Identifying and Overcoming Cost Barriers to Sustainable Construction in Johor Bahru

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ABSTRACT

The construction industry increasingly recognises sustainable construction as a series of activities aimed at integrating eco-friendly resources into building processes to achieve environmental sustainability. Despite its potential, adoption remains constrained by various challenges. This study seeks to identify cost-related barriers to sustainable construction and recommend strategies to address them. A quantitative approach was employed, involving the distribution of questionnaires to targeted respondents within the Johor Bahru construction sector. Feedback was obtained from 63 participants, highlighting perspectives on the benefits, cost barriers, and potential solutions. The findings highlight key benefits of sustainable construction, including reduced utility costs and improved energy efficiency. The significant barriers include perceived risks, high initial investment costs, limited capital, and lack of professional expertise. Respondents also indicated that increased government investment is a crucial measure to overcome these challenges. The study concludes that addressing these barriers is essential for advancing sustainable construction practices in Johor Bahru and fostering broader adoption within Malaysia's construction industry.

Keywords: cost-related barriers, sustainable construction, overcome

INTRODUCTION

Sustainable construction has emerged as a critical focus in the global construction sector, aiming to integrate eco-friendly practices to reduce environmental impact while enhancing the quality of life for future generations. It involves the use of green resources and technologies across all stages of construction, including design, renovation, and demolition (Szydlik, 2014; Wang, Chong & Liu, 2021). Despite its recognised importance, adoption has been hindered by various barriers, necessitating continuous evaluation and strategic interventions to address challenges (Ayarkwa, Opoku, Antwi-Afari, & Li, 2022). The concept of sustainable construction is closely aligned with the "triple bottom line" principle, which encompasses social progress, economic growth, and environmental protection. Practices such as resource reduction, material reuse, recycling, and minimising construction waste are integral to achieving sustainability. The seven core principles of green construction outlined by the Counseil International du Batiment (CIB) further underscore the need for life-cycle costing, quality assurance, and environmental preservation (Szydlik, 2014).

Research has shown that sustainability extends beyond technical and economic aspects, requiring behavioural shifts and collaboration among stakeholders. Durdyev et al., (2018) highlighted, governments play a pivotal role as facilitators, while societies, as key stakeholders, influence the adoption of these practices. Additionally, integrating lean construction and building information modelling (BIM) has demonstrated potential for improving construction efficiency and sustainability outcomes (Momade & Hainin, 2018).As environmental sustainability emphasises maintaining ecological balance and reducing reliance on non-renewable resources, the construction industry must prioritise the preservation of life systems and cultural heritage. By addressing these challenges and leveraging innovative strategies, sustainable construction can significantly contribute to the broader goal of a greener, more equitable future (Chen & Luo, 2020). Sustainable construction, though globally recognised for its potential to mitigate environmental degradation, faces significant implementation challenges, particularly in cost-related aspects. High initial investment costs, combined with perceived risks and uncertainties, remain the most prominent barriers to adopting sustainable practices in the construction industry (Durdyev et al., 2018). These cost concerns are exacerbated by limited public awareness, insufficient government intervention, and a lack of expertise among construction professionals, further hindering the adoption of green construction principles (Ametepey et al., 2015; Jaffar et al., 2022).

Globally, the construction sector is one of the largest consumers of natural resources, using 40% of raw materials annually, including virgin timber, sand, and aggregates, as well as significant amounts of water and energy (Ametepey & Ansah, 2015). The industry's reliance on these resources and the resultant environmental strain highlights the urgency for sustainable construction. However, the additional costs associated with implementing eco-friendly materials and practices, alongside limited understanding of their long-term benefits, pose significant obstacles, as seen in countries such as South Africa, Ghana, and Malaysia (Aigbavboa, Ohiomah & Zwane, 2017; Zulu et al., 2022; Wang et al., 2021).

In Malaysia, specifically, the low level of sustainable construction adoption can be attributed to ineffective procurement methods, inadequate regulatory frameworks, and limited enforcement and monitoring mechanisms. The lack of urgency and passive cultural attitudes towards green principles further complicate efforts to promote sustainability within the sector (Jaffar et al., 2022). Johor Bahru, in particular, has seen minimal research on sustainable construction, leaving a gap in understanding its unique challenges and opportunities. Given these issues, this study aims to identify the cost-related barriers to sustainable construction in Johor Bahru, explore their implications, and propose practical measures to overcome these challenges. By addressing the cost concerns and associated constraints, the findings will provide valuable insights for improving the adoption of sustainable practices within the local construction industry.

