Future directions for advancing Green Star NZ to achieve zero-carbon goals: insights from industry professionals

International Journal of Building Pathology and Adaptation

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Received 7 September 2024
Revised 8 November 2024
11 January 2025
Accepted 15 January 2025

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Abstract

Purpose – The building industry is a critical sector that must significantly reduce its carbon emissions for New Zealand (NZ) to meet its 2050 zero-carbon goals. Green Star NZ, a leading Green Building Rating System in NZ, offers a structured framework for assessing and certifying building environmental performance. This research investigates industry professionals' perspectives on Green Star NZ's effectiveness in achieving NZ's zero-carbon goals, addressing gaps in existing literature.

Design/methodology/approach – Through qualitative analysis of semi-structured interviews, the research identified key areas where Green Star NZ either supports or falls short of zero-carbon practices, according to 22 practising professionals. A thematic analysis method was used to analyse the data.

Findings – The results indicate that while Green Star NZ suits NZ, it faces adoption challenges due to few supportive policies, complex certification and material supply issues with sustainable materials. The study addressed these barriers through targeted policies, streamlined processes and market support for sustainable technologies. Moreover, cost is directly or indirectly tied to Green Star NZ.

Originality/value – This study offers insights and recommendations to improve Green Star NZ, assisting NZGBC and stakeholders in advancing towards a zero-carbon future. Implementing these suggestions can boost Green Star NZ's effectiveness. Through the project experience and the viewpoints of industry professionals, it fills the research gap by assessing Green Star NZ's framework, identifying challenges and proposing

The authors gratefully acknowledge the Building Research Association of New Zealand (BRANZ) for its scholarship support for the first author as part of the Building Capability to Help the Construction Industry Transition to Zero Carbon Project.

Declaration of competing interest: The authors have no competing interests to declare which are relevant to the content of this article.

Funding: This study was funded by the Building Research Association of New Zealand (BRANZ) as a Master's student scholarship.

Ethics approval: This study was granted permission by ethics committee. Data was collected under the interviewees' agreement.

Data availability: The data is available upon reasonable request.

Authors' contribution statements: Jiaxin Liang: Writing – review and editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Vishnupriya Vishnupriya: Writing – review and editing, Validation, Supervision, Methodology, Conceptualization. An Thi Hoai Le: Writing – review and editing, Validation, Supervision, Methodology, Conceptualization. Xiong Shen: Writing – review and editing, Validation, Supervision, Conceptualization. All authors read and approved the final manuscript.

International Journal of Building Pathology and Adaptation
Vol. 43 No. 8, 2025
pp. 41-58
Emerald Publishing Limited
e-ISSN: 2398-4716
p-ISSN: 2398-4708
DOI 10.1108/IJBPA-09-2024-0177

improvements. The findings also position NZ's experience as a possible model, advancing global green building practices and providing policymakers with recommendations.

Keywords Zero carbon, Green building rating system, Green Star NZ, New Zealand, Technologies, Sustainability

Paper type Research paper

1. Introduction

The construction industry is one of the main culprits of carbon emissions due to the high resource demands and pollution from both construction and the buildings (Doan *et al.*, 2017). This is equally true for NZ, where the building industry's emissions have jumped 66% in the past decade, challenging its clean-green image (NZGBC, 2019).

Commercial buildings are crucial for achieving energy efficiency and carbon reduction goals, but their decarbonisation is complicated and costly due to their larger space, intricate energy systems and higher energy demands (Lu and Lai, 2020). According to the National Construction Pipeline Report 2023 (MBIE, 2023b), commercial structures account for 46% of non-residential buildings in NZ.

Several countries have introduced and implemented policies to reduce the building sector's emissions and achieve zero-carbon goals. The US Inflation Reduction Act (IRA) (The US Government, 2022) promotes clean energy. It reduces fossil fuel reliance by supporting heat pumps, electric HVAC systems and renewable energy technologies (Jordan *et al.*, 2023). However, while impactful, the IRA may need additional supportive policies to bridge regulatory and infrastructural gaps. In the UK, Building Regulations (The UK Government, 2010) and the Climate Change Act (The UK Government, 2008) with its 2050 Target Amendment (The UK Government, 2019) encourage energy efficiency and low-carbon practices, but the Act's institutional focus limited its support for broader energy transition areas (Averchenkova *et al.*, 2021; Fankhauser *et al.*, 2018). Australia's National Construction Code (NCC) (ABCB, 2022) promotes energy-efficient building design, though operational challenges hinder its impact on GHG emissions (Enker and Morrison, 2020). Malaysia's green building initiatives, including energy research and development and solar incentives, have yielded cost and energy savings, but skilled practitioner education is needed to maximise sustainable practices (Ismail *et al.*, 2015). In these cases, the shared need for comprehensive frameworks and policies to drive zero-carbon transitions, a goal also pursued by NZ through initiatives like the Building for Climate Change (BFCC) framework (MBIE, 2020) and the Carbon Neutral Government Programme (CNGP) (MfE, 2023).

Increased environmental awareness has driven greater interest in green buildings, which aim to be environmentally friendly throughout their construction and operational stages (Li *et al.*, 2017). The benefits span environmental, social and economic dimensions, resulting in improved occupants' health, lower healthcare costs and higher rents (Darko *et al.*, 2017). Tailored to each country's building industry, there are around 600 different GBRSs globally, such as BREEAM (Building Research Establishment Assessment Method) in the UK, LEED (Leadership in Energy and Environmental Design) in the US, Singapore's BCA (Building and Construction Authority) Green Mark Scheme and Australia's Green Star AU.

Previous studies on GBRSs have compared BREEAM and LEED with other systems (Shan and Hwang, 2018). However, limited research has specifically focused on Green Star NZ. Previous studies on Green Star NZ examined technological opportunities and barriers in integrating it with Building Information Modelling (BIM). Others compared it with international systems, analysing categories, weightings or sustainability assessments (see Table 1). However, these studies have not assessed Green Star NZ's effectiveness in supporting NZ's zero-carbon goals.

Considering Green Star NZ's importance in achieving zero carbon, this study aims to explore the current practices of using Green Star NZ and identify the areas for improvement. Specifically, it seeks to answer the research question: How do industry professionals perceive Green Star NZ's effectiveness in contributing to NZ's zero-carbon goals, and which aspects need improvement?

