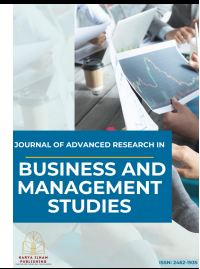




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# The Role of Stakeholder Engagement in Green Building Technology Adoption in Malaysia

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### ABSTRACT

Green building technology (GBT) is recognised as a fundamental driver of sustainable construction in Malaysia. Despite the implementation of various policies and initiatives to promote GBT, its diffusion across the construction industry remains relatively limited. As GBT adoption relies on the coordinated involvement of multiple stakeholders, stakeholder engagement has become increasingly recognised as a fundamental prerequisite for successful implementation. However, Malaysian research has largely treated stakeholder engagement as one variable among many and has concentrated on barriers, leaving the role of engagement itself under-theorised. As a result, it remains unclear how, through which mechanisms, and under what conditions stakeholder engagement actually facilitates GBT adoption. This conceptual paper synthesises recent literature published between 2021 and 2026, retrieved from Scopus, Web of Science, and Google Scholar, alongside seminal studies on stakeholder theory, collaborative governance, and the diffusion of innovations, to examine how stakeholder engagement facilitates GBT adoption in Malaysia. The paper identifies the primary and supporting stakeholders involved, examines five engagement dimensions: communication, collaboration, knowledge sharing, resource mobilisation, and decision-making involvement and analyses the challenges that weaken stakeholder engagement, including conflicting interests, communication gaps, weak coordination, limited capacity, and governance shortcomings. The paper also outlines practical implications for key stakeholders, including government agencies, developers, contractors, and professional bodies, to support the effective adoption of GBT. The paper concludes that strengthening stakeholder engagement is necessary but contingent upon institutional design and Malaysia's specific context. It also proposes a future research agenda for empirically validating the conceptual relationships identified in this review.

## 1. Introduction

The built environment is one of the largest contributors to global and national resource use, accounting for a substantial share of energy consumption, greenhouse-gas emissions, and material

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throughput across the building life cycle. In rapidly urbanising economies such as Malaysia, where construction activity remains buoyant, the sector's environmental footprint is a central concern for national sustainability policy. Green building technology (GBT) refers to the integrated use of energy-efficient systems, water-saving fixtures, sustainable materials, and low-impact design and operational practices that reduce a building's environmental impact while improving occupant comfort and health offering a practical means of addressing this challenge [17]. Malaysia has developed a comparatively mature policy architecture to promote GBT. The sustainability agenda of the Twelfth Malaysia Plan (2021–2025), the national green technology strategy, the Green Building Index established in 2009, complementary rating tools, and a range of fiscal incentives together signal a strong policy commitment to greening the construction sector [13,15,30]. Despite this architecture, adoption has been slower and more uneven than policy ambition implies. Certified green buildings remain a small proportion of the total building stock, and uptake is concentrated in the commercial office segment and among large, publicly listed developers in major urban centres, while residential, regional, and small-and-medium-enterprise (SME) markets lag considerably [15, 29]. This persistent gap between policy provision and market outcome motivates a closer examination of the social and organisational processes that mediate adoption.

GBT adoption is a systemic process that unfolds across the policy, planning, construction, and operational stages of the building life cycle, and it cannot be delivered by any single party. It depends on the coordinated involvement of government agencies, developers, contractors, consultants, suppliers, building owners, and occupants, each of whom controls resources, knowledge, or decisions that shape whether green technologies are specified, installed, and used as intended [19]. Stakeholder engagement refers to the active involvement of relevant stakeholders in communication, collaboration, and decision-making processes, and is widely recognised as a critical determinant of sustainable construction outcomes. The importance is evident at each life-cycle stage: engaging industry in the design of incentives and regulations improves their relevance and builds commitment to compliance [7]; early and inclusive involvement of the design team improves the integration of green performance targets; contractor engagement improves installation and commissioning quality; and owner and occupant engagement ensures that designed performance benefits are realised in use. Consistent with this, projects delivered through high-quality engagement achieve stronger sustainability outcomes and experience fewer implementation conflicts [22].

