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Original Article

Critical Pathways for Advancing Sustainable and Environmentally Responsible Design in Commercial Building Projects

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Liew Mei Xian[1], Md Azree Othuman Mydin[*,1]

[1] Department of Building Surveying, School of Housing, Building and Planning, Universiti Sains Malaysia, Penang, Malaysia

[*] **Correspondence email:** azree@usm.my

Abstract

Nowadays, one of the biggest worldwide problems is resource depletion and environmental damage. The construction industry has taken leading roles in energy conservation and emission reduction since buildings are the primary habitat for humans and are major sources of energy consumption and pollution emissions. In recent years, the concept of sustainability has drawn the interest of numerous disciplines. Green building (GB) is the fundamental element of sustainable development as it defines the style of buildings designed and constructed by environmentally friendly principles. In this regard, this study draws attention to evaluating and addressing the most important topics: the priority criteria for advancing GB for commercial buildings. Therefore, to enhance and promote the development of green buildings, it is crucial to comprehend the factors that determine the successful application of green features to ensure that the obstacles during the construction process are overcome. The research identifies key criteria such as energy efficiency, material selection, water conservation, and indoor environmental quality through comprehensive literature reviews, surveys, and case studies. By analysing stakeholder perspectives, including architects, builders, and tenants, this research highlights the most impactful criteria for promoting green building initiatives. The findings offer valuable insights for policymakers, developers, and industry professionals, ultimately contributing to a more sustainable built environment. This study highlights the elements driving the acceptance of green buildings and barriers to their execution, providing valuable insights for stakeholders engaged in the ongoing discourse concerning green building development. Consequently, interested parties will gain better understanding of the factors affecting the priority criteria for the progression of green buildings in the commercial buildings.

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1. Introduction

1.1. Research Background

According to Bungau and Constantin [1], the concept of green buildings encompasses a wide array of practices, technologies, and materials to improve energy efficiency, reduce waste, and create healthier living environments. However, despite the potential benefits of green construction, several persistent challenges have hampered its widespread adoption. Among these challenges are the complexities surrounding defining and measuring what constitutes a "green" building [2]. While beneficial, current certifications, such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) can often create confusion and inconsistencies in application. Those systems are designed to prioritise and address the sustainability pillars. Consequently, the lack of universally accepted criteria can deter builders and stakeholders from investing in green technologies, thereby slowing the momentum needed for transformation in the industry [3].

Moreover, the financial implications of adopting green building practices cannot be overlooked. Initial costs for sustainable materials and technologies often present a significant barrier to entry for many developers. Despite the long-term savings and environmental benefits, the short-term economic challenges can lead to hesitation among stakeholders. Additionally, insufficient knowledge and understanding of green technologies can result in poor implementation and missed opportunities for optimising sustainability. Therefore, addressing these issues is imperative for fostering an environment conducive to advancing green buildings [4]. According to a survey conducted in Malaysia, one of the biggest obstacles to the growth of green buildings in that nation is a lack of public awareness, as observed by Jaffar et al. [5] in their study. To develop a local construction industry that can be more user-friendly and environmentally friendly, especially in Malaysia, one challenge that needs to be addressed is a lack of awareness and understanding.

This research project on identifying priority criteria for the advancement of green buildings addresses a crucial gap in the knowledge domain surrounding sustainable construction practices. This study addresses the barriers and obstacles hindering the widespread acceptance of green building principles, offering practical recommendations for improving the industry. By identifying priority criteria, this project will provide a road map for industry professionals, policymakers, and academics. A more cohesive understanding of effective green building practices can lead to improved compliance and commitment from all parties involved, ultimately driving the movement toward sustainable construction.

1.2. Literature Review

1.2.1. Introduction of Green Buildings

According to the United States Environmental Protection Agency [6], a green building refers to designing, building, and operating structures in an environmentally responsible and resource-efficient way throughout their lifespan. This includes the stages of site selection, design, construction, operation, maintenance, renovation, and deconstruction. Green building practices enhance and extend traditional design considerations such as economy, functionality, durability, and occupant comfort.