Table 1. Summary of recent research related to Green Star NZ

Author(s)	Short description in research aspects	Perceptions of Green Star NZ
Doan *et al.* (2017)	This study systematically reviewed the development of four Green Building Rating Systems, including LEED, BREEAM, CASBEE and Green Star NZ, focusing on their evolution, strengths, weaknesses and ability to assess sustainability comprehensively	Green Star NZ's evolution, strengths and weaknesses are well-covered, but its technology, materials and zero-carbon role are often overlooked
GhaffarianHoseini *et al.* (2017)	This research aimed to advance the effective application of BIM to support Green Star NZ certification. It focused on the gaps between these systems and provided stakeholders with insights into the advantages and obstacles of implementing these two systems	Green Star NZ's integration with BIM is a key focus, yet its technological aspects, materials and contribution to zero-carbon goals are often overlooked
Doan *et al.* (2018)	This study explored the connection between BIM adoption and Green Star certification through semi-structured interview with industry professionals, aiming to enhancing the development of these two systems	Green Star NZ's focus on integration with BIM leaves its technological aspects, materials and contribution to zero-carbon goals largely unexamined
Doan *et al.* (2019)	This study explored key stakeholders' views on Green Star adoption in NZ and its potential BIM integration, providing insights to help professionals and academia develop effective implementation strategies for both systems	The discussion of Green Star NZ highlights professionals' views on its integration with BIM but ignores its technology, materials and zero-carbon role
Atanda and Öztürk (2020)	This study analysed social criteria in seven Green Building Rating Systems—BREEAM, LEED, CASBEE, Green Star, SBTool, GSAS and SBAT—to help building practitioners integrate social sustainability into their decision-making	The discussion of Green Star NZ focuses on social criteria but does not cover its technology, materials and zero-carbon role
Ade and Rehm (2020)	This study reviewed the histories of BREEAM, LEED, Green Star, Green Star NZ and Homestar, focusing on their categories and weightings to understand their development and operation and provide insights for future research and development	Green Star NZ's history, categories and weightings are well-covered, but its technology, materials and zero-carbon role are often overlooked
Abdelaal *et al.* (2022)	This research's purpose was to explore the effectiveness of five Green Building Rating Systems: LEED, BREEAM, BEAM Plus, Green Star and Homestar, in evaluating buildings' total carbon emissions	Green Star NZ's carbon measurement effectiveness is discussed but overlooks its technology, materials and zero-carbon role
Olanrewaju *et al.* (2022)	This study explored BIM integration with Green Building Rating Systems (LEED, BREEAM, Green Star, DGNB), analyzing BIM-enabled GBRSs, implementation levels and relationships to identify areas for future research	Green Star NZ's integration with BIM is a key focus, yet its technological aspects, materials and contribution to zero-carbon goals are often overlooked
Doan *et al.* (2023)	The purpose of this research aimed to assess the advantages, barriers and potential solutions for combining Green Star NZ with BIM	Green Star NZ's BIM integration is a key focus, but its technology, materials and zero-carbon contribution are often overlooked

(*continued*)

Table 1. Continued

Author(s)	Short description in research aspects	Perceptions of Green Star NZ
Olanrewaju *et al.* (2024)	This research assessed operational, embodied and whole life cycle (OEW) credits in five Green Building Rating Systems: LEED, BREEAM, Green Star NZ, LOTUS and GREENSL, highlighting their advantages, disadvantages and areas for improvement	Green Star NZ's OEW credits are discussed but does not address its technology, materials and contribution to achieving zero-carbon goals

By exploring industry professionals' perspectives on Green Star NZ, the findings of this study will provide insight into (1) The professionals' perceptions of NZ's GBRSs; (2) The professionals' perceptions of technologies and sustainable materials related to the GBRSs; (3) Areas where the existing rating systems could be improved. The results of this study can help the industry's stakeholders gain a holistic view of Green Star NZ and how these systems would contribute to zero-carbon goals for the building industry.

2. Literature review

2.1 Green Star NZ and its contributions to zero carbon

Like many other countries, NZ also developed various green building rating systems to assess buildings' sustainability, such as Green Star NZ, Homestar, National Australian Built Environment Rating System NZ (NABERSNZ) and Toitu carbon zero certification (Nidhin *et al.*, 2023). These rating tools each contribute to NZ's zero-carbon goals, each with its unique focus. For instance, Toitu carbon zero certification (Envirocare, 2023) focuses on carbon neutrality, while Homestar emphasises sustainability in residential buildings (NZGBC, 2023b). Green Star NZ, launched in 2007 by the NZ Green Building Council (NZGBC), has become the country's primary rating system for commercial buildings (Doan *et al.*, 2021). Although NABERSNZ also assesses non-residential projects, it only focuses on office buildings and their energy consumption (NABERSNZ, 2023). In contrast, Green Star NZ offers a more comprehensive evaluation of commercial construction projects besides office buildings (NZGBC, 2023a). As the government's preferred tool, Green Star NZ is particularly well-suited to NZ's context compared to LEED and other tools because it considers the country's geography, cultural background, regulatory requirements and market maturity (MBIE, 2022a).

According to Doan *et al.* (2021, 2023)'s study, the adoption of Green Star NZ has grown steadily since its introduction. Compared to 3,200 certified residential projects under Homestar since its 2010 launch, Green Star NZ's adoption remains lower than the government and the GBC anticipated.

The cost of green building practices (Ade and Rehm, 2020; Zhang *et al.*, 2018) and lack of knowledge (Darko *et al.*, 2017) are generally cited as significant challenges. The obstacles Green Star NZ faces are similar to those faced by green buildings elsewhere (Darko *et al.*, 2017). These barriers emphasise the importance of understanding the cost-related aspects of Green Star NZ; hence, understanding the industry professionals' perspectives on these potentially cost-related aspects is a gap that this study seeks to address.

2.2 Green Star NZ's weighting system and assessment criteria

Green Building Rating Systems (GBRSs), developed by Green Building Councils (GBCs) within the World Green Building Council (WGBC) network, promote sustainable building practices. They define "green building," highlighting its benefits, supporting industry skills development and assessing buildings' sustainable performance. GBRSs can be categorised into two types: (1) issue-specific tools targeting a particular environmental impact and (2) holistic tools simultaneously handling multiple environmental concerns.

Green Star NZ is a holistic tool that can handle multiple environmental issues simultaneously and is most commonly used to evaluate the environmental features of buildings throughout the design and construction phase (Cielo and Subiantoro, 2021). It employs a comprehensive approach through a detailed weighting system that evaluates buildings' sustainability performance from environmental, social and economic aspects. Like other international rating tools, such as BREEAM and LEED, Green Star NZ offers certification levels up to 6 stars. Green Star NZ's current version includes four sub-evaluation systems for assessing sustainability across commercial building types and communities: *Green Star-Design and As Built*, *Green Star–Interior*, *Green Star-Community* and *Green Star-Performance*. Each system offers a set of categories to help stakeholders assess different project aspects. For instance, *Green Star-Design and As Built* focuses on new structures and significant renovations' design and construction, while *Green Star–Interior* targets the fit-outs of new interior spaces. *Green Star-Performance* assesses existing buildings' operational sustainability, and *Green Star-Community* evaluate the sustainability of communities and precincts.

Most rating tools focus heavily on the environmental and social aspects, often neglecting economic and institutional factors. Whilst some well-developed rating tools, such as LEED and BREEAM, were proven to help improve building performance, these rating tools' roles in the industry's decarbonisation have yet to be verified. Green Star NZ, which has a framework like LEED and BREEAM, adopts a comprehensive approach to evaluating buildings. While international GBRSs provide valuable frameworks, local GBRSs operated by NZGBC are crucial for addressing NZ's specific sustainability needs. Green Star NZ offers a comprehensive framework to evaluate the sustainability of NZ's green buildings, aligning with the country's zero-carbon goals (NZGBC, 2023c). As the primary tool for evaluating commercial buildings, several carbon-emissions-related factors in the rating tool may involve using various green technologies or sustainable materials (NZGBC, 2023a), making it essential to understand these elements to enhance the tool's effectiveness in reducing carbon emissions. However, despite its emphasis on environmental aspects, social and economic factors are often overlooked (Doan *et al*., 2017). This imbalance may limit Green Star NZ's impact on building performance and zero-carbon goals. While it aims to enhance performance, further research is needed to assess its effectiveness in driving measurable improvements and achieving zero-carbon objectives.

Numerous studies have proposed various frameworks for effective Green Star implementation, for instance, Asdrubali *et al*. (2015) proposed a framework that reclassifies rating criteria into five macro-level areas for improved comparison. Raouf and Al-Ghamdi (2023) emphasise the critical role of maintaining quality standards in achieving green building performance and present a framework to identify hidden factors within the construction and operational processes that negatively affect quality. Another sustainable office building renovation framework, integrating green building rating criteria and cost-benefit analysis for early-stage decision-making, developed focuses on LEED, BREEAM and DGNB systems (Šuman *et al*., 2020). National practices can be aligned with global sustainability standards by developing a framework to integrate LEED into local building codes and address the gaps in the Nigerian Building Codes (Atanda and Olukoya, 2019).

