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QUALITATIVE EVALUATION OF THE DRIVERS AND BARRIERS OF SUSTAINABLE CONSTRUCTION PRACTICES IN CANADA: A CASE STUDY

Sh. Monshet [1] and T. M. Froese [1]
[1] Department of Civil Engineering, University of Victoria, Victoria, BC, Canada

ABSTRACT: Sustainable building adoption is increasingly prioritized to mitigate climate change, reduce energy consumption, and enhance environmental performance. However, decision-making in sustainable design remains complex, influenced by economic, environmental, and social factors. This case study investigates the key drivers and barriers shaping sustainability decisions through stakeholder interviews and qualitative analysis using NVIVO. Focusing on the Engineering Expansion Building at the University of Victoria, the research integrates insights from industry professionals, policymakers, and academics to identify real-world challenges beyond those documented in existing literature. The findings reveal that institutional sustainability targets, regulatory mandates, and financial incentives act as key drivers, motivating stakeholders to pursue carbon reduction, operational efficiency, and high-performance building standards. However, significant barriers persist, including high upfront costs, cost-benefit uncertainties, extended project timelines, and technical knowledge gaps in sustainable materials and lifecycle cost integration. The generated coding hierarchy and clustering maps highlight the interdependencies between financial, regulatory, and technical constraints, with regulatory mandates emerging as both an enabler and a challenge. The study underscores the need for more flexible policy frameworks, enhanced financial mechanisms, and data-driven tools to support sustainability integration. Addressing these barriers through stakeholder collaboration, regulatory refinements, and post-occupancy performance assessments will be crucial in advancing more effective and widespread adoption of sustainable building practices. These findings contribute to refining sustainability decision-making strategies and inform future research on optimizing sustainability performance in the built environment.

1. INTRODUCTION

Sustainable buildings play a critical role in mitigating climate change, reducing energy consumption, and enhancing urban resilience. As rapid urbanization accelerates and environmental concerns intensify, the construction industry faces increasing pressure to adopt sustainable practices that minimize ecological harm while promoting economic viability and social well-being. Despite advancements in green building technologies, policy incentives, and regulatory frameworks, stakeholders continue to encounter significant challenges in implementing sustainable design and construction practices. Decision-making in sustainable building projects is inherently complex, influenced by a multitude of interrelated factors. These include economic considerations such as initial costs and long-term financial impacts (von Paumgartten, 2003); environmental objectives like energy efficiency and carbon footprint reduction (Fenner et al., 2018); social aspects encompassing occupant health and community impact (Stender and Walter, 2019); and technical elements involving the availability of sustainable materials and technologies (Rohracher, 2001). Additionally, organizational factors such as leadership commitment and stakeholder collaboration (Herazo and Lizarralde, 2016) play a crucial role in shaping sustainable outcomes. The interplay of these diverse factors necessitates a holistic approach to decision-making in sustainable construction.

Existing research has examined the drivers and barriers to green building adoption (Ahn et al., 2013; Darko & Chan, 2017), primarily through surveys and literature reviews. While these studies offer useful insights, they fall short in establishing direct causal relationships between project-specific variables and sustainability outcomes. A deeper understanding of the precise factors that enable or hinder sustainability improvements in individual construction projects is needed.

In Canada, sustainable building practices are shaped by an extensive framework of codes, standards, and rating systems that establish minimum performance requirements, promote best practices, and encourage continuous improvement. The National Building Code of Canada (NBCC) (Canadian Commission on Building and Fire Codes, 2020a) provides a broad regulatory framework addressing safety, health, accessibility, and energy efficiency. Complementing this, the National Energy Code for Buildings (NECB) (Canadian Commission on Building and Fire Codes, 2020b) sets energy efficiency standards for commercial, institutional, and large multi-unit residential buildings. At the provincial and territorial levels, jurisdictions often adapt the NBCC to address local conditions. For instance, British Columbia's Building Code (BCBC) references the NECB for energy efficiency while incorporating additional regional provisions, including the BC Energy Step Code, which allows municipalities to mandate or incentivize higher energy performance in new construction.