LITERATURE REVIEW

The implementation of sustainable construction has gained global attention for its potential to mitigate environmental challenges; however, financial constraints remain a significant barrier to its widespread adoption. The implementation of sustainable construction is often hindered by financial constraints, a key issue highlighted in various studies. Wong et al. (2021) noted that financial barriers stem from the absence of thorough life-cycle cost analyses and insufficient capital, making it challenging for clients and construction professionals to adopt green principles. Similarly, Ahzahar et al. (2022) and Szydlik (2014) emphasised that sustainable construction processes often involve additional expenses, which discourage adoption.

Tafazzoli (2017) highlighted that unanticipated costs and high initial investment expenditures are significant barriers, limiting clients' ability to opt for sustainable methods. Roslee et al. (2022) expanded on this by identifying the complexity of designing green projects, high costs of green materials and technologies, and the need for comprehensive cost demonstrations as additional challenges. Their findings indicated a 3–4% increase in costs when using green materials compared to traditional materials, with capital costs rising by at least 1–25% for green projects (Samari, Godrati, Esmaeilifar, Olfat, & Shafiei, 2013). Furthermore, Wong et al. (2021) argued that the absence of a unified and reliable data framework complicates the financial evaluation of sustainable projects. Most financial institutions are reluctant to fund sustainable building projects unless their potential benefits and financial returns are clearly demonstrated, an area still fraught with inconsistencies due to varying standards and certification criteria.

Other scholars have also examined these financial barriers. For instance, Darko et al. (2018) highlighted that the high upfront costs of green construction materials and technologies are a universal deterrent, particularly in developing countries. Similarly, Hwang and Tan (2012) found that the lack of government subsidies and financial incentives further discourages the adoption of sustainable construction practices. Additionally, Zuo and Zhao (2014) pointed out that the perception of higher costs, even when long-term savings are evident, undermines the willingness of stakeholders to invest in green projects.

Kibert (2016) identified that misconceptions about the cost-effectiveness of sustainable construction contribute significantly to its limited implementation. In contrast, Shi, Du, and Evans (2016) suggested that the lack of financial support and investment frameworks tailored for green construction projects exacerbates the challenges. Similarly, Wu, Ding, and Love (2017) found that financial risks associated with new technologies and materials further complicate the decision-making process for stakeholders. Chong et al. (2017) stressed that limited access to cost-effective green materials is a persistent issue, particularly in regions where such resources are not readily available. Lastly, Qian, Chan, and Khalid (2020) demonstrated that inconsistent tax policies and unclear financial regulations often discourage stakeholders from committing to sustainable construction investments.

METHODOLOGY

The study adopted a positivistic paradigm, which aligns with the quantitative research methodology. This approach is widely regarded as suitable for construction industry studies due to its focus on numerical data and statistical analysis. Quantitative methods enable structured responses and allow for a clear analysis of relationships among variables, making them ideal for identifying and understanding cost barriers in sustainable construction (Naoum, 2012; Darko et al., 2018).

Target Population and Sampling

The study targeted construction industry professionals in Johor Bahru, specifically consultants, contractors, and developers. To ensure the relevance and credibility of responses, the targeted respondents were sourced from reputable directories published by the Construction Industry Development Board of Malaysia (CIDB), The Association of Consulting Engineers Malaysia (ACEM), and The Johor Master Builders Association (JMBA). This selection ensures that participants possess expertise and knowledge about green construction principles, making them ideal respondents for the study (Wong et al., 2021; Ahzahar et al., 2022). Using Slovin's formula, the sample size was determined to be 85 companies out of a population of 107, with a precision level of 5%. Slovin's formula is widely acknowledged as an effective tool for determining a representative sample size while accounting for variability within a population. This method ensured that the sample was both manageable and representative, crucial for accurate and meaningful data collection (Etikan, 2016).

Questionnaire Distribution and Response Rate

The delivery-and-collection method was employed to distribute the questionnaires to the respondents, yielding a high response rate of 74.11% (63 out of 85 questionnaires returned). This response rate significantly exceeds the typical response rates of 20–30% for postal surveys in construction industry research, as noted by Akintoye (2000) and Dulaimi et al. (2003). The high response rate reflects the study's relevance to the target respondents and demonstrates the effectiveness of the chosen data collection method. The focus on a high response rate ensured the reliability of the findings, as responses were gathered from knowledgeable participants in both public and private sectors, including developers, contractors, project managers, architects, engineers, and quantity surveyors. The involvement of diverse roles strengthened the comprehensiveness of the data collected (Hwang & Tan, 2012).

