated that a higher level of BIM application correlated with a reduction in critical risk levels, addressing the research objectives RO1, RO2, and RO3.

3.2 Qualitative Analysis Results

The qualitative data from interviews and focus group discussions provided valuable insights into integrating BIM with risk identification. Participants identified challenges such as the need for targeted training, stakeholder collaboration, and adapting BIM for risk management. Despite growing awareness of BIM's benefits, practical implementation faces obstacles like resource limitations and a steep learning curve.

The study also highlights that integrating BIM strategies with risk identification improves project management in IBS projects. The quantitative analysis confirms that BIM helps visualize and mitigate risks, supporting findings by (Romli et al., 2024) on the importance of professional training. The qualitative analysis further emphasizes the need for collaboration among stakeholders and overcoming barriers like training costs to ensure effective BIM implementation.

4. CONCLUSION

The findings of this study emphasize the importance of integrating Building Information Modelling (BIM) strategies with critical risk identification processes to enhance the management of Industrialised Building System (IBS) projects. The quantitative analysis revealed a significant relationship between the application of BIM and the reduction of potential critical risks, supporting the achievement of research objectives related to measuring risk levels, BIM strategies, and their interrelationship. This correlation confirms that effective BIM implementation contributes to better visualization, coordination, and mitigation of risks within IBS projects.

The qualitative findings further highlighted practical considerations such as the necessity for targeted training programs, collaborative stakeholder involvement, and overcoming barriers like resource limitations and complex learning curves.

Ultimately, the developed framework proposed in this research integrates BIM with critical risk identification strategies, offering a structured approach for enhancing risk management in IBS projects. This framework aims to guide construction professionals in leveraging BIM's capabilities to improve project outcomes, reduce risks, and foster a proactive approach to project management. Future studies should focus on practical implementations and longitudinal evaluations to validate and refine the proposed framework for widespread adoption.

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