Beyond mandatory codes, voluntary certification systems provide structured frameworks to assess and promote sustainability performance. These include:

- CSA S478-2019: Guideline on Durability in Buildings – Published by the CSA Group, this standard provides criteria for designing durable and resilient buildings, covering all stages of a building’s life cycle.
- Leadership in Energy and Environmental Design (LEED) – Developed by the U.S. Green Building Council and adapted for Canada by the Canada Green Building Council (CaGBC), LEED evaluates buildings based on site selection, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality.
- BOMA BEST (Building Owners and Managers Association’s Building Environmental Standards) – A certification system that focuses on improving the environmental performance of existing commercial and institutional buildings.
- Green Globes – A rating system assessing new construction, existing buildings, and renovation projects across various sustainability categories.
- Built Green Canada – A certification program focused on residential buildings, covering single-family homes, high-density projects, and renovations with an emphasis on energy efficiency, water conservation, indoor air quality, and resource management.
- CaGBC Zero Carbon Building Standard – Launched in 2017, this certification focuses on reducing greenhouse gas (GHG) emissions associated with building operations and embodied carbon in building materials. It sets stringent targets for energy efficiency, renewable energy use, and carbon reductions to drive the Architecture, Engineering, and Construction (AEC) industry toward a low-carbon future.

While these frameworks provide a solid foundation for sustainable building practices, several gaps and challenges hinder optimal decision-making in design and construction. One major limitation is that codes and standards establish minimum performance levels, ensuring a baseline level of sustainability but not necessarily encouraging the most sustainable design choices. As a result, a significant gap often exists between code-minimum buildings and those that achieve high ratings in voluntary certification systems (Tokarik & Richman, 2016). Another significant gap in current sustainability frameworks is their limited consideration of local and cultural factors that influence building practices. While national and international standards provide overarching sustainability criteria, their effectiveness in diverse regions depends on their ability to adapt to local contexts. Customization of evaluation criteria to include regional materials, climate-responsive design, and cultural preferences could enhance their relevance and applicability (Dessein et al., 2015). Furthermore, existing sustainability assessment tools often lack a holistic evaluation mechanism that integrates all dimensions of sustainability—economic, environmental, and social—into a single framework.

Current credit-based systems attempt to balance multiple sustainability factors but often require subjective trade-offs between different performance metrics, leading to inconsistencies in sustainability assessment. This study seeks to explore the real-world decision-making processes involved in sustainable building projects in Canada by conducting semi-structured interviews with key stakeholders—including developers, architects, engineers, policymakers, and building owners—in a sustainable building case study. Through qualitative analysis, this research aims to identify common patterns, trends, and interdependencies among the drivers and barriers of sustainable building design. By comparing stakeholder perspectives with insights from the literature, the study highlights challenges, opportunities, and key influences in sustainable building adoption.

2. METHODOLOGY

2.1 Case Study

2.1.1 Engineering and Computer Science Expansion and New Lab Building at the University of Victoria

This case study examines the expansion of the Engineering and Computer Science (ECS) building and the addition of a new high-bay research and structures laboratory. Planning for the project began in 2019, followed by a comprehensive design phase spanning from 2020 to 2023. Both buildings are currently under construction and have been designed to meet LEED Gold v4 and Net Zero Carbon certification standards. These sustainability goals are expected to result in a significant reduction of up to 90% in heating and cooling energy consumption.

A key feature of the project is the use of mass timber structures, which generate lower carbon emissions compared to conventional construction materials such as concrete and steel. Additionally, the buildings will incorporate energy-efficient technologies, including heat pumps for heating and cooling, as well as a green solar roof to enhance renewable energy generation and thermal insulation.

Figure 1: Model of engineering expansion project at the University of Victoria

2.2 Interview

In conjunction with performing a literature review to identify the main dimensions of sustainable construction practices, preliminary interviews have been conducted with some of the key stakeholders of the case-study buildings to understand the drivers and barriers that affected sustainable decision-making. The data collected from the interviews are analyzed and used to assess the suitability of the dimensions initially selected and to identify additional KPIs for each dimension based on the stakeholders' opinions and experiences with the project. The interview protocol consists of four main stages as laid out in the following sections.

