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An integrated challenge–strategy framework for construction waste management in New Zealand: behavioural and organisational challenges and strategies

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Abstract

Purpose – Rapid construction growth is increasing construction and demolition waste and associated environmental burdens. Construction waste management involves structured practices aimed at reducing, reusing and recycling waste. Despite its recognised benefits, implementing sustainable strategies remains challenging. This research aims to examine the challenges and potential solutions for managing construction waste in New Zealand, focusing on stakeholder perspectives and sustainable practices.

Design/methodology/approach – A systematic literature review of Scopus and Google Scholar identified 43 eligible studies. Ten semi-structured interviews with New Zealand subject-matter experts complemented the review. Thematic synthesis was used to derive challenge domains, map barriers to coordinated strategy packages and develop an integrated conceptual framework.

Findings – Six challenge domains were identified: governance and compliance; infrastructure and resource capacity; financial constraints; waste management planning; culture and education and market availability and demand. Strategies addressing these challenges emphasise stakeholder collaboration, financial incentives, education, logistics and infrastructure planning and technological innovation. Public–private partnerships, certification schemes and procurement requirements were identified as enabling mechanisms that reinforce consistent waste-minimising decisions and accountability across supply chains.

Practical implications – The framework guides policymakers and practitioners in aligning regulation, incentives, collaboration and technology adoption to improve diversion and material value retention. It supports Sustainable Development Goals 9, 11, 12 and 13 through innovation, responsible consumption and production and reduced waste-related emissions.

Originality/value – Integrating systematic review evidence with expert interviews, the study offers a New Zealand-focused challenge–strategy framework that explains how interacting institutional, organisational, and market conditions shape waste minimisation outcomes across design, construction and end-of-life stages.

Keywords Circular economy, Construction waste, New Zealand, Stakeholder collaboration, Sustainable construction, Waste management

Paper type Research article

1. Introduction

The growth of cities and rapid construction development worldwide are linked to improvements in social and economic dimensions. However, this growth presents

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significant environmental challenges, particularly regarding the construction waste generated and its management. Globally, the construction industry accounts for 13% of the gross domestic product (GDP) (Shiha and Dorra, 2023) and up to 30% of the total waste generated (Ghorbani *et al*., 2025). In New Zealand, the construction sector plays a crucial role in the national GDP, contributing 6.7% and providing nearly 300,000 jobs (New Zealand Government, 2022a, b). This trend is expected to persist due to the anticipated increase in the urban population and development driven by housing demand (Albsoul *et al*., 2024).

Consequently, construction waste has a substantial adverse effect on the environmental, social, and economic dimensions (Doan *et al*., 2023; Lima *et al*., 2021). From an environmental lens, the construction sector is responsible for substantial greenhouse gas emissions, coupled with waste generation (Tafesse *et al*., 2022; Zea Escamilla *et al*., 2016). Moreover, construction waste increases pollution, which poses serious ecological damage (Meshref *et al*., 2023). At the social level, improper disposal of construction waste presents health risks and undermines community well-being (Aboginije *et al*., 2020; Tafesse *et al*., 2022). Economically, waste leads to material surplus, cost overruns, affecting project budgets and timelines (Marzouk and Azab, 2014; Udawatta *et al*., 2015).

Managing construction waste sustainably is vital to mitigate these impacts. Sustainable construction waste management aims to strategically reduce waste generation and enhance diversion rates during the design, construction, and demolition of buildings (Victar and Waidyasekara, 2025). In this study, sustainable construction waste management is defined as a life-cycle process that prioritises waste prevention and value retention of construction materials, traditionally reflected in the waste hierarchy as reduce–reuse–recycle (3 Rs) and increasingly articulated in circular-economy scholarship through expanded "R" strategies (Kirchherr *et al*., 2017; Reike *et al*., 2018). For clarity, this study uses "3 Rs" as shorthand for the core hierarchy actions most commonly operationalised in construction waste management practice and reporting (Austin and Rahman, 2022), while recognising that the expanded R-framework extends these principles and informs the interpretation of strategies discussed in this paper. A triple-bottom-line perspective is adopted, recognising the interdependence of environmental, social, and economic dimensions of sustainability (Doan *et al*., 2023; Lima *et al*., 2021). Several effective strategies for managing construction waste have been developed, including the adaptive reuse of existing buildings (Tam and Hao, 2019), prefabrication techniques (Ajayi *et al*., 2017; Ly *et al*., 2025) and design optimisation (Banihashemi *et al*., 2024; de Magalhães *et al*., 2017). These examples span different phases of the building life cycle; the focus here is not phase-specific performance evaluation, but the cross-cutting implementation challenges and strategy packages that enable waste minimisation and diversion across design, construction, and demolition. However, the implementation of these strategies remains challenging due to regulatory limitations, fragmented collaboration among stakeholders, and financial constraints (Awino and Apitz, 2024). These barriers are further compounded by the absence of a strong sustainability-oriented culture within the industry, which limits long-term commitment to waste reduction and shared responsibility for environmental outcomes (Ajayi *et al*., 2015; Minh *et al*., 2025). A sustainability-oriented culture refers to the collective values, behaviours, and practices within the construction sector that prioritise waste reduction, resource efficiency, and environmental stewardship as integral professional norms and guiding principles for decision-making (Blaisi, 2019; Yu *et al*., 2021).

