The Effectiveness of BIM Features Application Strategies for Building Refurbishment Project Performance Improvement

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ABSTRACT

Revitalizing an old structure through refurbishment is a way to infuse new life into a building that has served its purpose or fallen short of expectations. The growing demand for refurbishment projects can be attributed to various factors, including the aging building stock, limited land availability for future development, the implementation of building regulations, and the need to meet new standards. Consequently, an imbalance between new constructions and existing buildings has fueled the need for refurbishment endeavour. This research paper presents a study that explores the effectiveness of different strategies for implementing Building Information Modelling (BIM) features in enhancing the performance of building refurbishment projects. The study adopts a combined quantitative and qualitative approach to measure the significance of BIM features in relation to building refurbishment project performance. It aims to uncover the correlation between BIM feature application strategies and building refurbishment project performance and provides recommendations on utilizing BIM features to improve project outcomes. The study encompasses a comprehensive review of existing literature on BIM and building refurbishment projects, followed by a mixed-methods approach. This approach involves quantitative analysis of data from refurbishment projects that have implemented BIM, as well as qualitative analysis of expert interviews with industry professionals. The findings of the expert interviews shed light on the factors influencing the effectiveness of BIM in building refurbishment projects, such as the level of BIM adoption, the availability of skilled personnel, and the integration of BIM into project workflows. The paper concludes by discussing the implications of the study for employing BIM in building refurbishment projects, emphasizing the need for further research to explore the potential of BIM in this context. The study contributes valuable insights to enhance the understanding of BIM utilization in building refurbishment projects, offering guidance to practitioners and decision-makers in leveraging BIM technologies for such endeavor.

Keywords: Building refurbishment, building information modelling, project performance, strategies.

1. INTRODUCTION

Refurbishing an aging or under performing building provides an opportunity to rejuvenate its existence and extend its usefulness. The consideration of refurbishment in the life cycle estimation of a structure is emphasized, as significant rehabilitation work becomes necessary to maintain and prolong the building's functionality [1]. Various factors have contributed to the rising demand for refurbishing projects [2], such as the aging building stock, limited availability of land for future development, the implementation of building regulations, and the need to meet new standards. Consequently, an imbalance between the number of new constructions and existing buildings has created a greater need for refurbishment initiatives [3]. Extensive research in mainstream literature has extensively explored and highlighted the advantages of refurbishment projects over new construction and demolition. Refurbishment not only presents notable economic, social, and environmental benefits but also offers the opportunity to modernize buildings and implement energy-saving measures [4].

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Despite the demonstrated benefits of refurbishment, managing such projects is challenging and unpredictable due to the inherent complexity of building structures. In line with the digitization of the construction industry during the fourth industrial revolution, there is a need to integrate and utilize Building Information Modelling (BIM) as an innovative approach to facilitate risk management strategies and identify potential critical risks based on the characteristics of refurbishment project life cycles. BIM serves as a crucial technology for integrated project management, providing all project participants with real-time information on building risk management, which was previously managed manually [5]. While BIM has become widely used in the construction industry for efficient project management, its application in building refurbishment projects is still an emerging area of research. Given the increasing demand for sustainable and cost-effective refurbishment solutions, there is growing interest in exploring the potential of BIM in this domain.

The paper presents the study's findings, which indicate that the application of BIM features in building refurbishment projects can result in significant performance improvements. It identifies the most effective BIM features and strategies for achieving these improvements, as well as explores the relationship between BIM feature application strategies and project performance dimensions. Insights from expert interviews shed light on factors influencing the effectiveness of BIM in building refurbishment projects, including the level of BIM adoption, the availability of skilled personnel, and the integration of BIM into project workflows. The paper concludes by discussing the implications of the study for the utilization of BIM in building refurbishment projects, emphasizing the need for further research to fully explore the potential of BIM in this context. The study contributes valuable insights that can guide practitioners and decision-makers in effectively employing BIM technologies for building refurbishment projects.

2. METHODOLOGY

The study aimed to assess the effectiveness of application strategies for BIM features in improving the performance dimensions of building refurbishment projects. A mixed-methods approach was employed, combining both quantitative and qualitative data collection and analysis. The research primarily focused on the central region of Peninsular Malaysia, specifically Kuala Lumpur and Selangor. The respondents selected which is 44 of respondents for this study were BIM experts certified by MyBIM, an organization under the Malaysian Construction Industry Development Board (CIDB).

The adoption of a mixed-methods approach in this research endeavour signifies a judicious and comprehensive methodological choice. By integrating both quantitative and qualitative methodologies, this approach offers a multi-faceted lens through which to investigate the multifaceted phenomenon of integrating BIM features in building refurbishment projects. The quantitative aspect provides the opportunity to employ statistical analyses and metrics to objectively measure and quantify performance improvements attributed to BIM application strategies. This includes metrics such as cost-effectiveness, time efficiency, and resource optimization, enabling a rigorous assessment of the tangible benefits.

Furthermore, the mixed-methods approach allows for a triangulation of findings, enabling the validation and corroboration of results obtained through different methodological lenses. This methodological synergy not only enhances the robustness and validity of the research but also provides a more holistic and nuanced understanding of the complex dynamics surrounding the application of BIM features in building refurbishment projects. It acknowledges the interplay of objective data-driven metrics with subjective, experiential insights, ensuring a more comprehensive evaluation of the strategies' effectiveness.