2.2.1 Participant Identification

Stakeholders in the construction industry are generally classified into two main categories: internal stakeholders, who are contractually engaged with the client—such as architects, engineers, contractors, tenants, financiers, and suppliers—and external stakeholders, who have a vested interest in the project but are not contractually bound. External stakeholders include landowners, local communities, environmental groups, regulatory bodies, and municipal and provincial governments (Baldwin & Bordoli, 2014).

For the Engineering Expansion Building project at the University of Victoria (UVic), participants were identified from both stakeholder groups. To gain a comprehensive understanding of sustainability-related decision-making in the project, semi-structured interviews were conducted with five key representatives directly involved in the project's governance, planning, and implementation. Participants were selected based on their formal roles in the project, their expertise in sustainability and building design, and their involvement in decision-making committees or operational oversight. The interviews were conducted online using the Zoom platform and lasted approximately 30 to 45 minutes each.

An interview was conducted with the Director of Campus Planning and Sustainability at UVic, who is responsible for overseeing capital projects, including site selection, programming, stakeholder engagement, and the formulation of sustainability policies and objectives. The director is also actively involved in project governance committees, where they contribute expertise on sustainable design and decision-making processes. Additionally, a faculty member from the Civil Engineering Department was interviewed. This individual serves as a member of both the building committee and the steering committee for the expansion project, providing insights from an academic and research perspective. Their role involves shaping the design and implementation of sustainability strategies to ensure that the facility aligns with both educational and environmental goals. The Chair of the Civil Engineering Department was also interviewed, representing the academic client for the project. As the department head, they play a pivotal role in ensuring that the facility meets the department's long-term vision, accommodating instructional laboratories, research spaces, and student work areas. Their responsibilities in project governance include advocating for a functional design that fosters innovation in civil engineering education while maintaining alignment with UVic's sustainability commitments. Furthermore, two Facility Managers at UVic participated in the study. Facility managers are responsible for the operation, maintenance, and long-term sustainability of campus infrastructure. Their involvement in the project ensures that design choices adhere to operational feasibility, energy efficiency objectives, and lifecycle cost considerations. They provide critical insights into building system performance, facility management optimization, and sustainable operational strategies.

2.2.2 Ethics Review

This research adheres to the ethical principles outlined in the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* (TCPS-2 2018). The three core principles—respect for persons, concern for welfare, and justice—are carefully integrated into the study's design and implementation.
Respect for persons is upheld by ensuring voluntary and informed consent, allowing participants to fully understand the research's purpose, nature, and potential implications. Participants also retain the right to withdraw at any time without consequence. Concern for welfare is addressed through rigorous privacy safeguards, including data anonymization and secure storage. Furthermore, the study aligns with broader societal goals by promoting sustainable construction practices, benefiting both the environment and public well-being.

The ethics review process for this research adheres to the principles outlined in the Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans. The three core principles of TCPS-2 – respect for persons, concern for welfare, and justice – are carefully considered and integrated into all aspects of the research design and execution.

Respect for persons entails recognizing the intrinsic value of human dignity and the autonomy of research participants. In this study, voluntary and informed consent is obtained from all interviewees, ensuring they understand the nature, purpose, and potential implications of their involvement. Participants have the right to withdraw from the research at any time without consequence. Concern for welfare involves minimizing risks and maximizing benefits for participants. This study employs measures to protect the privacy and confidentiality of participants, such as anonymizing data and securely storing research materials. Additionally, the research aims to contribute to the broader goal of promoting sustainable construction practices, which can have positive impacts on the environment and societal well-being. The principle of justice necessitates the fair and equitable treatment of all individuals involved in the research. This study upholds justice by ensuring an inclusive and non-discriminatory participant selection process, respecting cultural diversity, and striving for the equitable distribution of potential benefits derived from the research findings.

2.2.3 Interview Questions Development

In research related to green construction, three primary interview structures are commonly used: structured, open-ended, and semi-structured interviews. Structured interviews involve asking all participants the same set of predetermined questions, ensuring consistency and facilitating the comparison of responses. This approach is typically used to obtain clear, specific information on a defined topic. Open-ended interviews, in contrast, allow participants to discuss their perspectives freely without following a fixed set of questions. The interviewer adapts the discussion based on participants' responses, enabling a more exploratory and flexible dialogue (Mohareb et al., 2017). Semi-structured interviews combine elements of both approaches by using a core set of predefined questions while allowing for additional follow-up questions based on participants' answers, providing both structure and flexibility (Xu et al., 2021).