According to the study of Khan et al. [7], Figure 1 shows the projected growth of sustainable living. It is categorised into viable, bearable, and equitable dimensions, spanning three years: 2015, 2030, and 2050, measured in billions of square meters. This significant expansion in building floor area necessitates a well-organised plan and strategic resource management by utilising various tools and techniques to facilitate the adoption of green buildings. As a result, green buildings contribute to

achieving nine distinct Sustainable Development Goals (SDGs). Given the rapid growth of building floor area in many nations, researchers have developed various techniques or strategies to accomplish the sustainability goals across different aspects of life.

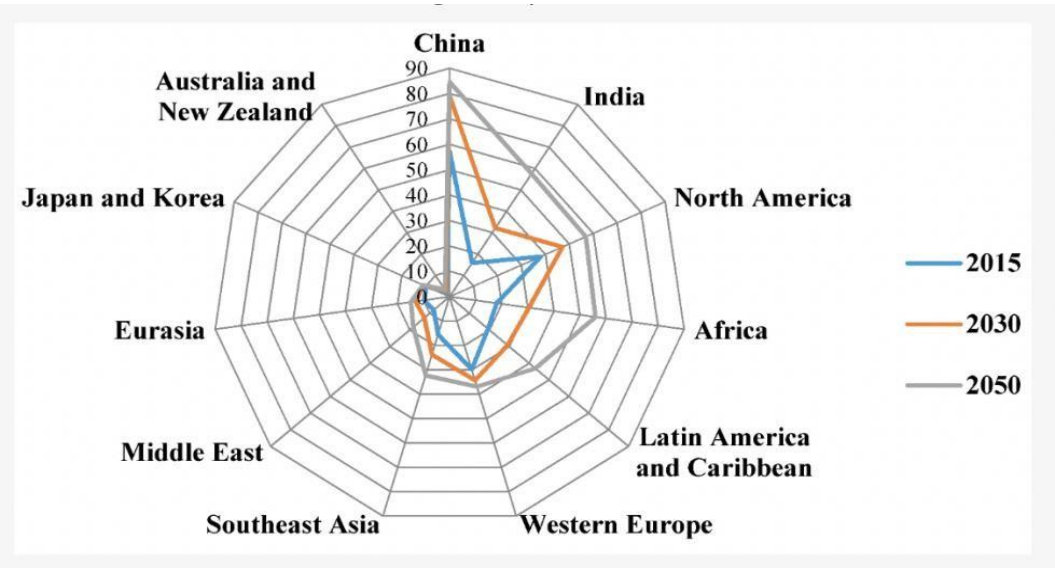

Figure 1: Buildings Floor Area Growth by Region in Billion m^2.

1.2.2. Challenges in Adopting the Green Building Practices

Figure 2 highlights the key constraints and barriers to implementing sustainable building practices in Jordan. These include understanding different perspectives, organisational issues, material availability, costs, practical examples and measurements, stakeholders' support, education, training, and scientific research. Previous studies have identified institutional and organisational challenges as primary reasons for the slow adoption of sustainable construction practices. The lack of national standards for sustainable materials and green building codes has further delayed progress. One of the study's key findings was the widespread lack of understanding of implementing sustainable building practices [8] effectively.

1.2.3. Increasing Cost

The increasing cost of development is one of the primary issues for many developers who are going green. It can be proven that the construction (hard cost) and finance (soft cost) costs of green buildings are higher than those of non-green buildings [9]. Although cost is a concern, modern developers should adopt a different perspective and strive for the greatest long-term solution rather than the cheapest one. Green buildings may even command higher rental prices and are occasionally valued more than traditional structures. Not only do green buildings have financial advantages, but they also have intangible social and environmental benefits [10]. Compared with conventional buildings, green building costs are higher as they incur higher costs on materials and technologies used in the design phase and the high cost during the construction phase. Therefore, due to this high-cost issue, developers are hindered from green buildings [11].

Furthermore, green buildings have various positive effects, such as reducing air, water, and soil pollution during construction, less noise and waste, higher operational costs, productivity, and health and well-being. These advantages are reflected in the value of green buildings, often called the price premium. A substantial body of research consistently demonstrates notable sales and rental premiums

for green buildings [12]. Price premiums can offset the additional costs developers incur, thereby incentivising the construction of green buildings. Developers may be incentivised to construct green buildings when the price premium and government subsidies surpass the incremental costs.