Malaysia is a particularly important case because high policy ambition coexists with persistently slow adoption, and several features of its context make engagement especially consequential. Private-sector certification is largely voluntary, so adoption must be won through persuasion and coordination rather than mandate; governance is fragmented across federal, state, and local authorities, whose discretionary powers vary by jurisdiction [19]; the supply chain is import-dependent and must suit tropical conditions [25]; and demand is segmented, with sustainability pressure concentrated among listed firms while smaller developers and buyers remain price-sensitive and less aware [5,6]. These conditions make the quality of stakeholder engagement especially important for driving adoption in Malaysia.

Against this background, this paper has a focused aim. It examines how the dimensions of stakeholder engagement facilitate green building technology adoption in Malaysia and the conditions under which they are effective. To achieve this aim, the paper examines the roles of communication, collaboration, knowledge sharing, resource mobilisation, and decision-making involvement in supporting adoption, and discusses the challenges that influence their effectiveness in the Malaysian context. Most studies on green building in Malaysia focus on barriers, incentives, and adoption factors rather than stakeholder engagement itself [11,21,24]. As a result, it remains unclear how stakeholder engagement facilitates GBT adoption, which engagement dimensions are most

influential, and under what conditions they succeed or fail. Because stakeholder engagement remains under-theorised, existing studies acknowledge its importance but do not clearly explain how its different dimensions contribute to adoption. This paper addresses this gap by presenting stakeholder engagement as a multidimensional governance process rather than a single adoption factor. It integrates stakeholder, participation, collaborative governance, and diffusion perspectives within the Malaysian context. This is consistent with wider systematic reviews showing that stakeholder mapping across sustainable building studies remains inconsistent and that few studies clearly identify which stakeholders are responsible for addressing specific adoption factors [8].

## **2. Stakeholder Engagement In Green Building Technology Adoption**

Stakeholders are individuals, groups, or organisations that influence, or are affected by, the adoption of green building technology, and value is created by managing the relationships among them rather than by satisfying any single party [10]. This relational view is important for green building, where interdependence among stakeholders is high and outcomes depend on cooperation across organisational boundaries. Not all stakeholders carry equal weight. The salience model of Mitchell et al. [18] distinguishes stakeholders by their power, legitimacy, and urgency, which helps explain why regulators and large developers shape adoption more strongly than smaller or peripheral actors, and why engagement strategies must be differentiated rather than applied uniformly. Beyond identifying and prioritising stakeholders, engagement is also a continuous process that involves managing relationships and monitoring engagement performance over time, and neglecting this measurement stage is a recognised weakness in construction sustainability practice [3].

Stakeholder engagement differs in its level of participation. According to Arnstein's [2] Ladder of Participation, lower levels of engagement, such as informing and consultation, provide limited stakeholder influence, whereas higher levels, including partnership and delegated power, enable meaningful participation in decision-making. Reed et al. [22] extended this logic to environmental management, proposing a typology that runs from passive information provision through consultation to functional participation and self-mobilisation, and cautioning that wider participation does not automatically produce better outcomes. Collaborative governance theory explains the conditions required for effective collaboration among multiple stakeholders. According to Ansell and Gash [1], successful collaboration depends on face-to-face dialogue, trust, shared understanding, and appropriate institutional design. However, collaboration may be less effective when power is unevenly distributed or when stakeholders have limited incentives to participate.

Diffusion of innovations theory connects engagement to adoption directly. Innovations spread through social systems by way of communication channels and peer networks that reduce uncertainty and supply social proof of viability, so the density and quality of the relationships among stakeholders shape how quickly green technologies diffuse [23]. Synthesising these perspectives, this paper conceptualises stakeholder engagement as a multidimensional process in which stakeholders communicate, collaborate, share knowledge, mobilise resources, and participate in decision-making to support green building technology adoption. Understood in this way, stakeholder engagement is one of the critical mechanisms supporting successful green building technology adoption, and its contribution depends on the depth of engagement and the governance conditions surrounding it.