While existing research on construction waste management offers insights into challenges faced by developed nations such as the UK, Australia, and China, direct transferability to New Zealand is constrained by several contextual differences. Politically and institutionally, waste management responsibilities are structured through the waste Minimisation Act 2008, which places obligations on territorial authorities to promote effective and efficient waste management and minimisation and to adopt waste management and minimisation plans, creating a governance setting that is not directly comparable with many international

jurisdictions. In addition, the national waste-disposal levy provides a distinct economic instrument shaping disposal and diversion decisions, with construction and demolition disposal facilities (class 2) subject to a levy rate of NZD 30 per tonne from 1 July 2024 (with scheduled increases thereafter) (MfE, 2025). Economically and socially, New Zealand's dispersed settlement pattern is associated with uneven service coverage and capacity; for example, national reporting highlights regional variation in access to recycling facilities, with many concentrated in Auckland, which can constrain diversion performance outside major centres (Oakden *et al*., 2025). Consequently, there remains a lack of focused investigation into challenges specific to New Zealand's building sector and how these conditions shape implementation barriers.

Although general waste management strategies and best practices have been well-documented (Tam and Hao, 2019; Wang *et al*., 2019), the applicability to New Zealand's unique regulatory, cultural, and environmental landscapes remains inadequately explored. Recent research on residential green buildings in New Zealand has highlighted the role of waste processing facilities in achieving diversion rates of up to 75%, although the study was limited to a small number of Homestar-certified housing projects (Tong *et al*., 2025). This evidence demonstrates progress within the residential sector; however, broader challenges across diverse building types and stakeholder contexts remain under-examined. Moreover, existing literature often overlooks the behavioural and attitudinal dimensions of local industry stakeholders, such as their awareness, collaboration, and commitment to waste minimisation, while focusing predominantly on technical measures or broad policy recommendations (De magalhães *et al*., 2017; Naji *et al*., 2022). This oversight is critical, as stakeholder engagement and perspective are essential for effective strategy implementation (Albsoul *et al*., 2025).

This research adopts a life-cycle perspective across design, construction, and demolition to develop an integrated challenge–strategy framework for construction waste management in the New Zealand building sector. The research objectives are: (1) To analyse key challenges to effective construction waste management; (2) To propose practical strategies to enhance sustainable construction waste management within the New Zealand building sector. The methodology design directly addresses these objectives by synthesising existing knowledge through a comprehensive literature review, then capturing the perspectives of industry stakeholders through interviews, to enhance the relevance of findings to New Zealand. The research advances knowledge in the field of construction waste management, thereby contributing to fostering collaboration and shared responsibility among stakeholders, ultimately aiming to maximise the environmental, social, and economic benefits as well as the sustainability of the building sector in New Zealand.

Findings from this research provide the building industry with targeted strategies, enabling comprehensive and sustainable planning for waste management practices. Researchers can use these insights as a reference point to advance investigations into waste management models. Policymakers can also gain a better understanding of priority areas, which supports formulating sustainable construction waste management regulations.

2. Methodology

The research follows a qualitative approach incorporating a systematic literature review (SLR) and semi-structured interviews. Qualitative research methods are employed to explore real-world problems where background knowledge is limited and contextual understanding is essential (Lim, 2025). This approach was deemed most suitable for addressing the study's objectives, which focus on identifying context-specific challenges and developing practical strategies for sustainable construction waste management. The SLR provides a foundational understanding of established challenges and existing strategies, grounding the research in empirical evidence. The semi-structured interviews complement this by eliciting rich, experience-based insights from subject matter experts in the building sector, thereby capturing

behavioural, organisational, and cultural factors that cannot be easily quantified (Hammarberg *et al*., 2016). Together, these methods provide both theoretical grounding and empirical depth, strengthening the methodological rigour and contextual relevance of the study.