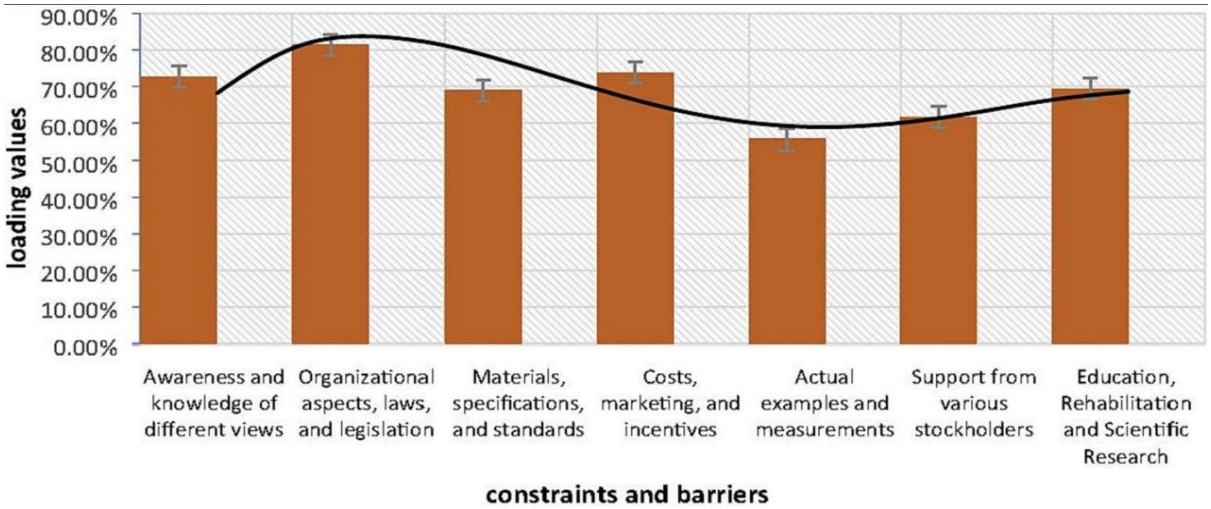

Figure 2: Constraints and Barriers of Implementing Sustainability Building Practices in Jordan.

1.2.4. Green Building Materials

Green building materials are specifically made to cause the least harm to human health. Low levels of odour and pollutants make them ideal for creating a healthier interior atmosphere. When interior decoration or renovation works are done, harmful pollutants included in conventional building materials can be discharged, which exposes those who spend a lot of time indoors to serious risk [13]. Contractors and other professionals have a variety of green materials at their disposal for building construction. These include recycled and reused materials, products created through sustainable production methods, locally sourced resources, and materials derived from environmentally friendly sources. Using these materials can help in creating healthy, sustainable buildings. Regarding energy use and greenhouse gas emissions, many of the acoustic materials currently in use cannot be regarded as sustainable; additionally, some may be hazardous to human health [13]. Because of their high performance and affordability, mineral wool is frequently used for thermal and acoustic insulation; however, when inhaled, their fibres can lodge in the lung alveoli and irritate the skin. However, the choice and use of green materials primarily depend on their functionality, technical performance, and cost-effectiveness. The construction industry plays a significant role in this problem. This is due to the rising production of greenhouse gases, which has become a critical environmental issue that will continuously harm human life.

1.2.5. Lack of Awareness Level and Knowledge

The findings of a study on the prospects for advancing sustainable construction (SC) methods in Kuwait are presented in the paper by Al Sanad [14]. It shows that by evaluating the state of the sustainable construction practice, the level of knowledge and awareness among the construction stakeholders are the main forces behind the adoption of green practices and become the serious obstacles to sustainable construction. Additionally, the lack of awareness about sustainable construction's long-term environmental, economic, and social benefits further exacerbates the situation. Therefore, the absence of clear guidelines, incentives, and regulatory frameworks could facilitate the transition towards more sustainable practices.