2.3 Sustainable materials and innovative technologies within Green Star NZ

Green Star NZ has strict standards for relevant technologies and materials criteria, highlighting several aspects consistent with reducing carbon emissions, including using energy-efficient systems, renewable energy and sustainable materials (NZGBC, 2023c). The tendency of sustainable buildings, such as the Life Cycle Assessment (LCA) approach and the development of low-carbon materials (MBIE, 2023a), shows that the building industry has a higher requirement for the sustainability of technologies and materials.

Another issue is that NZ's zero-carbon policy is underdeveloped compared to other countries, and the current building code lacks zero-carbon-related requirements

(Bui *et al.*, 2021). This has led to gaps in whole-of-life embodied carbon emissions data for materials and products (Nidhin *et al.*, 2023). Some studies highlight the need for prioritising technologies to reduce carbon emissions from materials and products for NZ's zero-carbon targets (Bui *et al.*, 2021). Despite Green Star NZ's strict criteria for technologies and materials, the slow adoption of low-carbon options, coupled with weak policies and incomplete carbon data, underscores a critical gap in aligning the building industry with NZ's zero-carbon goals.

Research currently focuses on comparing Green Star NZ with other systems rather than its effectiveness, weighting, innovative technologies and sustainable materials. There is a significant gap in understanding industry professionals' views on these issues and future improvement for Green Star NZ. More research is needed to guide Green Star NZ in accelerating progress towards zero-carbon goals, requiring further discussions with industry professionals to identify more effective enhancements.

Further research is needed to assess its effectiveness in improving the certified buildings' performance and exploring potential improvements to the tool.

3. Research methodology

3.1 Research design

When exploring the gaps in the current rating systems, the qualitative research approach offers a thorough analysis and trustworthy qualitative data (Saunders *et al.*, 2019). This study aimed to investigate the industry professionals' perspectives on Green Star NZ using semi-structured interviews to explore the in-depth insight and perspective of the interviewees and encourage them to express their thoughts freely (Ebekozien *et al.*, 2023) and provide flexibility for both interviewers and interviewees. A semi-structured interview approach was chosen to avoid limiting valuable insights from industry professionals.

The interview consisted of ten questions, which were divided into three sections: (1) interviewees' background, (2) understanding of the green building rating system and (3) practical project experience.

Three pilot interviews were conducted before the primary interviews to assess the questionnaire's clarity and time requirements (Goh and Chua, 2016), allowing for proper adjustment before the data collection commences (Doan *et al.*, 2023). This stage also helped refine the researcher's interview techniques (Roberts, 2020). To ensure the protocol's questions were comprehensible across various frameworks and to prevent the primary interview pool, industry professionals with experience in international GBRSs, such as LEED, WELL and BREEAM, were selected for the pilot interview.

To ensure data reliability, professionals with a certificate from NZGBC and sustainability expertise were invited for the formal interview. Potential interviewees were selected from NZGBC's website, which lists contact information and shortcuts to participants' LinkedIn profiles. Two sampling methods considered for exploratory research, purposeful sampling and snowball sampling, were employed to select participants considering the willingness to participate in the interview and the limited number of Green Star specialists (Ahmed, 2024). Purposive sampling was used to identify participants with specific knowledge of Green Star NZ and maximise in-depth results and valuable information with limited research resources (Campbell *et al.*, 2020). Snowball sampling expands the pool through referrals (Ahmed, 2024; Campbell *et al.*, 2020).

Research interview invitations were sent to the professionals via email and LinkedIn. Before the interviews, an information sheet and interview protocol were sent to the interviewees to ensure they understood the research information. The consent form was sent simultaneously, and interviewees were required to read and sign it before the interviews to align with ethical protocol standards.

To minimise bias, interviewees were selected from diverse roles, including consultants, building performance engineers, on-site coordinators, architects and contract administrators across NZ organisations (Bui *et al.*, 2023).

3.2 Data collection

Between October 2023 and October 2024, 20 online interviews were conducted with 22 construction professionals via Microsoft Teams or Zoom. With the interviewees' permission, digital records were created, and automatically generated transcripts via Teams and Zoom were amended manually via Microsoft Office Word later.

To enhance the credibility and validity of the data, the transcripts were carefully reviewed and sent to the interviewees for member checking after each interview and before data analysis began, allowing participants to confirm or clarify their viewpoints. Member checking is a trustworthy and commonly used method for data collection in qualitative research (Walther *et al*., 2013). Additionally, it is a method that encourages interviewees to be actively involved in the research, helps decrease researcher bias and improves the trustworthiness of qualitative results (Candela, 2019). Interviews lasted between 30 and 60 min each for adequate engagement, as recommended by Merriam and Tisdell (2015). A total of 22 interviews were conducted, ensuring participants of varying experiences and backgrounds from different regions of NZ.

3.3 Data analysis

Thematic analysis, a widely used method in qualitative research (Ebekozien *et al*., 2023), was employed to analyse data from the semi-structured interviews, providing effective, trustworthy and insightful results. This study followed the six-step approach outlined by (Braun and Clarke, 2006). Participants were first coded using Arabic numerals by the interview sequence to preserve confidentiality. The researcher thoroughly reviewed each transcript in the familiarisation phase, identifying recurring ideas. A priori codes, such as market adoption, technologies and sustainable materials, were developed based on the literature review and initial impressions from the data. Using a "code scheme", each code was recorded with a definition to ensure a systematic approach (Campbell *et al*., 2013). This allowed each theme to capture detailed viewpoints without overlap. Due to time constraints, these codes were implemented manually in Excel, where key viewpoints were highlighted to facilitate detailed analysis.

A theme map based on the main themes and secondary codes was created during the second phase by categorising the sub-themes under original codes for more generalised groupings. The thematic maps included new sub-themes identified during the review of transcripts and the refinement phase. For instance, under *a priori* code "Sustainable materials," secondary codes covered Green Star materials credit challenges and relevant materials' accessibility. Despite time constraints, the researcher simplified the original code scheme using a method outlined in Campbell *et al*.'s (2013) study to preserve the original meaning of transcripts while extracting common opinions across multiple interviewees.

4. Results and discussion

The interviewees represented a mix of construction professionals, with 45.45% of the professionals being consultants, 22.73% engineers, 13.64% architects and designers and 18.18% included on-site coordinators, project coordinators, a life-cycle design coach and a pre-construction and contract administrator as seen in Table 2. The average working experience of the 22 interviewees is around 12 years, and about 36.36% of them had 15 or more years of experience in the building industry. All interviewees had relevant Green Star qualifications, such as Green Star Accredited Professional (GSAP) or Green Star Practitioner. Additionally, all had projects related to GBRSs, and 45.45% participated in projects assessed by international rating tools.