## **3. Research Methodology**

This study adopts a conceptual review approach to synthesise existing literature on stakeholder engagement and green building technology adoption. A conceptual review is appropriate for

integrating existing knowledge, identifying research gaps, and advancing theoretical understanding of a phenomenon [26]. Literature was retrieved from Scopus, Web of Science, and Google Scholar using keywords relating to stakeholder engagement, green building, sustainable construction, and technology adoption. Search strings combined three concept clusters using Boolean operators: engagement (“stakeholder engagement”, “stakeholder participation”), technology (“green building”, “sustainable construction”), and outcome or context (“adoption”, “Malaysia”); a representative string was (“stakeholder engagement” OR “stakeholder participation”) AND (“green building” OR “sustainable construction”) AND (“adoption” OR “Malaysia”). The literature search focused on publications published between 2021 and 2026 to ensure that the review reflected recent developments. This was supplemented with seminal theoretical works [2,10,23] and institutional reports from organisations such as the World Green Building Council, the Construction Industry Development Board (CIDB), and the International Finance Corporation (IFC). Studies included in this review were peer-reviewed articles, review papers, and authoritative institutional reports written in English that addressed stakeholder engagement, participation, or governance in green building or sustainable construction, with a particular focus on Malaysia and comparable developing countries. The selected literature was analysed thematically to identify the key stakeholder groups, dimensions of stakeholder engagement, and factors affecting effective stakeholder engagement in green building technology adoption.

#### **4. Key Stakeholders In Green Building Technology Adoption**

Green building adoption engages several stakeholder groups whose influence is best understood not as equal participation but as differentiated salience along the dimensions of power, legitimacy, and urgency [18]. Government agencies, developers, and contractors are the primary stakeholders because they directly influence policy, investment, and implementation decisions. In contrast, consultants and designers, suppliers and manufacturers, building owners and investors, and building occupants play supporting roles by providing technical expertise, resources, investment support, and market demand. Although all stakeholder groups contribute to green building technology adoption, their levels of influence vary across different stages of the adoption process. This categorisation is broadly consistent with international reviews of stakeholders in sustainable building [3,8].

Government and policymakers hold the greatest structural influence, defining the regulatory environment, administering incentive programmes, and shaping demand through procurement for public-sector buildings. Federal agencies set the overall policy landscape, while local authorities exercise considerable discretion through planning and building approvals, assessment-rate policies, and sustainability requirements that vary markedly across jurisdictions [13,19]. Since government decisions shape the environment for technology adoption, strong engagement between government and industry is critical to achieving successful adoption outcomes.

Developers are the primary market decision-makers determining the rate and pattern of adoption. Their choices are shaped by financial appraisal, perceptions of market demand, the capabilities of their technical teams, and regulatory requirements. Adoption is highest among large publicly listed developers in the commercial office segment, driven by institutional-tenant demand and corporate sustainability commitments, and lowest among cost-sensitive small and medium residential developers constrained by price sensitivity and limited buyer awareness [6,29]. These differences indicate that stakeholder engagement strategies should be tailored to different categories of developers rather than adopting a one-size-fits-all approach. In particular, small and medium-sized developers require greater technical support, financial incentives, and awareness programmes to improve green building technology adoption.

Contractors translate green design specifications into built performance, so their technical competence directly determines installation and commissioning quality. The capability of contractors varies considerably, as large, specialised firms generally possess greater expertise in green building, whereas smaller contractors often have limited experience in implementing sustainable construction practices. Contractor capacity is a recognised bottleneck in Malaysia, where skills shortages in the installation of green systems contribute to higher project costs and performance gaps [15,20].

Consultants and designers, such as architects, engineers, quantity surveyors, and sustainability specialists, support green building technology adoption by providing advice on technology selection, system integration, and cost planning. However, green building expertise is concentrated in a small number of firms clustered in Kuala Lumpur, and limited sustainability content in professional education produces graduates who are less prepared to advise on technology selection and performance modelling, which reduces specification quality and developer confidence [30]. Suppliers and manufacturers enable adoption by providing the materials, systems, and equipment required to realise green designs. Malaysia's supply chain remains dominated by imported products, creating cost, delivery, and local-suitability challenges, and the development of a competitive domestic supply chain adapted to tropical conditions is a strategic priority for reducing adoption costs [25].