Figure 3 presents the respondents' perceptions regarding the key barriers to adopting green building practices, ranked according to their mean values. The findings indicate that the most significant challenge identified is the "lack of awareness" (mean = 4.24), followed closely by the "lack of government support/no incentives" (mean = 4.16). These results suggest that insufficient education on sustainable building practices and the absence of adequate policy support are critical obstacles to advancing green buildings. This aligns with previous studies by Winston [15], which emphasise the importance of regulatory frameworks in promoting sustainable development. Conversely, the least significant barriers, according to respondents, are the "risk associated with the implementation of new practices" (mean = 3.61) and "economic conditions" (mean = 3.34). Given that green construction is still a relatively new concept in many regions, raising awareness among stakeholders about its benefits is crucial to its widespread adoption. Effective educational initiatives can help to overcome those key challenges, particularly the lack of knowledge about sustainable building techniques and their long-term advantages. Economic concerns remain a major deterrent, with respondents perceiving "green buildings as expensive" and citing overall "economic conditions" as fundamental obstacles. The financial implications of sustainable construction have a particularly significant impact in profit-driven industries where project contracts are often awarded based on the lowest bid.

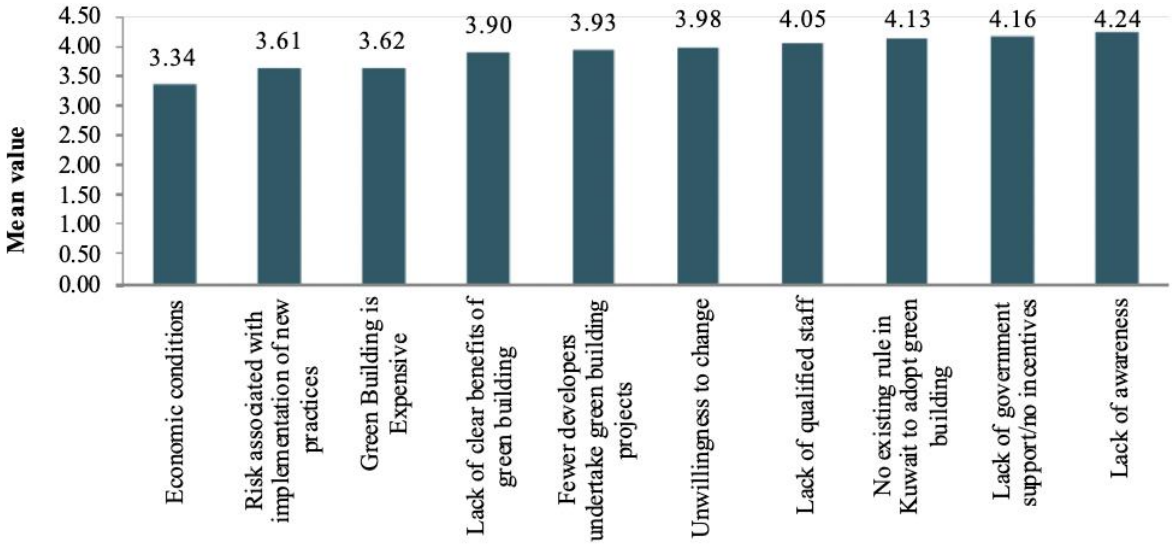

Figure 3: Perception of the Barriers towards Implementation of Green Construction Practices.

2. Methodology

2.1. Research Process

Figure 4 indicates the research process for this research. It is divided into three distinct phases.

Phase 1 begins by identifying the research topic and issues, followed by formulating the problem statement, research objectives, and key research questions. A comprehensive literature review is conducted to establish a theoretical foundation, providing insight into existing studies and practices related to the barriers and challenges faced when carrying out green building advancements in commercial buildings. This phase ensures that the study is grounded in relevant academic and industry knowledge, setting the stage for the methodological approach in the subsequent phases.

Phase 2 focuses on data collection through various research methodologies to address the study's objectives. A literature evaluation is conducted alongside a structured questionnaire distributed via an

online survey to evaluate the key criteria influencing the effectiveness of green building practices. In-depth interviews are conducted with relevant stakeholders to identify the barriers and challenges commercial buildings face in adopting green building technologies and practices. Additionally, guided interviews are used to derive actionable recommendations for prioritising green building criteria for stakeholders in the commercial building sector. This phase is essential for gathering both qualitative and quantitative data to support the study's findings to achieve this research's objectives.