4.1 Professionals' perceptions of Green Star NZ

4.1.1 The status of practices of Green Star NZ. The interviews revealed a consensus among most interviewees that, although NZ has many green rating tools, its status of green building practices is unsatisfactory. The participants pointed out that construction companies are often willing to pay for those Green Star credits that could contribute to the certification but do not

Table 2. Interviewees demographics

No.	Construction position	Experience (years)	Organisation type	Green building projects experience
P1	Building Optimization Manager	7	Consultancy	NABERSNZ, Green Star
P2	Building Performance Engineer	8	Multi-discipline	NABERSNZ, Homestar, Green Star
P3	Building Services Engineer	20	Consultancy	NABERSNZ, Green Star
P4	Manager	10	Non-profit Building Organisation	LEED, Green Star
P5	Building Services Engineer	8	Consultancy	NABERSNZ, Green Star, Homestar
P6	Consultant	12	Consultancy	NABERSNZ, Green Star
P7	Consultant	15	Consultancy	LEED, Green Star, Homestar
P8	Consultant	15	Consultancy	LEED, WELL, BREEAM, NABERSNZ, Green Star
P9	On-Site Coordinator	1	Property Development	Green Star
P10	Consultant	16	Consultancy	LEED, Green Star, Homestar
P11	Consultant	9	Multi-discipline	WELL, NABERSNZ, Green Star
P12	Consultant	2	Multi-discipline	WELL, NABERSNZ, Green Star
P13	Life-Cycle Design Coach	7	Information Technology	LEED, BREEAM, Green Star
P14	Pre-Construction and Contract Administrator	10	Project Management	LEED
P15	ESG Manager	25	Property Development	LEED, NABERSNZ, Green Star
P16	Economical and Sustainability Engineer	3.5	Consultancy	Green Star
P17	Architect	30	Consultancy	Green Star
P18	Consultant	12	Consultancy	Green Star, Homestar
P19	Consultant	26	Consultancy	LEED, BREEAM, Green Star, Homestar, Passive House, Living Building challenge, Estidama
P20	Architect	20	Consultancy	Green Star, Homestar
P21	Interior Designer	2.5	Property Development	Green Star
P22	Project coordinator	2	Property Development	Green Star

consider whether they benefit the occupants, as green building certificates can bring market benefits. Evaluating to obtain certificates could be ineffective and even counterproductive. Interviewee P2 elaborated on this viewpoint by exemplifying a leading Green Star building in Wellington that was constructed many years ago but is now abandoned and explained that the low adoption rate of these rating tools would be difficult to change because of the complex administration of the rating tools.

Previous literature highlighted the slow adoption of the Green Star in NZ, with just over 250 certified projects between 2007 and 2019 (Doan *et al.*, 2023; Abdelaal and Guo, 2021). However, this challenge is not exclusive to NZ, as green building certification globally still represents a tiny fraction of total construction projects (Yinqi *et al.*, 2019). The absence of mandatory policies in NZ results in certification adoption being dependent on clients' spontaneity. Nidhin *et al*. (2023) suggested that this lack of government regulations may contribute to low market uptake.

While regulatory gaps largely drive the slow adoption of Green Star certification, another challenge lies in the broader context of sustainable building practices. Although there needs to be a drive towards technological adaptation, there is limited attention to innovative technologies (MBIE, 2023a). The manual development process and poor communication between academia and industry discourage professionals from adopting innovative technologies, eventually slowing the uptake of alternative materials and novel technologies (Giesekam *et al.*, 2016). Consequently, a lack of knowledge among professionals remains a major barrier to using low-carbon and eco-friendly products. To overcome this, it is essential to bridge the knowledge gap through targeted education and training for practitioners, accelerating the adoption of sustainable building practices.

Administrative hurdles significantly slow NZ's progress in green building practices, with time-consuming paperwork and burdensome processes being key issues (Doan *et al.*, 2019). Interviewees highlighted these barriers as drivers of NZ's poor performance compared to countries like the US, where mandatory green policies and incentives, such as density bonuses, have increased certification rates (Adekanye *et al.*, 2020). Streamlined processes, mandatory policies and incentives like those used in LEED could improve GBRSs' adoption in NZ.

As indicated by the participant, Green Star-rated buildings' sustainability and long-term viability can be questioned. This sentiment reflects broader apprehensions seen in Bui *et al.*'s (2023) study, emphasising the need to ensure green buildings maintain their value and functionality over time.

4.1.2 Perceptions of the weightings of Green Star NZ. Most interviewees acknowledged Green Star NZ as a holistic tool, highlighting its benefits for occupants through sustainable construction and operation and its positive impact on social aspects. They noted that its comprehensive approach is educational, raising public awareness and promoting an environmentally friendly society. However, some, like P9, argued that while the holistic framework has merits, it may not be necessary for a tool to cover all aspects of sustainability. Disadvantages such as the need for large project teams and the time-intensive certification process could hinder practical application, potentially reducing uptake despite its broader sustainability focus.

P10 used another rating system, Homestar, as an example to explain this viewpoint: At the early stage, the Homestar had LED-related points because NZGBC tried to increase the use of LED. As LED lighting became more ubiquitous, subsequent versions of Homestar no longer allocated points for lighting as most users had transitioned to using LEDs. This example highlights the need for Green Star NZ to periodically review and adjust its weightings to remain relevant and effective. Green Star NZ's renewal has also adapted its weightings from a tool emphasising the environmental aspect to a more holistic tool with more concern about social and economic factors in recent years. The shift proves that the weightings in the rating systems are not changeless but must adapt to changing sustainability priorities.

The balance of sustainability dimensions in Green Star NZ has significant implications for the future of green building practices and the development of relevant policies and industry standards in NZ. As P10, P17 and P21 pointed out, focusing solely on environmental factors may overlook the interconnected nature of sustainability, potentially undermining the overall effectiveness of the rating system. Too much emphasis on any single dimension could lead to unintended negative consequences, highlighting the need for a well-considered weighting approach.

P5 noted that Green Star NZ currently pays limited attention to the social aspect, particularly in supporting staff welfare and education in the building sector. This opinion reflects the results of Doan *et al.* (2019), who found that Green Star NZ allocates only 10% to social credits and none to economic aspects. This issue is not unique to Green Star NZ, similar imbalances exist in other relatively mature international rating systems, such as LEED and BREEAM (Doan *et al.*, 2017). As Doan *et al.* (2017) noted, Green Star NZ can only examine whether a building is "green" but not its sustainability, which is a persistent problem.

While Green Star NZ's holistic strategy reflects greater sustainability awareness, it raises concerns about its effectiveness. Incorporating social and economic aspects aims for a comprehensive framework but risks diluting the focus on environmental performance. Transitioning from a "green building" approach centred on environmental goals to a broader sustainability strategy is challenging. As per the WGBC's definition (Council, 2022), sustainability must balance environmental, social and economic factors. Green Star NZ aligns with this vision, but careful weighting is essential to ensure no pillar is neglected and that zero-carbon goals remain uncompromised.

4.2 Professionals' perceptions of technologies related to Green Star NZ

Technologies play a crucial role in Green Star NZ, significantly influencing the advancement of sustainable practices in NZ. The practical effectiveness of technology determines the extent of progress toward sustainability.

The results revealed that 45% of participants agreed that technology could help achieve low or zero carbon. P5, P6, P9, P12, P16, P17, P18, P19, P21 and P22 thought there were many opportunities with technologies in the building industry. Over time, the efficiency of technologies may continue to improve, significantly reducing carbon emissions. This perspective was consistent with the global tendency of the building industry to use more innovative design methods, technologies and materials in construction towards sustainability (MBIE, 2023a).

However, P1, P2, P4, P7, P8, P10, P13, P14 and P15 acknowledged technology's contribution to zero carbon, but other factors must be considered. P2, P4, P6, P7, P15 and P21 voiced concern about the high cost of technology, hindering its adoption. Cielo and Subiantoro (2021) identified innovative technologies' high cost as a barrier to green building practices, highlighting a possible gap between their theoretical potential and practical application. Interviewees (P4, P5, P11, P13, P16) advocated integrating sustainability early, with P4 further suggesting hiring a GSAP for a sustainable strategy. However, early planning can only reduce the additional costs for more sustainable strategies later and does not directly address the high cost of innovative technologies. Therefore, targeted policies and incentives are needed to accelerate the adoption and development. Countries facing similar high-cost barriers have adopted financial solutions, like Italy's tax incentives for energy-efficient home upgrades (Silk, 2020) and the EU's European Green Deal, which offers financial support for sustainable practices (European Commission, 2019). In NZ, the Green Investment Finance (NZGIF) invests in businesses adopting sustainable technologies (NZGIF, 2019). Future research could explore how different policy mechanisms can overcome these barriers and promote wider adoption of low-carbon technologies.