Building owners and investors shape adoption through acquisition, capital-improvement, and operational-management decisions. Mandatory sustainability disclosure for listed companies has elevated the importance of green performance within corporate property portfolios, and international investors increasingly treat green certification as an acquisition criterion, creating market-based demand that complements formal policy [5]. Private and small building owners generally demonstrate lower levels of engagement due to limited awareness and insufficient incentives to undertake building refurbishment [21]. Building occupants are the end users of green buildings and influence green building technology adoption mainly through market demand. Corporate occupants with strong sustainability commitments create greater demand for green buildings, whereas residential occupants often have limited awareness, willingness to pay, and influence over developers' decisions [6,28]. Table 1 summarises the key stakeholder groups, their roles, and the main constraints affecting their engagement.

**Table 1**  
Key Stakeholder Groups in Green Building Technology Adoption

| Stakeholder Group         | Role in GBT Adoption                                                         | Key Influence                            | Main Constraint                                                 |
|---------------------------|------------------------------------------------------------------------------|------------------------------------------|-----------------------------------------------------------------|
| Government & policymakers | Develop policies, regulations, incentives, and public procurement programmes | High decision-making authority           | Fragmented responsibilities and weak coordination               |
| Developers                | Make decisions on the adoption of green building technology in projects      | High influence on project implementation | Cost concerns, especially among SMEs and residential developers |
| Contractors               | Implement green building technologies during construction                    | Responsible for project delivery         | Limited green skills and technical expertise                    |
| Consultants & designers   | Advise on technology selection, design, and system integration               | Provide technical expertise              | Limited expertise and training                                  |
| Suppliers & manufacturers | Supply green materials, products, and technologies                           | Support technology availability          | Dependence on imported products and limited local supply        |

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|                    |                                                                        |                                |                                                 |
|--------------------|------------------------------------------------------------------------|--------------------------------|-------------------------------------------------|
| Owners & investors | Invest in, own, and manage green buildings                             | Influence investment decisions | Limited awareness and split incentives          |
| Occupants          | Create demand for green buildings and support sustainable building use | Influence market demand        | Limited awareness and decision-making influence |

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## 5. Stakeholder Engagement Dimensions

Stakeholder engagement can be divided into five interrelated dimensions that explain how stakeholders interact and contribute to green building technology (GBT) adoption. Each dimension is discussed in terms of definition, importance, and contribution to GBT adoption. The discussion also explains the conditions that influence the effectiveness of each dimension, as stakeholder engagement is not always equally beneficial in every context. Table 2 summarises the five dimensions, their contributions to GBT adoption and key challenges. This multidimensional view is consistent with recent evidence that stakeholder promotion strategies operate through several mechanisms and vary across the phases of the building life cycle [14].

Communication is the foundational dimension, encompassing the exchange of accurate, accessible information and the provision of channels through which stakeholders can share experience and concern [4]. It matters because informed stakeholders are better able to evaluate technologies, understand available support, and coordinate their actions. In Malaysia, research consistently documents pervasive communication gaps, including low awareness of incentive programmes and insufficient information sharing between government agencies and industry. Communication contributes to adoption chiefly by raising awareness and reducing uncertainty. To improve its effectiveness, communication should include targeted, multilingual information and advisory services that meet the needs of different stakeholder groups. However, communication alone is often insufficient to encourage adoption, as information sharing without incentives and capacity-building is unlikely to change stakeholder behaviour [2].

Collaboration refers to stakeholders working together to achieve shared goals by combining their resources, knowledge, and expertise. In the context of green building, examples include joint government–industry training programmes, collaborative pilot projects, and incentive schemes developed in partnership with industry organisations [19]. Collaboration supports green building technology (GBT) adoption by strengthening technical capability, improving resource sharing, and accelerating the adoption process. However, effective collaboration requires clear roles, shared responsibility, adequate resources, and strong institutional support. In Malaysia, fragmented governance and limited coordination among organisations may reduce the effectiveness of collaborative efforts [1].

Knowledge sharing accelerates adoption by reducing information asymmetries, enabling peer learning from successful projects, and building collective technical capacity. The circulation of verified performance data, documented implementation lessons, and accessible technical guidance reduces the uncertainty facing prospective adopters [4,27]. Professional associations in architecture, engineering, and construction management are critical facilitators through their conferences, publications, and continuing professional development. Knowledge sharing contributes to adoption by lowering search costs and de-risking investment, but its effectiveness is constrained by the geographic concentration of expertise in Kuala Lumpur firms and by competitive incentives that can discourage firms from disclosing hard-won know-how [30].