This study employed a semi-structured interview approach not only to collect data on the factors influencing sustainable design decisions in case study projects but also to enable the researcher to engage more deeply with the interviewees and uncover nuanced motivations and obstacles related to sustainable decision-making.

The interview questions are designed to gather insights into the key drivers and barriers of sustainable design. Examples of the questions used in this study are as follows:

- What were the key drivers or motivations behind incorporating sustainable elements in this construction project?
- How does sustainable design align with the overall goals and values of the organization or project?
- Are there any specific sustainability standards or certifications that the project aims to achieve? If so, what are the reasons behind pursuing those certifications?
- What challenges or barriers do you encounter when trying to implement sustainable design elements in the building project?

2.2.4 Data Analysis and Validation

Qualitative research often presents challenges in generalization due to the complexity of human experiences and the context-specific nature of findings. In this study, interview data were analyzed using NVIVO, a qualitative data analysis software that enables systematic coding, organization, and interpretation of textual data. NVIVO was employed to code interview transcripts from key stakeholders involved in the sustainable building project, facilitating a structured approach to thematic analysis. This process allowed for the identification of recurring patterns and interconnections among various decision-making factors.

To guide the analysis, predefined coding categories—economic, environmental, and social drivers and barriers—were developed based on insights from existing literature. The interview transcripts were imported into NVIVO, where a manual line-by-line coding process was applied. Relevant sections of text were coded deductively according to the established categories. As the analysis progressed, inductive coding was also employed to capture emergent themes beyond the initial framework. This involved creating new codes when recurring ideas, stakeholder concerns, or nuanced decision-making factors appeared that were not fully represented by the original categories. These emergent codes were continuously reviewed, refined, and, when appropriate, reorganized under broader thematic clusters to enhance coherence and interpretability. NVIVO's query functions and word frequency analysis were used to support deeper analysis. These tools helped to identify key patterns, cross-cutting themes, and the relative prominence of various issues discussed by participants. This structured methodology enhanced the reliability of the findings by ensuring a systematic and transparent categorization of stakeholder perspectives, ultimately informing the study’s conclusions.

To ensure the validity and credibility of the analysis, multiple validation strategies were implemented. First, member checking was conducted, allowing participants to review and provide feedback on the interpretations drawn from their interviews. Specifically, each participant was sent a concise summary of the key themes and insights that emerged from their respective interviews. The participants were encouraged to verify the accuracy of interpretations, clarify any ambiguities, and provide additional input if necessary. Additionally, an audit trail was maintained throughout the research process, documenting each stage of data collection and analysis. This included detailed records of methodological decisions, coding processes, and the rationale behind specific interpretations.

3. RESULTS

Figure 2 illustrates the key drivers and barriers influencing decision-making for sustainable building design considered in this study, categorized into economic, environmental, and social dimensions. The green nodes represent drivers, highlighting factors that promote sustainability adoption, while the red nodes denote barriers, indicating challenges faced by stakeholders. Regulatory mandates appear in both sections across all three dimensions, demonstrating their dual role in facilitating sustainability while also posing compliance and implementation challenges. Economic drivers, such as return on investment, life cycle cost, and cost efficiency, emphasize financial incentives, whereas economic barriers, including cost efficiency concerns and perceived financial risks, indicate sustainability adoption struggles. Environmental factors, such as green resources, renewable energy, and biodiversity impact, are strong motivators, but issues related to materials, water management, and greenhouse gas emissions emerge as barriers due to technical and logistical constraints. The social dimension highlights community engagement, cultural heritage, equity, and occupant comfort as critical drivers, yet these same aspects also appear as barriers, reflecting the complexities of balancing sustainability goals with stakeholder priorities.