Another consideration is using the correct technologies or selecting the right equipment (P2, P4, P14) and effectively operating and managing them (P4, P7, P10, P15), highlighting the importance of the user's knowledge of green building practices. Darko *et al*. (2017) emphasised that knowledge gaps challenge zero-carbon practices in the global building sector. Therefore, educating practitioners and users on proper equipment operation and zero-carbon management could be an effective solution.

P2 and P13 noted that the effectiveness of technology in achieving zero carbon depends on how "zero carbon" is defined. P7 and P13 suggested that zero carbon implies minimising emissions rather than eliminating them, with technologies used only when further carbon offsetting is unfeasible. In NZ, while carbon offsets are commonly employed, opinions remain divided due to concerns about transparency. P3 opposed carbon offsetting, arguing that reducing carbon emissions should take precedence over purchasing credits or overseas offsetting. P7 and P8 noted that NZ's overreliance on technologies is often at the expense of passion design. Supporting this, Chen *et al*. (2015) found that GBRSs, except for BREEAM and CASBEE, insufficiently prioritise passive design, with LEED even penalising it. The role of passive design in achieving zero carbon warrants further exploration.

P4, P6, P8, P12, P14, P15, P18 and P22 highlighted renewable energy, particularly solar energy, as key to achieving low or zero carbon, emphasising its industry reputation for sustainability and user-friendliness. P6 noted increased solar photovoltaic (PV) installations in buildings. Cielo and Subiantoro (2021) highlight the market potential for solar energy in NZ's commercial building area. However, MBIE (2022b) reported that solar energy contributes less than 0.5% of the country's electricity generation, reflecting a low adoption rate. This may be due to the need for local council consent, approval from electricity retailers for grid-connected systems and compliance with relevant national standards. Additionally, unlike Australia, NZ lacks high feed-in tariff rates that could incentivise solar adoption (Cielo and Subiantoro, 2021). Therefore, solar energy's contributions to zero carbon in NZ need further exploration.

4.3 Professionals' perceptions of sustainable materials to Green Star NZ

Interviewees' opinions on sustainable materials contributing to low, or zero-carbon buildings can be divided into three categories (see Table 3). Interviewees with positive views (P4) believed that higher green buildings certification levels should focus more on materials, and these interviewees suggested that using sustainable materials would make the building sector more efficient and sustainable, aligning with Nidhin *et al*.'s (2023) emphasis on low-carbon products and materials' role in decreasing carbon emissions.

In contrast, P3 believed that materials do little to help zero carbon now and in the future. They argued that sustainable materials may have a limited impact if buildings cannot reduce overall emissions. The perspectives that express a neutral attitude (P8) noted that achieving net zero emissions requires seeking alternative materials during the lifecycle, better management plans, replacing sustainable materials with low-carbon ones and maintaining them. In other words, the effectiveness of sustainable materials needs to be considered considering the user behaviours, which further emphasises the importance of user-sustainable behaviours mentioned above. P19 mentioned that materials are not inherently green or sustainable; their impact depends on the environment in which they are used. This viewpoint reflected the importance of using materials and resources sustainably during NZ's progress towards zero carbon.

Regarding Green Star material-related requirements, P5, P9 and P20 found the credit requirements relatively easy to meet, attributing this to the effectiveness of early project goal setting in guiding material selection. Meanwhile, P11 and P18 noted that some materials cannot meet the NZ market's Green Star credit requirements. P16 and P17 observed that achieving Green Star scores depends on each project's unique conditions, with P17 further emphasising the architect's critical role in selecting appropriate materials. P4 explained the difficulty in obtaining credits because attention to how materials affect building efficiency has recently gained importance. Issues include the availability of Environmental Product Declaration (EPD) products, lack of service equipment data, complexity in on-site tracing data

Table 3. Perceptions of sustainable materials to the GBRSs

Perceptions	Illustrative quotes
Sustainable materials contribute to low, or zero-carbon buildings	"To get to the higher ratings, you have to start looking at things like materials." (P4)
Sustainable materials do little to help zero carbon now and in the future	"I don't think it's helping anything going forward . . . you'll get to low carbon but accept that there will always be emissions." (P3)
Sustainable materials' effectiveness must consider user behavior	"We weren't targeting huge reductions in the materials . . . Better management and a plan to replace those sustainably with low-carbon options are needed." (P8)
Materials are not inherently green or sustainable; their impact depends on the environment they are used in	"There are no green or sustainable materials. There are just materials. What is good in one environment can be harmful in another." (P19)

and EPD expirations. These challenges align with the need to address the link between NZ's construction market and low-carbon product availability, as highlighted by Doan *et al*. (2021).

According to P5 and P6, NZ's materials are generally good, but the small market and high costs pose significant challenges. The high-cost issue primarily stems from two factors: production and transportation. P10 noted that NZ's EPD products often need to be exported for processing before re-importing, making the process as time-consuming as local processing. Additionally, foreign markets have greater demand and lower processing costs than NZ. A similar situation was noted by Giesekam *et al*. (2016) in their study. This perspective may reflect NZ's developing green building practices, which need time for the industry to adapt.

NZ offers more sustainable materials than some European countries or Australia, but technology in this area lags per P13's views. Importing materials increases transport emissions, as Doan *et al*. (2021) noted. Sustainable materials are unevenly distributed, with Auckland having better access than smaller regions such as Nelson, where P15 highlighted supply shortage. These regional disparities hinder green building ratings and progress towards zero-carbon goals. Supporting local production or improving regional supply networks could help address these challenges.

Most interviewees had positive views on the future of these materials. They believed that the high requirement for sustainable materials in Green Star NZ promotes the building industry since there have been changes in the availability of sustainable materials in both domestic and overseas markets in recent years. There is still enormous potential for sustainable materials in NZ. These factors can potentially drive innovation and create an opportunity for the industry (P5, P8, P10, P11, P20). Such stringent certification requirements stimulate innovation and adaptation. Thus, one interviewee predicted that NZGBC may improve the requirement for sustainable materials and reusing materials in new versions of rating tools. However, industry scepticism towards low-carbon materials often impairs their adoption (Giesekam *et al*., 2016). Barriers to adoption include high costs, limited consumer interest, underdeveloped supply chains and scarce local availability (Giesekam *et al*., 2016). Barriers may arise because many NZ companies are small and have limited research and development, complicating the evaluation of new materials (Giesekam *et al*., 2016). Interviewees shared varied opinions on measures, including technologies and energy solutions, to help NZ achieve its zero-carbon goals, influenced by their backgrounds and project experiences. Those with extensive Green Star certification experience offered more efficient solutions and recognised technologies tailored to specific projects as critical to supporting zero-carbon objectives.

Additionally, cost is the keyword directly or indirectly related to Green Star's framework, technologies and sustainability materials. To improve the status of practices of NZ's GBRSs, the issues of high cost should be addressed.