Resource mobilisation encompasses the processes through which stakeholders collectively secure the financial, human, technical, and institutional resources required for adoption. Effective

mobilisation requires the alignment of public financial incentives, private investment, professional capacity-building, and technical support services [17]. It contributes to adoption by improving the financial readiness and technical capacity of potential adopters. However, Malaysia continues to face challenges in mobilising the resources needed for green building technology adoption. Limited green financing, insufficient investment in sustainability training for the construction industry, and the concentration of technical expertise in major urban areas continue to restrict wider adoption [18].

Decision-making involvement refers to the extent to which different stakeholders are included in the formal processes that determine green building standards, incentives, and requirements. Inclusive decision-making ensures that diverse knowledge and interests are incorporated into policy design, producing more equitable and effective outcomes [1,18]. It contributes to adoption by generating instruments that are accessible and relevant across the full spectrum of market participants. However, decision-making in Malaysia is often dominated by large industry players and urban professional associations, limiting the participation of smaller contractors, regional developers, and end users. Therefore, improving stakeholder participation can enhance decision-making, although it requires additional time, coordination, and resources.

**Table 2**

**Engagement Dimensions and Their Contributions to Green Building Technology Adoption**

| Dimension                   | Focus                                              | Contribution                                      | Key Challenge                                                           |
|-----------------------------|----------------------------------------------------|---------------------------------------------------|-------------------------------------------------------------------------|
| Communication               | Information exchange and feedback channels         | Raises awareness; reduces uncertainty             | Information alone may not change behaviour                              |
| Collaboration               | Joint effort combining resources and authority     | Strengthens capability and supports adoption      | Requires strong coordination and resources                              |
| Knowledge sharing           | Sharing knowledge and experience                   | Improves understanding and reduces adoption risks | Limited expertise and knowledge sharing                                 |
| Resource mobilisation       | Securing financial, technical, and human resources | Improves financial and technical readiness        | Limited financing and unequal resource distribution                     |
| Decision-making involvement | Stakeholder participation in decision-making       | Supports more effective and inclusive decisions   | Dominated by large organisations and limited stakeholder representation |

## 6. Challenges Of Stakeholder Engagement

Stakeholder engagement is important for promoting adoption, several interrelated challenges can limit its effectiveness. Because engagement is contingent rather than uniformly beneficial, these challenges deserve as much attention as its potential contributions. Systematic reviews similarly emphasise that barriers such as resistance to change, weak coordination, and limited awareness remain understudied relative to drivers, even though they critically shape adoption [9].

The reviewed literature presents contrasting perspectives on the role and effectiveness of stakeholder engagement in promoting green building technology adoption. For example, studies disagree on the primary factors driving green building technology adoption. Darko et al. [7] identified policy incentives as the principal driver of green building technology adoption, whereas Chong et al. [6] argued that market demand and developers' commercial considerations exert greater influence in the Malaysian residential segment. A comparable tension surrounds communication, as Bohari et al. [4] regard information exchange as a direct enabler of adoption, whereas Ansell and Gash [1] and Arnstein [2] argued that information provision represents a lower level of participation that rarely changes behaviour without trust, adequate resources, and genuine decision-making authority. These

contrasting perspectives indicate that the effectiveness of stakeholder engagement is contingent rather than universal. Hence, engagement strategies should be adapted to the priorities, capacities, and institutional contexts of different stakeholder groups rather than applied uniformly.

Different stakeholder groups often have different priorities, which can create challenges for stakeholder engagement. Developers may focus on reducing project costs, government agencies prioritise regulatory compliance and sustainability goals, and contractors may prefer familiar construction practices instead of adopting new knowledge and skills. These differences can reduce collaboration and trust among stakeholders. Therefore, effective stakeholder engagement requires transparent communication, mutual understanding, and collaborative approaches that balance stakeholder interests and encourage active participation [10].

Technical terminology, regulatory complexity, and the proliferation of certification standards create communication barriers that impede productive dialogue between government agencies, technical professionals, and developers. Many developers and contractors report difficulty understanding certification requirements and incentive-eligibility criteria, which slows adoption and weakens engagement [24]. Bridging these gaps requires accessible, plain-language resources and advisory services that translate technical content into actionable guidance, along with professional development that strengthens cross-disciplinary communication.