Data Analysis Techniques

The study employed descriptive statistics and the Relative Importance Index (RII) for data analysis. Descriptive statistics provided a structured way to summarise and simplify complex data into meaningful patterns, enabling a clear interpretation of responses. As Jowwad and Gupta (2019) emphasised, descriptive statistics are well-suited for analysing quantitative data, offering clarity and facilitating reasonable conclusions. The RII method was used to rank the importance of variables related to cost barriers in sustainable construction. This technique, widely used in construction management research, is particularly effective for prioritising factors and understanding their relative significance (Doloi, 2008). The use of SPSS software further ensured accurate statistical computations, reducing errors and enhancing the reliability of the analysis (Kassem, Khoiry, & Hamzah, 2020).

RESULTS AND DISCUSSION

Respondent Information

Table 4.1 shows the information of various respondents from the Johor construction industry who had completed and returned the valid and "fit for use" questionnaire. According to Table 4.1, the highest number of responses were from the private sector which constitutes of 33 questionnaires, out of 63, giving it a percentage of 52%. There were 23 responses were from the public sector, standing at 36% while the remaining 7 responses constitutes about 12% overall from the self-employed sector. The Quantity Surveyor stands as the major respondent of the questionnaire distributed, at 29% of the total respondents. It is then followed by the Project Manager (19%), who provides their own viewpoint from both the public and private sector. Both the Project Manager and the Quantity Surveyor's opinions were considered useful to the study as they are the individuals who have carried out sustainable construction process. Apart from that, feedbacks gathered from Contractor (16%), Client/Developer (14%), Engineer (14%) and lastly Architect (8%) were of great significance in contributing to this study.

Most of the respondents have at least more than 10 years of experience which constitutes at least 36% of the total respondent. Based on the responses, it signifies that most of the respondents were associated and experienced in the construction industry for quite a long duration of time whereas the remaining are still inexperienced and considered to be amateurs. According to Table 1, only 4 number of respondents (7%) are not experienced with sustainable construction, making it the minority of the total respondents. There were 16 respondents having experience in terms of theoretical knowledge while the other 43 respondents has been practicing sustainable construction from time to time justified by their working experience of more than 10 years.

Table 1: Respondent background

Category	Selections Provided	Number of Feedback	Percentage
Working Sector	Public Sector, Private Sector, Self-Employed	23, 33, 7	36%, 52%, 12%
Career Background	Client/Developer, Contractor, Project Manager, Architect, Engineer, Quantity Surveyor	9, 10, 12, 5, 9, 17	14%, 16%, 19%, 8%, 14%, 29%
Working Experience	Less than a year, 1 to 2 years, 3 to 5 years, 5 to 10 years, More than 10 years	6, 4, 15, 15, 23	10%, 6%, 24%, 24%, 36%

THE CHALLENGES OF BIM IMPLEMENTATION IN CONSTRUCTION PROJECTS

Table 2 shows that the challenges of financial barriers of sustainable construction. The highest-ranked barrier with an RII of 0.898 is the perceived risks and uncertainties related to sustainable buildings. This suggests that stakeholders, particularly clients and contractors, view green construction projects as risky, potentially due to unclear long-term financial benefits or unfamiliarity with sustainable practices. Closely following is the financial constraints of clients and/or contractors (RII = 0.895), which emphasises the challenge of securing funding for projects that often require higher upfront investments. Limited access to capital (RII = 0.867) and lack of awareness and expertise among construction professionals (RII = 0.857) rank third and fourth, respectively, underlining the need for increased financial support and capacity-building initiatives. Interestingly, high wages for skilled labour due to complex design and engineering requirements shares the same RII (0.857), reflecting the financial strain caused by the scarcity of skilled professionals in sustainable construction. Lower-ranked barriers such as limited availability and higher costs of sustainable materials (RII = 0.832) and higher insurance premiums (RII = 0.797) highlight logistical and operational challenges, while

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appraisal and valuation challenges (RII = 0.749) reflect systemic gaps in assessing the financial viability of sustainable projects. These factors collectively illustrate a broad range of challenges, predominantly financial and technical, faced by stakeholders.

Table 2: Financial Barriers of Sustainable Construction

Statements	Mean	RII	Rank
Perceived risks and uncertainty related to sustainable buildings	4.492	0.898	1
Financial constraints of clients and/or contractors	4.476	0.895	2
Limited access to capital	4.333	0.867	3
Lack of awareness and expertise of construction professionals	4.349	0.857	4
High wages of skilled labour due to complex design requirements	4.286	0.857	5
Lack of government incentives/subsidies	4.270	0.854	6
Limited market demand	4.206	0.841	7
Limited availability and higher costs of sustainable materials	4.159	0.832	8
Higher insurance premiums	3.984	0.797	9
Appraisal and valuation challenges	3.746	0.749	10