4.4 Perspectives shaped by experience and specialisation

Interviewees with over 15 years of experience (P3, P10, P15, P17, P19, P20) frequently provided in-depth critiques of systemic aspects of Green Star NZ, highlighting complex administrative, high costs and limited market uptake, reflecting their broad industry knowledge and long-term perspectives. Those with 10–15 years (P4, P6, P7, P8, P14, P18) focused on the relationship between technologies and achieving zero-carbon goals, suggesting comparisons to other systems like LEED and BREEAM, while emphasising training and systematic refinement. Less experienced interviewees (P9, P12, P21) demonstrated optimism about green technologies and their potential within rating systems by highlighting recent project successes and Green Star NZ's impact.

Green Star NZ professionals shared insights on advancing sustainable building practices. Engineers highlighted operational and financial challenges, stressing the need for user expertise and effective technology implementation. Project coordinators identified administrative barriers like lengthy procedures and complex documentation, while architects and designers emphasised integrating sustainability at the design stage, advocating for passive design and framework adjustments. Common themes across roles included the need for streamlined processes, regular updates and cost-effective strategies to boost Green Star NZ adoption and its impact on achieving zero-carbon, sustainable buildings.

Figure 1 highlights the complex, multifaceted nature of achieving zero-carbon goals, revealing the need to address multiple dimensions and capture interviewees' views. Connections within the map were created based on correlations in the interview data, illustrating how themes and subthemes interconnect and influence each other within the context of Green Star NZ. Red-coded bubbles indicate challenges in adopting Green Star, while white-coded bubbles point to areas requiring focused improvements for Green Star NZ and green building practices.

A limitation of this research is that it relies on semi-structured interviews to examine professionals' viewpoints, though case studies and field surveys might have offered a more thorough understanding. Expanding the participant pool could offer deeper insights. Future research could involve larger, more diverse samples. Similarly, sensitivity analysis could assess how variations in material costs and energy efficiency impact the environmental performance of NZ green-certified buildings (Kalluri *et al.*, 2023).

5. Recommendations

The following recommendations can be drawn from the above findings:

(1) The NZ government should take the lead by introducing mandatory regulations and targeting commercial buildings to boost Green Star NZ's adoption. Financial incentives like subsidies or tax benefits could alleviate cost barriers, making Green Star certifications more attractive.

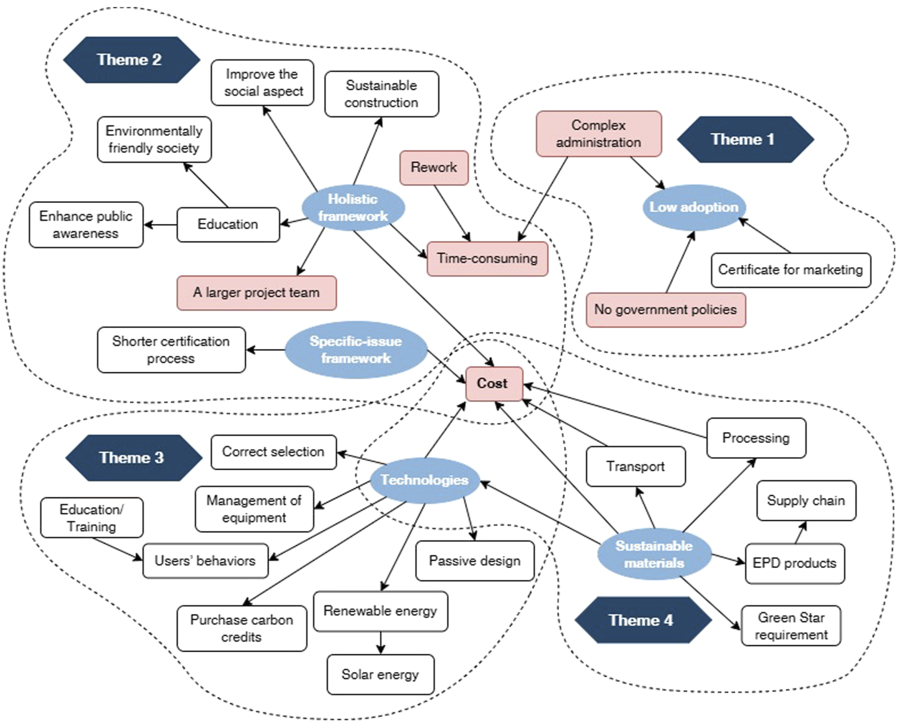

Figure 1. Qualitative thematic map highlighting the aspects that need improvement, the relationship between the overall content of the interviews

(2) NZGBC should streamline the Green Star NZ certification process to make it more accessible to certificated projects from small businesses and projects. A simple procedure will result in increased participation in the certification scheme.

(3) Regular assessments and revisions of Green Star NZ's framework and content are essential for its continued relevance and effectiveness. NZGBC should work closely with policymakers to develop sustainable materials and technologies-related policies. Moreover, NZGBC should periodically review and optimise Green Star NZ's holistic framework, which could balance the weightings to support sustainability and achieve zero-carbon goals.

(4) Additionally, NZGBC should provide industry practitioners with regular training courses and events focused on Green Star NZ and related technologies. These initiatives would help professionals understand the importance of Green Star NZ's contribution to achieving zero carbon and equip them with the skills to implement green building practices effectively.

6. Conclusion

NZ's government, the building industry and academics have been increasingly concerned with green buildings' contributions to achieving zero-carbon goals. As Green Star NZ has become an important GBRS to NZ, this study examined its effectiveness and potential improvement for achieving zero-carbon goals. This study conducted 20 online semi-structured interviews with professionals in NZ's building industry, and a thematic analysis was performed to identify key themes and their relationships.

The results showed that although Green Star NZ was considered more suitable for NZ than other GBRSs, its adoption remains low due to insufficient government policies and complex administration. Introducing financial incentives can reduce cost barriers and increase the appeal of certification. Government policies and the streamlined certification process could help address this problem. The interview highlighted key issues in Green Star NZ's weightings. While its holistic framework advances sustainability assessment, it imposes high demands on project teams and involves lengthy certification processes. Regular assessments and revisions are essential to keep the weightings relevant, effective and balanced, ensuring Green Star NZ supports zero-carbon goals without compromising overall sustainability. Technology is significant for zero-carbon goals but requires solutions to costs, regulations and user knowledge challenges supported by targeted laws and incentives. Solar energy, an important zero-carbon strategy, requires further study. Lastly, current sustainable materials requirements face supply chain challenges, yet Green Star NZ is expected to stimulate the market and address these concerns over time. This study provides valuable insights and recommendations for improving Green Star NZ, aiding NZGBC and stakeholders in advancing towards a sustainable, zero-carbon future. Implementing these suggestions can enhance Green Star NZ's effectiveness and serve as a model for researchers worldwide.

References

ABCB (2022), *National Construction Code*, Australia Building Codes Board, available at: https://ncc.abcb.gov.au/ (accessed 9 2024).

Abdelaal, F. and Guo, B.H. (2021), "Knowledge, attitude and practice of green building design and assessment: New Zealand case", *Building and Environment*, Vol. 201, 107960, doi: 10.1016/j.buildenv.2021.107960.

Abdelaal, F., Guo, B.H. and Dowdell, D. (2022), "Comparison of green building rating systems from LCA perspective", *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 062019.

Ade, R. and Rehm, M. (2020), "The unwritten history of green building rating tools: a personal view from some of the 'founding fathers", *Building Research and Information*, Vol. 48, pp. 1-17, doi: 10.1080/09613218.2019.1627179.

Adekanye, O.G., Davis, A. and Azevedo, I.L. (2020), "Federal policy, local policy, and green building certifications in the US", *Energy and Buildings*, Vol. 209, 109700, doi: 10.1016/j.enbuild.2019.109700.