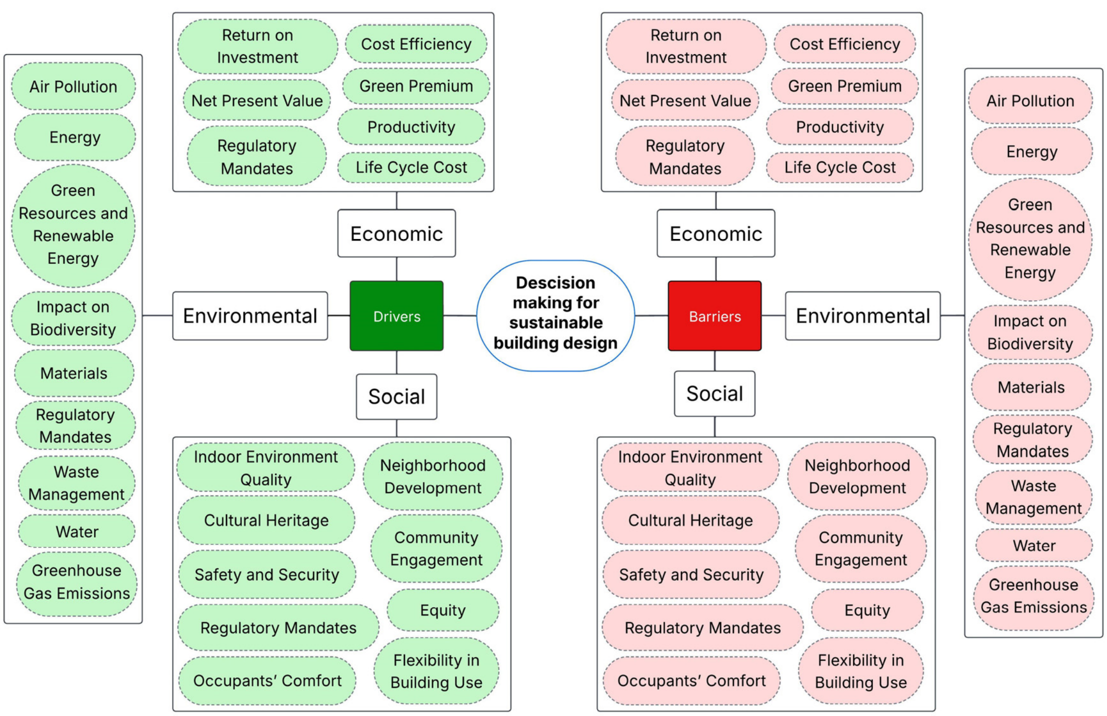


Figure 2: Map of implemented codes

The hierarchy chart in diagram 3 presents the key factors influencing the adoption of sustainable materials and technologies in the case-study building from the perspective of interviewees, with larger blocks indicating more frequently mentioned themes and smaller blocks representing less prevalent topics. Notably, regulatory mandates appear across economic, environmental, and social dimensions as both drivers and barriers, highlighting the dual role of policies in promoting sustainability while also posing compliance challenges. Economic constraints emerge as the dominant barriers, particularly regarding life cycle costs, return on investment, and cost efficiency, reinforcing financial viability as a critical concern for stakeholders. Conversely, community engagement and occupant comfort stand out as strong drivers, emphasizing the importance of social acceptance in sustainable building initiatives. Additionally, material selection and energy considerations are prominently featured within environmental drivers but also appear as barriers, reflecting ongoing challenges in sourcing and integrating sustainable materials.