Based on Table 3 The highest-ranked strategy with an RII of 0.911 is government investment in sustainable construction, underscoring the critical role of public funding and policy support in advancing sustainability initiatives. The second-ranked strategy, local production of green construction materials (RII = 0.889), emphasises the need to reduce costs and dependency on imported materials, which could help address the financial barriers noted in the first table.Green financing options and loans with favourable terms rank third (RII = 0.886), reinforcing the importance of accessible financial mechanisms to reduce the perceived and real risks associated with sustainable projects. Additionally, encouraging sustainable design-build practices (RII = 0.867) and regulatory support with streamlined permitting processes (RII = 0.854) rank prominently, suggesting that streamlining bureaucratic processes and adopting efficient project delivery methods are pivotal in reducing project costs and risks. Collaborative efforts, such as partnerships with sustainable technology providers (RII = 0.851) and education programs on financial benefits (RII = 0.851), reflect the importance of stakeholder engagement and awareness. Lower-ranked strategies, such as government incentives and subsidies for sustainable projects (RII = 0.838), indicate the need for additional economic policies to motivate adoption.

Table 3: Measures to Overcome Sustainable Construction

Statements	**Mean**	**RII**	**Rank**
Government should invest more on sustainable construction	4.556	0.911	1
Production of green construction materials locally	4.444	0.889	2

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Green financing options and loans with favourable terms	4.429	0.886	3
Encouraging sustainable design-build practices to streamline costs	4.333	0.867	4
Regulatory support and streamlined permitting processes	4.270	0.854	5
Procurement policies and green public procurement	4.270	0.854	6
Collaborations with sustainable technology providers	4.254	0.851	7
Education and awareness programs on financial benefits	4.254	0.851	8
Collaborative partnerships and consortiums	4.222	0.844	9
Government incentives and subsidies for sustainable projects	4.190	0.838	10

Comparative Insights

The analysis reveals that financial concerns dominate both the barriers and strategies. High RII values for perceived risks and financial constraints as barriers correlate with high RII values for strategies such as government investment and green financing options, emphasising the interconnectedness of these factors. The need for awareness programs (RII = 0.851 for strategies) corresponds to the lack of expertise barrier (RII = 0.857), highlighting education and training as a critical intervention. This result supported by Darko et al. (2018). The research emphasized the importance of government investment and innovative financing mechanisms to mitigate these challenges. Additionally, it stressed the need for stakeholder education to raise awareness and support the adoption of sustainable practices, highlighting a holistic approach to overcoming these barriers.

While operational barriers such as limited material availability and high insurance premiums are ranked lower, strategies like local production of materials are essential in addressing these issues effectively. This approach reflects a targeted effort to resolve both immediate and long-term challenges. In line with Vaghefi-Rezaee et al. (2024), the study emphasizes that sourcing green materials locally is vital for reducing costs and minimizing environmental impacts, particularly in emerging markets seeking to improve sustainability practices. Furthermore, it highlights that the adoption of efficient materials and reforms in insurance policies play a key role in achieving both short-term and long-term sustainability objectives in the construction industry.The RII analysis underscores the financial and systemic nature of barriers to sustainable construction, with a strong emphasis on risks, costs, and expertise gaps. Strategies with the highest RII values suggest prioritising government investment, local material production, and financial incentives to mitigate these barriers. A holistic approach combining financial mechanisms, policy support, and stakeholder collaboration is essential for advancing sustainable construction practices.

CONCLUSION

Sustainable construction holds significant potential to tackle environmental challenges while enhancing economic and social outcomes. However, its adoption faces critical barriers, such as high initial costs, perceived financial risks, limited access to capital, and insufficient awareness and expertise among stakeholders. Overcoming these obstacles demands a comprehensive strategy that incorporates increased government investment, innovative financing mechanisms, local production of sustainable materials, and targeted education initiatives. To address the economic challenges, future research could explore the long-term financial benefits of sustainable construction, such as reduced operational costs and energy savings. Analysing these benefits would help mitigate concerns over high initial investments. Additionally, investigating innovative financing options, including green bonds and public-private partnerships, could make sustainable practices more financially viable. Enhancing education and awareness among stakeholders is equally crucial to foster understanding and drive adoption of sustainable methods across the industry. This study provides valuable insights into improving sustainable construction practices in Johor Bahru by highlighting the need for a multifaceted approach. By integrating financial, regulatory, and educational measures, the construction industry can transition to sustainable practices that offer enduring economic and environmental advantages. The findings contribute to Malaysia's broader goal of embedding eco-friendly practices within its construction sector, supporting the balance between economic growth, environmental stewardship, and social progress. This research underscores the importance of collaborative efforts to pave the way for a greener and more resilient future.

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