Ahmed, S.K. (2024), "How to choose a sampling technique and determine sample size for research: a simplified guide for researchers", *Oral Oncology Reports*, Vol. 12, 100662, doi: 10.1016/j.oor.2024.100662.

Asdrubali, F., Baldinelli, G., Bianchi, F. and Sambuco, S. (2015), "A comparison between environmental sustainability rating systems LEED and ITACA for residential buildings", *Building and Environment*, Vol. 86, pp. 98-108, doi: 10.1016/j.buildenv.2015.01.001.

Atanda, J.O. and Olukoya, O.A. (2019), "Green building standards: opportunities for Nigeria", *Journal of Cleaner Production*, Vol. 227, pp. 366-377, doi: 10.1016/j.jclepro.2019.04.189.

Atanda, J.O. and Öztürk, A. (2020), "Social criteria of sustainable development in relation to green building assessment tools", *Environment, Development and Sustainability*, Vol. 22, pp. 61-87.

Averchenkova, A., Fankhauser, S. and Finnegan, J.J. (2021), "The impact of strategic climate legislation: evidence from expert interviews on the UK Climate Change Act", *Climate Policy*, Vol. 21 No. 2, pp. 251-263, doi: 10.1080/14693062.2020.1819190.

Braun, V. and Clarke, V. (2006), "Using thematic analysis in psychology", *Qualitative Research in Psychology*, Vol. 3 No. 2, pp. 77-101, doi: 10.1191/1478088706qp063oa.

Bui, T.T.P., Wilkinson, S., Domingo, N. and Macgregor, C. (2021), "Zero carbon building practices in Aotearoa New Zealand", *Energies*, Vol. 14 No. 15, p. 4455, doi: 10.3390/en14154455.

Bui, T.T.P., Wilkinson, S., Macgregor, C. and Domingo, N. (2023), "Decision making in reducing carbon emissions for building refurbishment: case studies of university buildings in New Zealand", *Building and Environment*, Vol. 242, 110557, doi: 10.1016/j.buildenv.2023.110557.

Campbell, J.L., Quincy, C., Osserman, J. and Pedersen, O.K. (2013), "Coding in-depth semistructured interviews: problems of unitization and intercoder reliability and agreement", *Sociological Methods and Research*, Vol. 42 No. 3, pp. 294-320, doi: 10.1177/0049124113500475.

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D. and Walker, K. (2020), "Purposive sampling: complex or simple? Research case examples", *Journal of Research in Nursing*, Vol. 25 No. 8, pp. 652-661, doi: 10.1177/1744987120927206.

Candela, A.G. (2019), "Exploring the function of member checking", *Qualitative Report*, Vol. 24, pp. 619-628, doi: 10.46743/2160-3715/2019.3726.

Chen, X., Yang, H. and Lu, L. (2015), "A comprehensive review on passive design approaches in green building rating tools", *Renewable and Sustainable Energy Reviews*, Vol. 50, pp. 1425-1436, doi: 10.1016/j.rser.2015.06.003.

Cielo, D. and Subiantoro, A. (2021), "Net zero energy buildings in New Zealand: challenges and potentials reviewed against legislative, climatic, technological, and economic factors", *Journal of Building Engineering*, Vol. 44, 102970, doi: 10.1016/j.jobe.2021.102970.

Council, W.G.B. (2022), *What Is a Sustainable Built Environment?*, World Green Building Council, available at: https://worldgbc.org/what-is-a-sustainable-built-environment/

Darko, A., Zhang, C. and Chan, A.P.C. (2017), "Drivers for green building: a review of empirical studies", *Habitat International*, Vol. 60, pp. 34-49, doi: 10.1016/j.habitatint.2016.12.007.

Doan, D.T., Ghaffarianhoseini, A., Naismith, N., Zhang, T., Ghaffarianhoseini, A. and Tookey, J. (2017), "A critical comparison of green building rating systems", *Building and Environment*, Vol. 123, pp. 243-260, doi: 10.1016/j.buildenv.2017.07.007.

Doan, D.T., Ghaffarianhoseini, A., Naismith, N., Ghaffarianhoseini, A., Zhang, T. and Tookey, J. (2019), "Examining green star certification uptake and its relationship with building information modelling (BIM) adoption in New Zealand", *Journal of Environmental Management*, Vol. 250, 109508, doi: 10.1016/j.jenvman.2019.109508.

Doan, D.T., Ghaffarianhoseini, A., Naismith, N., Zhang, T., Tookey, J. and Ghaffarianhoseini, A. (2018), "Examining the relationship between building information modelling (BIM) and Green Star", *International Journal of Technology*, Vol. 9 No. 7.

Doan, D., Wall, H., Ghaffarian Hoseini, A., Ghaffarianhoseini, A. and Naismith, N. (2021), "Green building practice in the New Zealand construction industry: drivers and limitations", *International Journal of Technology*, Vol. 12 No. 5, pp. 946-955, doi: 10.14716/ijtech.v12i5.5209.

Doan, D.T., Ghaffarianhoseini, A., Naismith, N., Ghaffarianhoseini, A., Zhang, T. and Tookey, J. (2023), "An empirical examination of Green Star certification uptake and its relationship with BIM adoption in New Zealand", *Smart and Sustainable Built Environment*, Vol. 12 No. 1, pp. 84-104, doi: 10.1108/sasbe-05-2021-0093.

Ebekozien, A., Aigbavboa, C., Nwaole, A.N.C., Dako, E.O. and Awo-Osagie, A.I. (2023), "Quantity surveyor's ethical responsiveness on construction projects: issues and solutions", *International Journal of Building Pathology and Adaptation*, Vol. 41 No. 5, pp. 1049-1066, doi: 10.1108/ijbpa-04-2021-0061.

Enker, R.A. and Morrison, G.M. (2020), "The potential contribution of building codes to climate change response policies for the built environment", *Energy Efficiency*, Vol. 13 No. 4, pp. 789-807, doi: 10.1007/s12053-020-09871-7.

Envirocare, T. (2023), *Toitu Carbonzero Certification*, Toitū Envirocare, available at: https://www.toitu.co.nz/what-we-offer/carbon-management

European Commission (2019), *Delivering the European Green Deal*, European Commission, available at: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en (accessed 11 October 2023).

Fankhauser, S., Averchenkova, A. and Finnegan, J. (2018), "10 years of the UK climate change act", Policy Paper. London School of Economics and Political Science, Grantham Research Institute on Climate Change and the Environment, Centre for Climate Change Economics and Policy, available at: http://www.lse.ac.uk/GranthamInstitute/publication/10-yearsclimate-change-act

Ghaffarianhoseini, A., Tien Doan, D., Naismith, N., Tookey, J. and Ghaffarianhoseini, A. (2017), "Amplifying the practicality of contemporary building information modelling (BIM) implementations for New Zealand green building certification (Green Star)", *Engineering Construction and Architectural Management*, Vol. 24 No. 4, pp. 696-714, doi: 10.1108/ecam-02-2016-0043.

Giesekam, J., Barrett, J.R. and Taylor, P. (2016), "Construction sector views on low carbon building materials", *Building Research and Information*, Vol. 44 No. 4, pp. 423-444, doi: 10.1080/09613218.2016.1086872.

Goh, Y.M. and Chua, S. (2016), "Knowledge, attitude and practices for design for safety: a study on civil and structural engineers", *Accident Analysis and Prevention*, Vol. 93, pp. 260-266, doi: 10.1016/j.aap.2015.09.023.

Ismail, A.M., Ramirez-Iniguez, R., Asif, M., Munir, A.B. and Muhammad-Sukki, F. (2015), "Progress of solar photovoltaic in ASEAN countries: a review", *Renewable and Sustainable Energy Reviews*, Vol. 48, pp. 399-412, doi: 10.1016/j.rser.2015.04.010.

