FACULTY OF CIVIL ENGINEERING & TECHNOLOGY
Universiti Malaysia Perlis (UniMAP) FKTA
FKTA Postgraduate Colloquium 2025
UNIVERSITI MALAYSIA PERLIS UniMAP

Assessing The Role of Uncertainty Factors in BIM Application Strategies and Performance in Building Refurbishment Project

Nur Hidayah Khairul Anuar*, Nurfadzillah Ishak, Fazdliel Aswad Ibrahim

Faculty of Civil Engineering & Technology, Universiti Malaysia Perlis (UniMAP), Perlis, Malaysia

KEYWORDS

Building Refurbishment Project
Uncertainty Factors Building Information Modelling
Performance Improvement

ABSTRACT

Building refurbishment projects are exposed to high levels of uncertainty due to complex existing building conditions, design changes, site constraints, and stakeholder involvement. These uncertainties often disrupt project performance in terms of cost, time, and quality. BIM offers potential strategies to enhance project performance; however, the implementation in refurbishment projects remains inconsistent, especially in addressing uncertainty. This study aims to establish the most significance BIM application strategies towards building refurbishment project performance improvement. A quantitative approach is applied using a structured questionnaire distributed to contractors G7 and BIM experts involved in refurbishment projects. Data will be analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM) via SmartPLS to examine direct and moderating relationships among variables. The study's findings concluded that the expected outcome will identify the most significant BIM strategies for managing uncertainty and improving refurbishment project performance, providing both theoretical and practical contributions to the construction industry.

1. INTRODUCTION

The construction industry plays a critical role in national economic growth, urban development, and sustainable transformation. In recent decades, the emphasis on sustainable construction practices has shifted attention from new-build projects towards refurbishment of existing buildings [1]. [2] discovered that the building refurbishment offers multiple benefits, including extending the service life of aging structures, improving energy efficiency, and reducing environmental impacts compared to demolition and reconstruction. Besides, with increasing global commitments to sustainable development, building refurbishment has become an essential strategy in addressing environmental, social, and economic challenges within the built environment [3].

Building refurbishment projects are rapidly becoming a significant part of the sector in Malaysian construction industry and recognized as more complex, highly vulnerable to uncertainty, and need more coordination compared to new construction which can lead to unsatisfactory project performance. According to [4], unlike new construction, building refurbishment involves working with existing structures, which often contain hidden defects, undocumented conditions, and unpredictable challenges during execution. Despite that, additional uncertainties arise from data incompleteness, design limitations, integration of old and new systems, and fragmented stakeholder interests. Besides, implementing refurbishment techniques includes managing the uncertainties in the building refurbishment project and improving the performance of an existing building to suit new criteria that need to be implemented [5].

Furthermore, in the fourth Industrial Revolution (IR 4.0) era of the digitalization, the construction sector has further reinforced the role of advanced technologies in enhancing project performances. Building Information Modelling (BIM) has emerged as one of the most transformative innovations in construction, widely adopted for improving collaboration, coordination, and performance in new-build projects. However, while BIM adoption is advancing in new construction, its application in building refurbishment projects remains significantly more complex and uncertain [6].

On the BIM side, there is strong awareness of digital tools like BIM among construction professionals in Malaysia, but adoption remains limited and insufficiently explored. According to [7], the major obstacles reported include high costs of software and training, lack of skill personnel, and unclear policies or standards. These challenges can be viewed as uncertainty- related factors that affect how well BIM application strategies can be applied in building refurbishment projects, which often leading to difficulties in achieving desired project performances. Besides, inadequate management of such uncertainties may result in delays, cost overruns, reduced quality, and underperformance in project delivery [8].

*Corresponding author: hidayahkhairulanuar@studentmail.unimap.edu.my

2. EXPERIMENTAL PROCEDURE

2.1 Building Refurbishment Project Uncertainties

Uncertainty in the building refurbishment projects refers to the unpredictable factors that affect project performance, including existing building conditions, design changes, site operation challenges, supply chain disruptions, and stakeholder interactions. Furthermore, studies [9] have highlighted that these uncertainties often result in higher risks compared to new construction projects.

These uncertainties can affect productivity, decision-making, and overall project performance. In many cases, poor anticipation or management of uncertainty leads to cost overruns, schedule delays, and quality deficiencies [10]. Therefore, identifying and understanding the sources and types of uncertainty are crucial to developing effective strategies to manage them.

2.2 Building Information Modelling (BIM) Application Strategies

BIM represents a transformative approach to construction project delivery by facilitating digital collaboration, information sharing, and process integration across the project lifecycle. In refurbishment projects, BIM can play a vital role in overcoming the challenges associated with existing building uncertainties by providing accurate as-built models, enhancing communication, and enabling proactive risk management [11].

BIM strategies include the use of digital collaboration, process integration, and risk management tools in order to restructure the project information and improve coordination among stakeholders. Previous studies [12] demonstrate that BIM enhances efficiency, yet its success in building refurbishment depends on contextual factors such as data accuracy and team collaboration.

Despite these benefits, the success of BIM application strategies in building refurbishment projects is highly dependent on the level of digital maturity, data quality, and stakeholder collaboration. Studies show that in several refurbishment contexts, BIM implementation remains limited due to fragmented project structures, lack of standardized data exchange, and resistance to digital transformation [13].

2.3 Project Performance in Building Refurbishment Project

According to [14], the measures of performance often include cost, time, quality, safety and overall efficiency. Although the impact of BIM on these parameters is well known, less is known about the moderating effect of uncertainty, which makes this study necessary.