2.1 SLR

The SLR aims to establish the conceptual framework for the global aspects of effective construction waste management practices. This approach addresses the research question by synthesising latent research papers that meet explicit criteria. The review process includes three main steps: (1) papers identification via database search; (2) screening and inclusion for relevant papers; (3) data extraction and reporting (Ferronato and Torretta, 2019).

The search strategy employed a complementary approach using the Scopus database and Google Scholar search engine. Scopus was chosen due to its higher accuracy and better coverage of peer-reviewed journals and publications (Schotten *et al*., 2017). Subsequently, Google Scholar was used as a supplementary search engine to support the comprehensiveness of the search and identify any additional relevant publications (Gusenbauer, 2019). The search covered English-language publications between 2013 and 2023. To ensure consistency across Scopus and Google Scholar, the English-language criterion was applied uniformly during screening, alongside other eligibility checks. A document search was conducted in Scopus within article titles, abstracts, and keywords (TITLE-ABS-KEY) using the Boolean string: TITLE-ABS-KEY ("construction waste" AND "waste management" AND (barrier* OR challenge* OR impact*) AND building*). Likewise, the search engine Google Scholar was used to retrieve literature with keywords such as 'construction waste,' 'waste management barriers,' 'waste management strategy', and 'construction waste impacts'. The primary search retrieved 331 papers from both academic platforms. To ensure the relevance of retrieved papers, non-peer-reviewed publications and studies not directly focused on building construction waste were excluded. Only research papers and reviews were considered the most credible sources for inclusion (Zhao *et al*., 2022). Review papers were included to consolidate recurring themes and support framework development, consistent with prior SLR practice that includes review-type studies within the reviewed corpus and presents a framework as a synthesis output (Farooq *et al*., 2020).

Initial paper screening involved examining the title and abstract to select papers relevant to the research question. A total of 28 and 82 papers were selected from Scopus and Google Scholar, respectively, for further full-text assessment (see Figure 1). Ultimately, 43 articles were shortlisted for comprehensive analysis after evaluating the research methodology, primary outcomes, and key findings. Subsequently, the extracted data were summarised to identify themes, patterns, and trends in the literature.

2.2 Semi-structured interviews

The interviews aimed to capture primary insights from subject matter experts into challenges to effective construction waste management in New Zealand and practical strategies to address them. The interview questions were developed based on the gaps identified through the SLR and were closely aligned with the research objectives. This ensured that each question was theoretically grounded and targeted towards exploring barriers, institutional factors, and opportunities for improving construction waste management practices. Semi-structured interviews provide comprehensive and rich information that is valuable for exploring perspectives on a specific research area (Adeoye-Olatunde and Olenik, 2021). This approach offers various advantages, including access to comprehensive informational data that provides valuable insights for research purposes. Moreover, participants can express their perspectives openly and enthusiastically, leading to the generation of reliable and comparable qualitative data (Ma *et al*., 2020).

Purposive and snowball sampling methods were employed to recruit participants, enhancing the validity and reliability of the conducted research (Campbell *et al*., 2020).

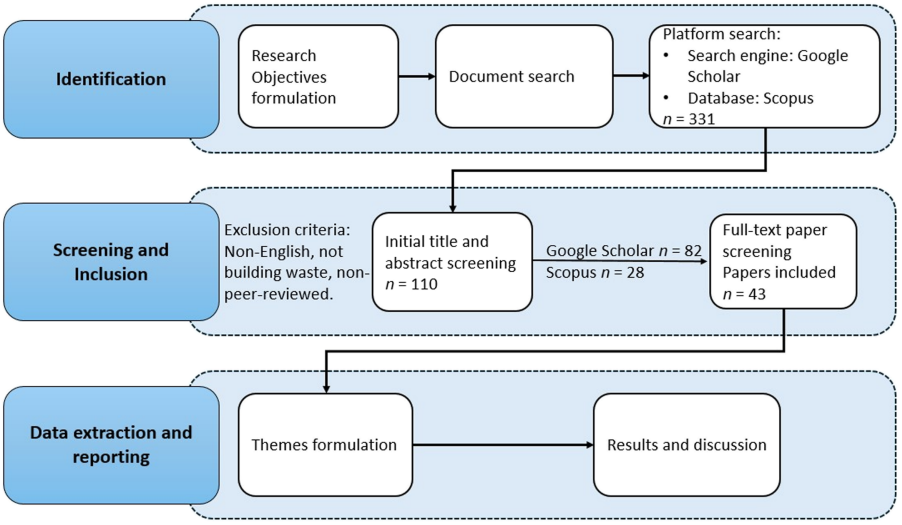

Figure 1. SLR methodology process. Source: Authors' own work

Participants included contractors, architects, engineers, project managers, and waste management professionals with a minimum of five years of experience. The settings for conducting the interviews were online and in person, based on the participants' preferences. Online interviewing offers time and location flexibility, while in-person interviewing could yield richer data through nonverbal cues (Bao *et al.*, 2020).