Jordan, K., Adams, P., Jaramillo, P. and Muller, N. (2023), "Closing the gap: achieving US climate goals beyond the inflation reduction act", *Renewable and Sustainable Energy Transition*, Vol. 4, 100065, doi: 10.1016/j.rset.2023.100065.

Kalluri, B., Vishnupriya, V., Arjunan, P. and Dhariwal, J. (2023), "Net-zero energy campuses in India: blending education and governance for sustainable and just transition", *Sustainability*, Vol. 16 No. 1, p. 87, doi: 10.3390/su16010087.

Li, Y., Chen, X., Wang, X., Xu, Y. and Chen, P.-H. (2017), "A review of studies on green building assessment methods by comparative analysis", *Energy and Buildings*, Vol. 146, pp. 152-159, doi: 10.1016/j.enbuild.2017.04.076.

Lu, M. and Lai, J. (2020), "Review on carbon emissions of commercial buildings", *Renewable and Sustainable Energy Reviews*, Vol. 119, 109545, doi: 10.1016/j.rser.2019.109545.

MBIE (2020), *Building for Climate Change Programme*, Ministry of Business, Innovation & Employment, Wellington.

MBIE (2022a), "Carbon-neutral government programme: Report back on the use of sustainable building rating systems", available at: https://www.mbie.govt.nz/dmsdocument/18636-carbon-neutral-government-programme-report-back-on-the-use-of-sustainable-building-rating-systems-proactiverelease-pdf

MBIE (2022b), *Energy in NZ 2022*, Ministry of Business, Innovation and Employment, Wellington, available at: https://www.mbie.govt.nz/dmsdocument/27910-national-construction-pipeline-report-2023

MBIE (2023a), "Building and construction sector trends Anuanl Report 2023", available at: https://www.mbie.govt.nz/assets/building-and-construction-sector-trends-annual-report-2023.pdf

MBIE (2023b), "National Construction Pipeline Report 2023", available at: https://www.mbie.govt.nz/assets/building-and-construction-sector-trends-annual-report-2023.pdf

Merriam, S.B. and Tisdell, E.J. (2015), *Qualitative Research: A Guide to Design and Implementation*, John Wiley & Sons, Hoboken, NJ.

MFE (2023), *About the Carbon Neutral Government Programme*, Ministry for the Environment, available at: https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/carbon-neutral-government-programme/ (accessed 2 2024).

NABERSNZ (2023), "NABERSNZ's background", available at: https://www.nabersnz.govt.nz/about-nabersnz/background/

Nidhin, B.K.S.N., Domingo, N., Bui, T.T.P. and Wilkinson, S. (2023), "Construction stakeholders' knowledge on zero carbon initiatives in New Zealand", *International Journal of Building Pathology and Adaptation*. doi: 10.1108/ijbpa-08-2022-0119.

NZGBC (2023a), *Green Star - Design and as Built NZ*, NZGBC, available at: https://nzgbc.org.nz/green-star-design-and-as-built

NZGBC (2023b), *Homestar*, NZGBC, available at: https://nzgbc.org.nz/introduction-to-homestar

NZGBC (2023c), *Introduction to Green Star*, NZGBC, available at: https://nzgbc.org.nz/introduction-to-green-star

NZGBC (2019), "A zero carbon roadmap for Aotearoa's buildings", available at: https://23159811.fs1.hubspotusercontent-na1.net/hubfs/23159811/A%20Net%20Zero%20Carbon%20Roadmap%20for%20New%20Zealand%20s%20buildings_Digital%20Version%2024_09_19.pdf

NZGIF (2019), *Accelerating Investment in NZ's Low Carbon Future*, NZ Green Investment Finance, available at: https://www.nzgif.co.nz/ (accessed 5 June 2024).

Olanrewaju, O.I., Enegbuma, W.I. and Donn, M. (2024), "Operational, embodied and whole life cycle assessment credits in green building certification systems: Desktop analysis and natural language processing approach", *Building and Environment*, Vol. 258, 111569.

Olanrewaju, O.I., Enegbuma, W.I., Donn, M. and Chileshe, N. (2022), "Building information modelling and green building certification systems: a systematic literature review and gap spotting", *Sustainable Cities and Society*, Vol. 81, 103865, doi: 10.1016/j.scs.2022.103865.

Raouf, A.M. and Al-Ghamdi, S.G. (2023), "Framework to evaluate quality performance of green building delivery: construction and operational stage", *International Journal of Construction Management*, Vol. 23 No. 2, pp. 253-267, doi: 10.1080/15623599.2020.1858539.

Roberts, R.E. (2020), "Qualitative interview questions: guidance for novice researchers", *Qualitative Report*, Vol. 25 No. 9, pp. 3185-3203, doi: 10.46743/2160-3715/2020.4640.

Saunders, M., Lewis, P. and Thornhill, A. (2019), *Research Methods for Business Students*, Pearson Education, London.

Shan, M. and Hwang, B.-G. (2018), "Green building rating systems: global reviews of practices and research efforts", *Sustainable Cities and Society*, Vol. 39, pp. 172-180, doi: 10.1016/j.scs.2018.02.034.

Silk, J. (2020), "Improve your Italian home and get a tax rebate", available at: https://www.propertyguides.com/italy/news/improve-italian-home-tax-rebate/ (accessed 10 November 2023).

Šuman, N., Marinič, M. and Kuhta, M. (2020), "A methodological framework for sustainable office building renovation using green building rating systems and cost-benefit analysis", *Sustainability*, Vol. 12 No. 15, p. 6156, doi: 10.3390/su12156156.

The UK Government (2008), *Climate Change Act 2008*, The UK Government, available at: https://www.legislation.gov.uk/ukpga/2008/27/contents (accessed 8 2024).

The UK Government (2010), *The Building Regulations 2010 - Conservation of Fuel and Power: Approved Document Part L*, The UK Government, available at: https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l (accessed 9 2024).

The UK Government (2019), *The Climate Change Act 2008 (2050 Target Amendment) Order 2019*, The UK Government, available at: https://www.legislation.gov.uk/ukdsi/2019/9780111187654 (accessed 9 2024).

The US Government (2022), *Inflation Reduction Act (IRA)*, The US Government, available at: https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/ (accessed 7 2024).

Walther, J., Sochacka, N.W. and Kellam, N.N. (2013), "Quality in interpretive engineering education research: reflections on an example study", *Journal of Engineering Education*, Vol. 102 No. 4, pp. 626-659, doi: 10.1002/jee.20029.

Yinqi, Z., He, W., Weijun, G., Fan, W., Nan, Z., Daniel, M.K. and Xiaoyu, Y. (2019), "A survey of the status and challenges of green building development in various countries", *Sustainability*, Vol. 11, pp. 1-29.

Zhang, L., Wu, J. and Liu, H. (2018), "Turning green into gold: a review on the economics of green buildings", *Journal of Cleaner Production*, Vol. 172, pp. 2234-2245, doi: 10.1016/j.jclepro.2017.11.188.

Further reading

MBIE (2019), *Energy in New Zealand 2019*, Ministry of Business, Innovation and Employment (MBIE), available at: https://www.mbie.govt.nz/dmsdocument/7040-energy-in-new-zealand-2019 (accessed 9 2023).

MFE (2022), *New Zealand and the United Nations Framework Convention on Climate Change* Ministry for the Environment, available at: https://environment.govt.nz/what-government-is-doing/international-action/nz-united-nations-framework-convention-climate-change/

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