The quantitative analysis involved the utilization of statistical methods to examine the relationship between the use of BIM features and project performance. On the other hand, the qualitative analysis aimed to gain a deeper understanding of the factors influencing the effectiveness of BIM in building refurbishment projects. To collect quantitative data, a survey was conducted among professionals involved in building refurbishment projects that implemented BIM. The survey sought information on the usage of BIM features, project performance dimensions (such as cost, time, quality, and sustainability), and the perceived effectiveness of BIM in enhancing project performance. The survey was distributed online to professionals with experience in building refurbishment projects utilizing BIM. Statistical methods were employed to analyse the collected data and identify correlations between the usage of BIM features and project performance.

For qualitative data, expert interviews were conducted with industry professionals who possessed expertise in building refurbishment projects and experience in BIM implementation. These interviews aimed to gain a deeper understanding of the factors influencing the effectiveness of BIM in building refurbishment projects. The interviews were conducted either in person or via teleconference, with the participants' consent to audio-record the sessions. The transcribed data was analyses using thematic analysis to identify common themes and patterns related to the research questions.

3. RESULT AND DISCUSSION

The results and discussion section of this paper presents the findings of study on the effectiveness of BIM features application strategies for building refurbishment project performance dimensions improvement. The study employed a mixed-methods approach, combining quantitative data collection and analysis through a survey and qualitative data collection and analysis through expert interviews. The quantitative approach been used to achieve the first and second objectives which is to measure the most significance for BIM features application strategies and building refurbishment project performance dimensions and to discover the relationship between Building Information Modelling features application strategies and building refurbishment project performance dimensions while the qualitative approach is to achieve objectives three which is to make a recommendation on the effectiveness of BIM features application strategies for building refurbishment project performance improvement.

Based on the research findings, it is evident that different aspects of BIM features application strategies and project performance hold varying levels of significance. The study highlights design aspects as the most significant for BIM features application strategies, while quality aspects are identified as the most significant for building refurbishment project performance dimensions. Thus, these findings successfully achieve the research's first objective of measuring the significance of BIM features application strategies and building refurbishment project performance dimensions.

Overall, the implementation of BIM features application strategies positively impacts project performance through improved collaboration, reduced errors and rework, and enhanced project outcomes. Therefore, these findings establish the relationship between BIM features application strategies and building refurbishment project performance dimensions, successfully achieving the second objective.

In summary, the selected aspects of cost, quality, time, design, technical, safety, and management for the implementation of BIM features application strategies are interconnected and have an impact on various variables. The literature review, as well as the data obtained through both quantitative and qualitative approaches, confirm the relationship between these aspects. Regarding cost, time, management, safety, and quality aspects, the findings align with the existing

literature. Previous research has consistently concluded that implementing BIM in construction projects can influence these aspects. The use of BIM can result in cost savings by minimizing rework, enhancing collaboration, detecting errors and conflicts early on, optimizing resource management, and improving overall project management [6][7].

Both the qualitative and quantitative approaches support the notion that design has the most significant impact when BIM features application strategies are implemented. This finding is also supported by [8], who suggest that BIM-based design aspects have the potential to reduce project management complexities and difficulties. The literature review further reinforces this idea, as it indicates that BIM implementation can enhance collaboration, visualization, accuracy, efficiency, and data integration, leading to improved designs in construction projects. In terms of the dependent variables, namely time, cost, quality, safety, and management, all aspects are interconnected and influence building refurbishment project performance dimensions. The literature review confirms the impact of these aspects on project performance, and the findings from both the quantitative and qualitative approaches corroborate this by indicating that all respondents acknowledge the influence of these aspects on building refurbishment project performance. Hence, there is consistency between the literature review and the data obtained through quantitative and qualitative approaches.

4. CONCLUSION

The quantitative findings of the study indicate a strong positive correlation between the utilization of BIM features and project performance in building refurbishment projects. Specifically, the study revealed that incorporating 3D modelling, clash detection, and collaboration tools significantly enhances project performance in terms of cost, time, quality, and sustainability. Complementing the quantitative results, the qualitative findings offer additional insights into the factors influencing the effectiveness of BIM in building refurbishment projects. Expert interviews emphasized the importance of factors such as the level of BIM adoption, availability of skilled personnel, and integration of BIM into project workflows in determining its effectiveness in improving project performance. The discussion section of the paper delves into a detailed analysis of these findings, discussing their implications for both building refurbishment projects and the implementation of BIM.

In conclusion, the interconnections and impact of various variables on BIM features application strategies and building refurbishment project performance dimension have been established through both quantitative and qualitative approaches, as well as the literature review. Time, cost, quality, safety, and management are all crucial aspects of project performance that are interdependent, meaning that issues in one area can affect the others. Additionally, design, technical, and structural considerations also play significant roles. The similarities found across the quantitative and qualitative approaches, as well as the literature review, underscore the importance of adopting a holistic approach to BIM features application strategies and project performance, considering all relevant variables and their interconnected nature. Overall, the results and discussion section of this paper provides a comprehensive analysis of the effectiveness of BIM features application strategies in improving building refurbishment project performance dimensions. By employing a combined quantitative and qualitative approach, the study offers a more comprehensive understanding of the effectiveness of BIM features in building refurbishment projects compared to relying on either approach alone.

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