Phase 3 involves data analysis and the interpretation of findings. The collected data from literature evaluation, questionnaires, and interviews are systematically analysed to derive meaningful conclusions. The findings are then synthesised to provide recommendations that align with the study's objectives, ensuring practical applicability in advancing green building adoption. This final phase culminates in a structured conclusion highlighting key insights and providing a framework for future research and policy considerations in green commercial building practices.

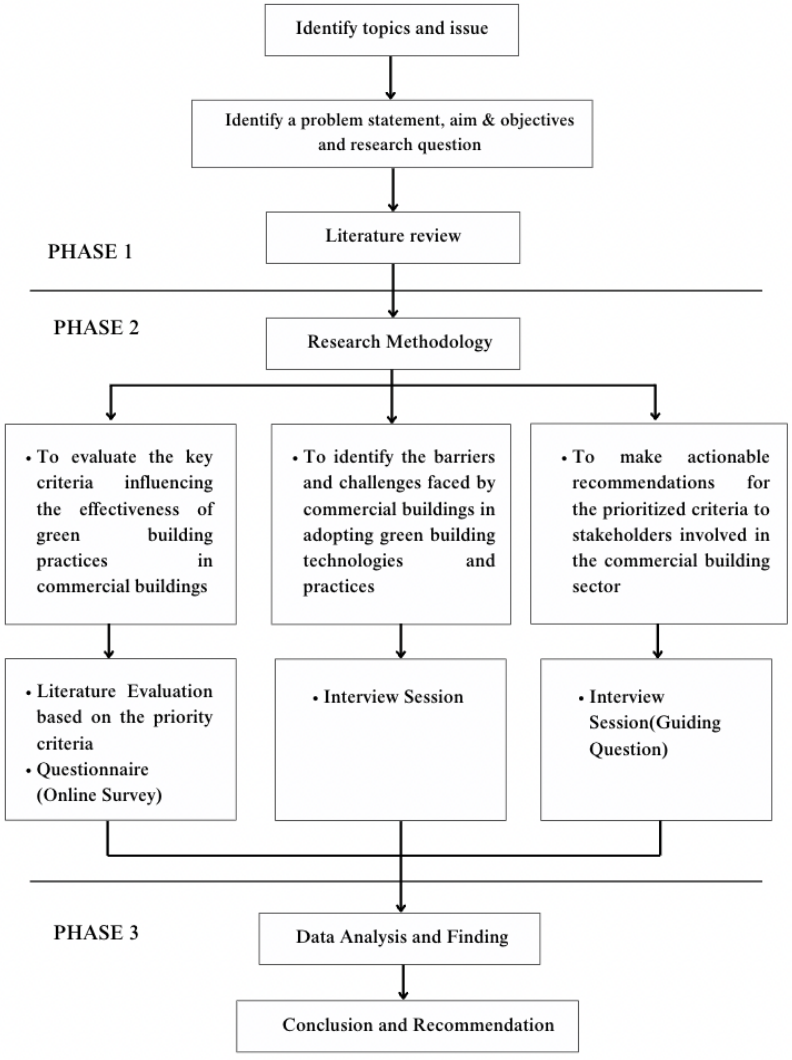

Figure 4: Research Process for Identification of Priority Criteria for the Advancement of Green Buildings for Commercial Buildings.

2.2. Interview Session Development

To achieve the second objective in this research, which is to identify the barriers and challenges faced by commercial buildings in adopting green building technologies and practices, an interview research methodology will be conducted with key stakeholders in the commercial construction industry, including architects, engineers, property developers, and facility managers (see Table 1). To enhance the validity of the data, various strategies were employed, including gathering multiple sources of evidence and having key informants review the relevant cases. These stakeholders provided valuable insights into their experiences and perspectives regarding the barriers and challenges in adopting green building practices. The collected feedback was analysed to determine the most critical criteria for successful implementation.