This research included ten interviews with professionals representing various areas of expertise in the construction industry, providing diverse perspectives on waste management practices, as shown in Table 1. The sample size of ten participants was deemed sufficient to achieve data saturation, as recurring themes began to emerge consistently across participants by the eighth interview, with no new significant insights identified in subsequent interviews. This level of saturation aligns with previous qualitative studies in construction management that used comparable sample sizes; Lu *et al*. (2018), Yuan *et al*. (2011), and Mak *et al*. (2019) conducted 8, 6, and 11 interviews, respectively.

The recruited experts possessed professional roles pertinent to the domain of construction waste management. Among the sample, project managers constituted the most significant

Table 1. Experts (E) details

Code	Profession	Experience (years)
E1	Site Manager	6
E2	Project Manager	10
E3	Waste Management Specialist	13
E4	Architect	7
E5	Contractor	9
E6	Project Manager	13
E7	Project Manager	7
E8	Project Manager	7
E9	Waste Management Specialist	21
E10	Technical Manager	8

Source(s): Authors' own work

percentage, accounting for 40%. This was followed by waste management specialists at 20%, with the remaining professions representing 10% of the total sample. Notably, all participants held either mid-level or senior positions, reflecting a substantial range of experience from a minimum of six years to a maximum of twenty-one years within the construction industry. Importantly, each of these roles involves decision-making or oversight related to waste management practices, such as waste reduction planning, on-site sorting, materials reuse, or compliance with waste regulations, ensuring that participants can provide informed and contextually relevant insights. The robust characteristics of the sample significantly enhance the research findings, thereby contributing meaningfully to the comprehensive scope of the study.

All interviews were audio recorded, and a thematic analysis was used to analyse the data, yielding deeper insights into the issues that surpass the scope of quantitative approaches (Mak *et al*., 2019). Data analysis followed a thematic approach, which is effective for analysing rich qualitative data from interviews, offering a contextual ground that quantitative research cannot provide (Mak *et al*., 2019). The thematic analysis adopted an inductive process, allowing themes to emerge naturally from the data without being restricted by pre-existing frameworks. This method requires systematic implementation and transparency to enhance the reliability of the findings (Castleberry and Nolen, 2018). The methodology involves six main steps: familiarising with the data, generating initial codes, identifying themes, reviewing themes, defining and labelling themes, and presenting the report (Kiger and Varpio, 2020). To ensure data accuracy, member checking and triangulation were employed to confirm the validity of the findings (Hamilton, 2020; Moon, 2019). Member checking was conducted with all interviewees. Interview transcripts and a summary of key results were returned to participants to confirm accuracy and ensure the analysis reflected their intended meaning. Feedback confirmed the overall interpretation; minor clarifications were incorporated to improve the wording of theme descriptions.

3. Findings

This section outlines the key themes identified by combining the SLR and semi-structured interviews. The findings are categorised thematically to highlight recurring patterns and similarities across the data sources.

3.1 Challenges in effectively managing construction waste

3.1.1 Waste management planning. Waste management planning was identified as a challenge because, although construction waste management is framed as a structured approach to minimise waste and optimise by-products (Yu *et al*., 2021), this intent is not consistently translated into early, measurable, and enforceable project-level planning. The waste hierarchy logic (for example, prioritising prevention and reuse) is well-established and associated with long-term benefits such as cost savings, resource efficiency and improved environmental performance (Mbadugha *et al*., 2021; Yu *et al*., 2021). However, planning is frequently under-prioritised relative to cost and programme pressures, and waste minimisation is often treated as secondary due to perceived costs and practical difficulties associated with reuse and recycling processes (Frempong-Jnr *et al*., 2023). As a result, waste objectives may be vague, responsibilities unclear, and site implementation inconsistent.

Interview findings reinforced this implementation gap. E10 noted that "All of the process is important, but the most important one is design and planning", and participants (E10, E7 and E6) emphasised the need to embed waste reduction objectives early and translate them into practical, measurable targets. In practice, however, interviewees described variability in how planning is operationalised, including inconsistent provision for on-site sorting and material repurposing arrangements (E4 and E8). E8 further highlighted the absence of baseline measurement and monitoring, stating the need to "start measuring how much waste we are producing . . . so we can baseline how we are actually currently performing".