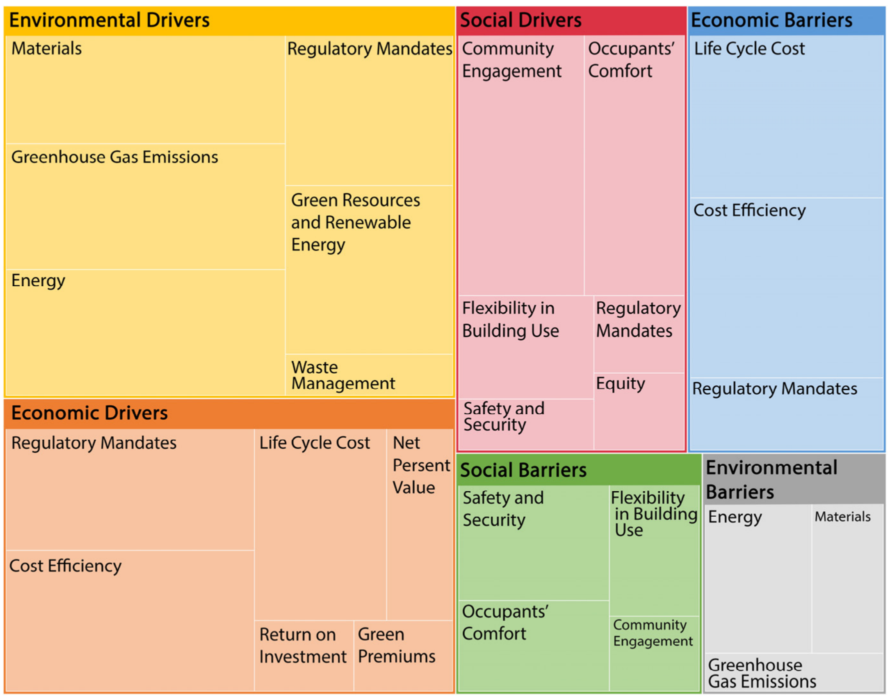
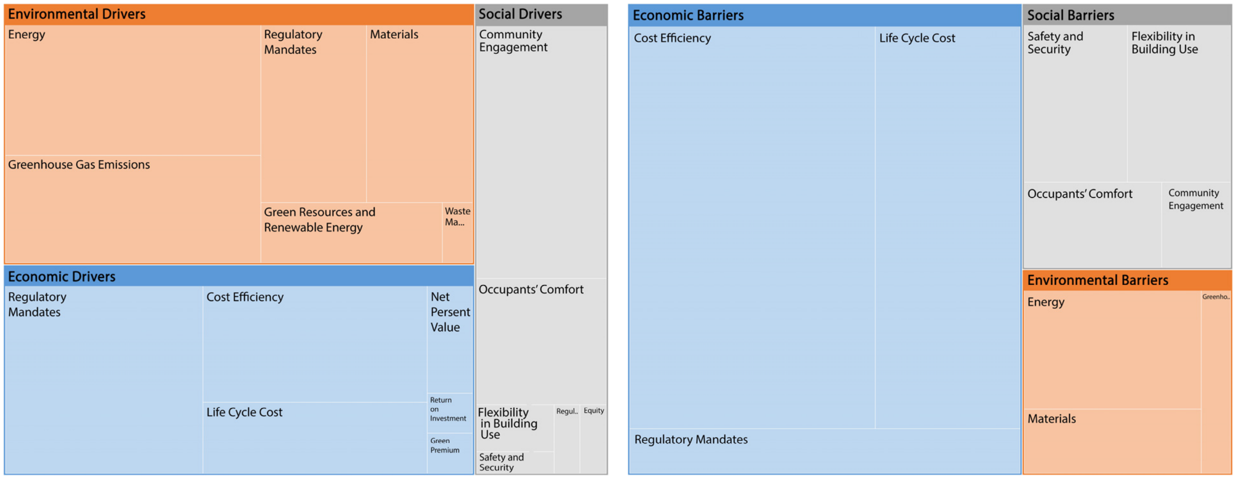


Figure 3: Hierarchy chart of sustainable material and technology adoption for all codes

The hierarchy charts in Figure 4 illustrate the key drivers and barriers influencing sustainable building adoption. The drivers in Fig. 4(a) are predominantly led by environmental factors, with energy efficiency, greenhouse gas emissions reduction, and regulatory mandates being the most significant motivators. Economic drivers such as cost efficiency, life cycle cost, and return on investment also play a crucial role in sustainability decision-making, while social drivers like community engagement and occupant comfort highlight the importance of stakeholder wellbeing. Conversely, the barriers in Fig. 4(b) emphasize economic constraints, particularly life cycle cost and cost efficiency, as the most substantial obstacles. Regulatory mandates appear in both charts, indicating their dual role in both enabling and restricting sustainability efforts. Environmental barriers, including energy and material limitations, reflect technical and resource-based challenges, while social concerns such as safety, security, and flexibility in building use suggest that adaptive and inclusive design strategies remain a key concern for stakeholders. Together, these charts highlight the complexity of balancing sustainability incentives with financial, technical, and regulatory challenges in sustainable building design.