Table 1: Interview Questions.

Interview Questions
1. Can you briefly introduce yourself and explain your role within the commercial building sector?
2. How long have you been involved in green building initiatives or sustainable construction practices?
3. What have been some of the major challenges your organisation has faced in adopting green building practices or technologies?
4. From your perspective, what are the most significant barriers to adopting green building technologies in commercial construction projects?
5. How would you describe the financial challenges of green building technologies? Are there particular cost-related concerns that hinder the adoption of green building practices?
6. In your experience, do you think there is sufficient understanding or knowledge of green building technologies within the commercial sector? If not, what are the knowledge gaps that need to be addressed?
7. Do you perceive a lack of awareness or interest in green building technologies among key stakeholders (e.g., developers, investors, facility managers)?
8. How do regulatory frameworks or building codes impact the adoption of green building technologies? Are there specific regulations facilitating or hindering the implementation of green building practices?
9. Are there particular technical or operational challenges that make integrating green building technologies into commercial buildings difficult?
10. How do you think the availability of skilled labour or trained professionals impacts the adoption of green building practices?
11. What is the role of collaboration and knowledge-sharing among stakeholders in overcoming the barriers to adopting green building practices?
12. Last but not least, what suggestions do you have for overcoming the challenges or barriers to adopting green building technologies in the commercial construction sector?

3. Results and Discussion

Thematic analysis is a significant approach in interpreting the data collected from interview sessions. This process involves identifying key themes, analysing the context in which they appear, and reporting on the trends found in the data. This method helps in organising and interpreting qualitative data by grouping responses into meaningful themes, making it easier to understand stakeholders' perspectives on green building practices [17]. The interviews were fully transcribed to ensure accurate recording of all the material obtained. The study systematically analysed the data gathered from these interviews to meet the research objectives. Additional resources, such as interview transcripts, audio recordings, and field notes, were also incorporated into the data analysis process to enrich the findings [18-22].

Material selection plays a crucial role in advancing green building design, particularly in commercial spaces, where sustainability and energy efficiency are becoming increasingly essential to meet environmental and economic goals [23-31]. As the commercial sector is a significant consumer of

resources and energy, the choice of materials directly influences a building's ecological footprint, operational efficiency, and long-term performance [32]. Materials must be carefully chosen in green building design to minimise environmental impact across their entire lifecycle, from production and transportation to installation, use, and eventual disposal or recycling [33-41]. One of the most critical considerations is the embodied energy of materials, which refers to the total energy required to extract, process, transport, and install them [42-46].

Selecting materials with low embodied energy, such as recycled or locally sourced materials, reduces carbon emissions and decreases dependency on non-renewable resources, which is vital in addressing the climate crisis [47]. For example, materials like bamboo, recycled steel, and reclaimed wood offer sustainable alternatives to conventional products like concrete and steel, which are resource-intensive and have a significant environmental footprint [48-54]. Moreover, choosing locally sourced materials helps reduce transportation costs and emissions, contributing to the building's overall sustainability by supporting local economies and minimising the carbon footprint of transportation. Sustainability considerations also extend to the durability and longevity of materials. Commercial buildings, especially large office spaces, often experience heavy foot traffic and need materials that can withstand wear and tear while requiring minimal maintenance. High-durability materials, such as concrete with low-maintenance finishes or advanced composite materials, can reduce the frequency of repairs and replacements, thus conserving resources and minimising waste over time. The life cycle of materials also includes considerations for deconstruction and reuse, which are essential elements in the circular economy [55]. Using recyclable or reusable materials ensures that when the building reaches the end of its life, materials can be reclaimed and repurposed for future construction projects, avoiding the creation of unnecessary waste in landfills. Additionally, material selection for green buildings must consider health and wellness factors, as commercial spaces are typically occupied by large numbers of employees and visitors exposed to the building's materials daily [56]. Using non-toxic, low-VOC (volatile organic compound) materials, such as paints, adhesives, and finishes, is essential for improving indoor air quality and creating healthier environments for occupants. Materials that contribute to a healthy indoor environment support employee well-being and productivity and help building owners avoid costly legal or regulatory issues related to air quality standards.