In refurbishment projects, time performance is often compromised by delays in design confirmation, limited site accessibility, and the discovery of hidden defects during construction. Despite that, cost performance is also affected by uncertain material quantities, fluctuating resource requirements, and unexpected refurbishment work. Meanwhile, quality performance depends on the compatibility between new and existing materials, as well as the precision of construction methods used [15].

3. RESEARCH METHODOLOGY

This study employs a quantitative research design using a structured questionnaire survey.

3.1 Data Collection

The questionnaire will be distributed by employing a self-administrated approach as a research medium to obtain feedback from contractor G7 from construction organization who are registered with Construction Industry Development Board (CIDB) Malaysia and the organization of BIM experts who are registered with the myBIM, which is a subsidiary of the CIDB Malaysia that involved in building refurbishment projects. In addition, the sampling method applied is stratified random sampling to ensure balanced representation across organizations.

3.2 Data Analysis

The collected data will be analysed using IBM SPSS for descriptive statistics and SmartPLS for inferential analysis. PLS-SEM is selected because it effectively handles complex models with smaller sample sizes and non-normal data distribution. In order to achieve the research objectives in this study, the first research objective will be analyzed using descriptive analysis. Next, the second objective will use correlation analysis to explore relationships. Lastly, the third objective will apply regression and moderation analysis through SmartPLS to identify significant strategies.

4. CONCUSION

The findings of this study are expected to establish an adequate framework for future research in order to understand how uncertainty factors influence BIM application strategies and building refurbishment project performance. By identifying the most impactful strategies, the study supports improved decision-making and successful implementation of BIM in managing refurbishment projects more efficiently.

ACKNOWLEDGEMENT

The author would like to express sincere appreciation to the Faculty of Civil Engineering and Technology (FKTA), Universiti Malaysia Perlis (UniMAP) for continuous support and guidance throughout this study. This study is financially supported by the Geran Pascasiswazah 2025, Universiti Malaysia Perlis (UniMAP). Special thanks are also extended to the supervisors and research colleagues for their constructive feedback and assistance in the progress of this work.

REFERENCE

[1] Anuar, N. H. K., Ishak, N., & Shohime, N. S. (2023). The Integration of Risk Identification with Building Information Modelling (BIM) Strategies for Building Refurbishment Project Lifecycle. Construction, 3(2), 308-315.

[2] Azmi, N. A., Ismail, N. A. A., & Rosman, A. F. (2024). The Adoption and Impact of Building Information Modelling (BIM) Towards Facilities Management (FM) in Malaysia. Malaysian Journal of Sustainable Environment, 11(3), 13–26.

[3] Azlan-Shah Ali, S. N. Kamaruzzaman, A. Zulkiflee, M., & Pitt. R. (2019). A Study of Design Performance of Refurbishment Projects in Malaysia. Journal of Asian Architecture and Building Engineering, 9(2), 323-329.

[4] Cervera, A. (2019). Building Information Modelling (BIM) Strategies for Building Refurbishment Project Lifecycle. Journal of Building Engineering, 20-30.

[5] Daoud, P. A. (2020). The complexity of refurbishment building projects in the Malaysian construction industry. Built Environment Journal, 17(1), 9–18.

[6] Egbu, A., Ali, S., Ahmad, R., & Rahmat, M., & CheAni, R. (2018). Risk factors that influence Building Information Modelling (BIM) adoption in Malaysian construction projects. Journal of Construction Engineering, 8(2), 70–81.

[7] Muniandy, P., A. Rahman, R., & Esa, M. (2023). Case Study on Barriers to Building Information Modelling Implementation in Malaysia. Journal of Facilities Management, 21(4), 511-534.

[8] Noori., N., & Ismail, M. (2022). Challenges of Adopting Building Information Modelling (BIM) Technology amongst SME's Contractors in Malaysia. IOP Conference Series: Earth and Environmental Science, 1067.

[9] Noori, N., Daud, S., & Ismail, M. (2021). BIM Adoption in Managing Construction Risks amongst Malaysian Quantity Surveyors: Current Practice and Challenges. International Journal of Sustainable Construction Engineering and Technology, 12(3), 166–175.

[10] Okakpu, P. (2020). The building refurbishment project performance in Singapore and Malaysia construction industry. Journal of Construction Engineering, 12(4), 45–50.

[11] Ranasinghe, A., Jefferies, N., Davis, F., & Pillay, P. (2021). Conseptualising Project Uncertainty in the Context of Building Refurbishment Safety: A Systematic Review. International Journal of Construction Engineering, 230-387.

[12] Shohime, N. S., Anuar, N. H. K., & Ishak, N. (2023). The Effectiveness of BIM– Based Risk Strategies for Building Refurbishment Project Performance Improvement. International Journal of Advanced Industrial Engineering, 4(3).

[13] Uotila, R. N., Saari, M., & Junnonen, J. (2020). Uncertainty in the Early Phase of a Municipal Building Refurbishment Project: A Case in Finland. Journal of Built Environment, 2(3), 442–576.

[14] Zhou, D., Kiviniemi, P., & Jones, A. (2020). Building Information Modelling (BIM) Risk Management Strategies Effectiveness of Building Refurbishment Project. International Journal Built Engineering, 70-87.

[15] Zhao, C. N., Hwang, H., & Gao, A. (2021). Green Building Construction Projects Performance in Singapore. Journal of Built Engineering. 148-155.