(a) (b)

Figure 4: Hierarchy chart of sustainable material and technology adoption; (a) Drivers, (b) Barriers

The word cloud generated from the interview transcripts (Figure 5) visually represents the frequency and prominence of key terms related to sustainable building adoption. The prominence of "carbon", "zero", and "certification" suggests a strong focus on carbon reduction strategies and the role of green certifications like LEED in guiding sustainability initiatives. "Cost" and "requirements" appear frequently, reflecting concerns regarding financial feasibility and regulatory compliance. Additionally, words such as "targets," "engineering", "design", and "timber" highlight discussions on material choices, construction methods, and industry-driven sustainability goals. The inclusion of "people", "living", and "community" suggests that social and human-centred aspects are also key considerations in sustainable building decisions.

Figure 5: Word cloud generated from the interviews

4. DISCUSSION

The results from the interviews provide several insights into the drivers and barriers of sustainable building design. While many sustainability dimensions, such as carbon reduction, cost efficiency, and occupant comfort, were anticipated, the qualitative analysis uncovered additional key performance indicators (KPIs) that were previously overlooked. These newly identified drivers and barriers emphasize the complexity of decision-making in sustainable building design and the necessity of an integrated, multi-stakeholder approach.

A key driver identified in the interviews is the influence of institutional sustainability targets on decision-making, with stakeholders stressing the need to align projects with broader organizational and governmental climate goals. Regional factors—such as local policies, climate, and resource availability—also shape sustainability strategies. Additional drivers include building resilience, client-led sustainability objectives, and evolving standards, which are often overlooked in existing literature. Economically, beyond traditional metrics like life cycle cost and ROI, market transformation and zoning incentives are increasingly impacting investment decisions. Government incentives and funding remain vital, while trade-offs and the triple bottom line framework guide sustainable choices.

On the barriers side, several underexplored challenges emerged, including time constraints, competing priorities, and extended project timelines, which hinder sustainability integration. Stakeholders also pointed to the complexity of certifications and uncertainties in cost-benefit assessments as deterrents to pursuing ambitious green standards. Finally, knowledge gaps in sustainable materials and limited data quantification highlight the need for better information access to support informed decisions.

The findings highlight that achieving sustainable building outcomes requires an integrated approach across governance, financing, stakeholder engagement, regulations, and a culture of environmental responsibility. Stakeholders must balance trade-offs between functionality, budget constraints, emissions reduction, and long-term operational gains, emphasizing the need for iterative value engineering. Conflicting design and energy regulations pose challenges, underscoring the need for more harmonized policies to support sustainability. The results also stress the importance of ongoing collaboration among policymakers, industry leaders, and academia to overcome barriers and strengthen drivers of sustainable construction. Incorporating these newly identified KPIs into sustainability frameworks can help decision-makers craft more effective, real-world strategies. Future research should aim to refine these insights through quantitative analysis and post-occupancy evaluations to ensure sustainability performance is both modeled and measured in practice.

5. CONCLUSIONS

This study explored the drivers and barriers influencing sustainable building adoption through stakeholder interviews and NVIVO analysis of the Engineering Expansion Building at the University of Victoria. Findings revealed that while regulatory mandates, institutional sustainability targets, and government incentives drive sustainability efforts, economic and technical challenges persist. Financial concerns, cost-benefit uncertainties, and funding limitations remain key obstacles, alongside regulatory complexity, knowledge gaps in sustainable materials, and extended project timelines.

The NVIVO-generated coding hierarchy and clustering maps highlighted the interconnected nature of these factors, with regulatory mandates acting as both a driver and a barrier. Stakeholders emphasized the need for greater policy flexibility, incentive-based sustainability initiatives, and improved data-driven decision-making tools. Achieving widespread sustainability adoption requires a holistic approach that integrates financial planning, regulatory clarity, stakeholder collaboration, and technical innovation. Moving forward, refining policy frameworks, enhancing sustainability education, and improving post-occupancy performance evaluations will be essential in bridging the gap between modelled sustainability outcomes and real-world implementation.

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