Energy efficiency is another critical factor in selecting materials for green commercial buildings. Many sustainable materials have properties that enhance the thermal and acoustic performance of the building, which contributes to reducing heating and cooling energy needs, leading to lower operational costs and increased comfort for occupants. Insulation materials, such as cellulose, sheep wool, or cork, provide natural thermal resistance, reducing the reliance on mechanical HVAC systems. In contrast, high-performance glazing and reflective roofing materials can mitigate solar heat gain, improving energy efficiency. Moreover, integrating advanced technologies into materials, such as phase-changing materials (PCMs) that store and release thermal energy, can enhance a building's energy resilience, making it more adaptable to changing environmental conditions and reducing the overall energy demand.

Water efficiency is also important in green building design, and materials that contribute to water conservation can significantly reduce a building's environmental impact. For instance, low-flow plumbing fixtures, rainwater harvesting systems, and permeable paving materials can reduce water consumption and minimise the risk of flooding in urban areas. In addition, using water-resistant and moisture-resistant materials, such as fibre-cement siding or treated wood, can prevent mould growth and structural damage, thereby increasing the lifespan of the building and reducing the need for repairs [57]. Furthermore, materials incorporating renewable resources or bio-based products, such as hempcrete or natural linoleum, offer sustainable alternatives to conventional petroleum-based products, contributing to a more circular and regenerative economy. Integrating such materials helps reduce

dependence on finite resources while promoting innovation and encouraging the development of new, sustainable building materials.

From an aesthetic and functional standpoint, selecting materials for green buildings also plays a vital role in shaping the overall design and user experience. For commercial spaces, creating environments that inspire creativity, collaboration, and productivity is key, and using natural materials like wood, stone, or plant-based finishes can help create a connection with nature, fostering a sense of well-being among employees and visitors. Biophilic design principles, which focus on incorporating natural elements into the built environment, can be enhanced by carefully selecting materials that promote visual and sensory connections to the natural world, improving occupant satisfaction and building performance [58].

Additionally, green building certification systems, such as LEED (Leadership in Energy and Environmental Design), provide guidelines for selecting materials based on their sustainability, performance, and environmental impact, ensuring that commercial spaces meet industry standards for energy efficiency, waste reduction, and environmental stewardship. By adhering to these guidelines and embracing a holistic approach to material selection, designers, architects, and developers can create resource-efficient buildings and contribute to a broader environmental agenda, addressing pressing global challenges like climate change, resource depletion, and urbanisation [59]. Moreover, investing in green building materials often results in long-term financial savings through reduced operational costs, higher building value, and greater market demand for environmentally responsible commercial spaces. Green buildings prioritising sustainable material selection can attract tenants, investors, and clients increasingly concerned with environmental impact, social responsibility, and cost-efficiency, positioning these buildings as attractive and forward-thinking assets in the competitive real estate market [60]. Hence, material selection is a fundamental aspect of advancing green building design in commercial spaces, encompassing a broad range of considerations from environmental impact and energy efficiency to occupant health and aesthetic value. By prioritising sustainable materials, green building projects can reduce operational costs, improve the well-being of occupants, and contribute to a more sustainable and resilient built environment.

4. Conclusions

In summary, this study identified several critical factors that impede the widespread adoption of green building technologies and practices within the commercial sector. By examining commercial buildings' barriers and challenges, the research provides valuable insight into the obstacles limiting the broader implementation of sustainable initiatives. For instance, high initial costs, limited awareness, and resistance to change remain significant obstacles, while regulatory complexities and a lack of incentives discourage adoption. Additionally, technical challenges, such as inadequate expertise and integrating sustainable systems into existing infrastructure, lead to further complications. Addressing these challenges requires a multi-faceted approach, such as policy support, financial incentives, stakeholder education, and advancements in green technology accessibility. Commercial buildings can transition towards more sustainable practices by overcoming these barriers, ultimately contributing to environmental conservation and long-term economic benefits.

Declaration of Conflict of Interest

The authors declared no conflict of interest with any other party on the publication of the current work.

ORCID

Md Azree Othuman Mydin https://orcid.org/0000-0001-8639-1089

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