Weak coordination among the multiple agencies and industry bodies involved in green building promotion reduces the coherence and effectiveness of engagement. Separate and sometimes conflicting activities that target the same audiences produce duplicated effort, contradictory messages, and stakeholder confusion [13]. Establishing clearer coordination mechanisms among key government and industry organisations ideally under a body with a clear mandate is essential to improve the efficiency and strategic coherence of engagement activities.

Limited awareness of green building benefits and policy support, combined with shortages of technical skills among developers, contractors, and smaller firms, constrains the quality of engagement. Where stakeholders lack basic knowledge of green concepts and the policy landscape, they are less able to participate effectively, and substantial resources must be spent on awareness-raising before meaningful dialogue and collaboration can take place [15,16]. This creates difficulty for engagement programmes operating under limited budgets.

Governance challenges including accountability gaps, limited transparency, and inadequate representation of diverse interests in formal decision-making can reduce the legitimacy and effectiveness of engagement. Where smaller contractors, regional developers, and end-user communities have limited access to policy processes, the resulting instruments may disproportionately reflect the interests of larger and better-resourced stakeholder groups rather than the broader needs of the industry, and formal inclusion can slide into tokenism that legitimises predetermined outcomes [2,19]. To address these challenges, decision-making processes should promote inclusive participation, transparency, and accountability while ensuring that stakeholder views are meaningfully considered.

Overall, these challenges are interconnected rather than independent. It reflects a fragmented, voluntary, and resource-constrained stakeholder engagement system in Malaysia, which weakens the effectiveness of stakeholder engagement. However, it remains unclear how these challenges influence one another. For example, weak coordination may lead to communication problems, while limited resources may increase the dominance of large urban stakeholders in decision-making. Therefore, addressing these challenges requires coordinated efforts among all stakeholder groups rather than separate solutions.

## **7. Practical Implications**

The analysis provides practical implications for different stakeholder groups by explaining how stakeholder engagement can be strengthened. Government agencies should strengthen inter-agency coordination, ideally by designating a lead body with a clear mandate over green building engagement so that initiatives reinforce rather than duplicate one another. It should improve the delivery and visibility of incentives through consolidated, plain-language information; expand awareness programmes targeted at under-served residential, regional, and SME segments; and simplify approval procedures, including institutionalised pre-application consultation that improves design quality and shortens processing times. Progressively linking incentives to verified in-use performance rather than certification alone would help ensure that engagement supports outcomes rather than paperwork. Engagement outcomes should also be monitored over time using clear performance indicators, so that engagement is treated as an ongoing process rather than a one-off activity [3].

Developers should engage contractors and sustainability consultants earlier through integrated design processes, invest in green competencies within their project teams, and adopt collaborative planning supported by pilot demonstration projects and post-occupancy performance data to de-risk investment decisions. Larger developers can extend their influence along the value chain by setting green requirements for their suppliers and subcontractors.

Contractors should improve technical skills through accredited green-installation training, participate actively in certification and supplier-led technical programmes, and strengthen communication with consultants and designers so that green specifications are implemented as intended. Closing the capability gap is central to reducing the cost and performance risks that currently deter adoption.

Professional bodies should conduct continuous training and continuing professional development, promote knowledge sharing through neutral venues and publications that reach beyond the major urban centres, and develop clear industry guidelines. They are also well placed to broaden participation by creating channels that include smaller, regional, and end-user voices, thereby countering the capture that otherwise skews engagement toward large, well-resourced actors. Across all groups, the cross-cutting priority is to move engagement from mere information-provision toward genuine partnership through structured, adequately resourced, and transparent platforms [1].

Beyond individual stakeholder actions, successful implementation requires coordinated governance across the green building ecosystem. Consistent with collaborative governance theory, government agencies, developers, contractors, professional bodies, and industry associations should establish continuous mechanisms for communication, joint decision-making, and performance monitoring. Such collaborative arrangements would strengthen accountability, reduce institutional fragmentation, and improve the long-term effectiveness of stakeholder engagement in promoting green building technology adoption in Malaysia.

## **8. Limitations And Future Research**

This study has several limitations. As a conceptual paper, it synthesises existing literature and develops theoretical perspectives rather than empirically testing the proposed relationships between stakeholder engagement and green building technology (GBT) adoption. Therefore, future empirical studies are needed to validate the proposed relationships. The review was limited to English-language publications retrieved from Scopus, Web of Science, and Google Scholar, which may have

excluded relevant studies published in other languages or available as grey literature. In addition, publication bias may have resulted in greater emphasis on studies reporting positive findings, while unsuccessful or ineffective stakeholder engagement practices may be under-represented. The review also focused on literature published between 2021 and 2026 to capture recent developments, which may have excluded earlier studies that provide insights into long-term institutional and stakeholder dynamics. Finally, the selection and interpretation of the literature involved researcher judgement, which may have influenced the findings.

These limitations provide directions for future research. Future studies should empirically examine the relationship between stakeholder engagement and GBT adoption using quantitative, qualitative, or mixed methods approaches. Researchers should also develop and validate measures of stakeholder engagement that distinguish meaningful participation from tokenistic involvement. Comparative studies across countries, building sectors (e.g., commercial and residential), and geographic contexts (e.g., urban and regional) could provide a better understanding of stakeholder engagement in different settings. In addition, longitudinal studies are needed to examine how stakeholder engagement, trust, and collaboration develop over time. Further research should also investigate situations in which stakeholder engagement is less effective or fails to support GBT adoption. These studies would strengthen the conceptual framework proposed in this paper and provide stronger evidence to support policy and practice.

## **9. Conclusion**

This paper examined the role of stakeholder engagement in promoting green building technology (GBT) adoption in Malaysia. It identified the key stakeholder groups involved and analysed five dimensions of stakeholder engagement: communication, collaboration, knowledge sharing, resource mobilisation, and decision-making involvement, and explained how these dimensions support GBT adoption. The paper also explains the key challenges that reduce the effectiveness of stakeholder engagement. The findings show that stakeholder engagement is important for promoting GBT adoption, but its effectiveness depends on the institutional and industry context. In Malaysia, factors such as fragmented governance, voluntary green building certification, limited local supply of green technologies, and differences in stakeholder interests can reduce the effectiveness of stakeholder engagement. Divergent priorities among government agencies, developers, and contractors can crystallise into conflicting interests that undermine trust and collaboration even where formal engagement mechanisms exist. Therefore, successful stakeholder engagement requires appropriate governance, effective coordination, and meaningful stakeholder participation. This paper makes a conceptual contribution by presenting stakeholder engagement as a multidimensional governance process rather than a single background factor. It integrates stakeholder, participation, collaborative governance, and diffusion perspectives within the Malaysian context. Unlike previous Malaysian studies that primarily identify stakeholder engagement as one of several adoption factors, this review explains the mechanisms through which communication, collaboration, knowledge sharing, resource mobilisation, and decision-making involvement facilitate GBT adoption, while highlighting the contextual conditions under which these engagement dimensions are more or less effective. The paper also provides practical implications for key stakeholder groups. Government agencies should strengthen policy coordination and incentive programmes, developers should encourage early stakeholder collaboration, contractors should improve their technical capabilities, and professional bodies should continue to support knowledge sharing and capacity-building. As this study is based on a conceptual review, the proposed relationships should be examined through future empirical research. Further studies are needed to evaluate the quality of stakeholder engagement and its

influence on GBT adoption across different contexts. Further research would strengthen the conceptual framework presented in this paper and provide evidence to support more effective policies and industry practices for promoting green building technology adoption.

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### Author Contributions

**Farah Nabilah Mohd Nazaruddin:** Conceptualization, methodology, data curation, formal analysis, investigation, visualization, writing original draft, writing review and editing. **Wan Nadzri Osman:** Conceptualization, methodology, supervision, validation, writing – review and editing. **Maheera Mohamad:** Methodology, validation, supervision, writing review and editing. All authors have read and agreed to the published version of the manuscript.

### Clarification On Third-Party Services and AI

No persons or third-party services were involved in the research or manuscript preparation. However, Grammarly and ChatGPT 4.0 were used to assist with language polishing and grammar checking of the text. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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