Consistent with these stakeholder views, the literature indicates that effective planning depends on reliable waste estimation and classification methods that can be integrated into project planning and decision-making (Islam *et al*., 2019; Lam *et al*., 2019). In the New Zealand context, empirical work suggests that design decisions and construction-stage conditions influence variability and predictability in waste generation (Domingo and Batty, 2021; Hernandez *et al*., 2023), reinforcing the need for robust planning supported by measurement systems. Overall, the challenge is therefore not limited to awareness of planning importance, but the inconsistent and insufficiently operationalised planning and measurement that weakens waste minimisation and diversion outcomes.

3.1.2 Governance and compliance. Governance barriers refer to a range of limitations present within institutions, regulations, and legislation that impede the effective management of construction waste (Esa *et al*., 2017). These barriers can be categorised as follows: (1) lack of accountability among waste generators (Esa *et al*., 2017; Yu *et al*., 2013); (2) the absence of strategic planning, which often results in confusion, inconsistent decision-making, and missed opportunities for collaborative efforts (Blaisi, 2019; Clark *et al*., 2006; Ossa *et al*., 2016); (3) inadequate government incentives for waste management infrastructure, coupled with the cost disparity between recycled materials and virgin materials (Bao *et al*., 2020); (4) a lack of motivation, understanding, and support for efficient construction waste management (Yu *et al*., 2013); and (5) the absence of standardised practices and policies that promote the sustainable management of construction waste (Hoang *et al*., 2020; Lu *et al*., 2011).

E1 identified the "absence of standardised practices" as a source of confusion, hindering effective waste management due to varied interpretations of regulations. while E5 emphasised collaboration, stressing the importance of mutual understanding of waste management requirements. E2 highlighted the necessity of raising awareness about legal obligations and environmental impacts. E4 advocated for "proactive engagement between regulatory bodies and the construction industry" to bridge the implementation gap. Additionally, E8 and E6 suggested increasing the waste levy to "apply more financial pressure on waste practice". However, E6 emphasised that construction companies will continue their current practices if customer demands are met, and any changes to their approach will depend on regulatory actions, indicating no intention to alter their operations otherwise.

The reviewed literature emphasised the pressing requirement for comprehensive, standardised guidelines that tackle different types of construction waste and disposal methods, aiming to establish standard practices across construction sites (Duan *et al*., 2019; Esa *et al*., 2017). Further insights indicate that Inadequate enforcement can lead to disregarding proper waste disposal procedures, undermining environmental benefits and jeopardising the health and safety of the public (Duan *et al*., 2019). In such cases, Esa *et al*. (2017) proposed that stricter enforcement measures, such as routine inspections and penalties for non-compliance, are crucial for ensuring adherence to construction waste management regulations.

3.1.3 Infrastructure and resources capacity. The capacity of human resources, waste segregation facilities, and recycling operations can influence operational waste management efficiency (Caldera *et al*., 2020). Other barriers include: (1) limited infrastructure for the proper disposal and treatment of waste (Alshdiefat *et al*., 2025; Brown and Milke, 2016; Yu *et al*., 2013); (2) Potential exposure to hazardous materials and contamination (Umar *et al*., 2017); (3) existing building standards and regulations that prevent salvaging materials (Akinade *et al*., 2020; Rakhshan *et al*., 2020).

Several interviewees underscored the inadequate infrastructure for waste sorting and processing in New Zealand, which compromises the effectiveness of waste management initiatives. For instance, E2 noted, "Insufficient facilities hinder the proper disposal and recycling of construction waste materials". Similarly, E4 remarked that "the lack of adequate infrastructure limits the possibilities for incorporating recycled materials into new construction projects". E4 further delineated the importance of technical advancements and establishing recycling hubs to optimise recycling capacity and capability.

Moreover, E3 and E6 noted that human resource constraints lead to infrequent inspections, a lack of site supervision for waste sorting, and gaps in the implementation of waste practices. E5 emphasised that inadequate facilities severely obstruct effective waste management strategies, resulting in "increased waste disposal instead of recycling". To address this issue, E5 proposed a collaborative approach driven by Public–private partnerships (PPPs) and stressed the need for government investments to expand recycling infrastructure nationwide. Alternatively, E1 suggested the implementation of "continuous monitoring and regulatory updates to maintain sustainability standards on construction sites". E6 advocated for active onsite waste management, suggesting that "it's a big piece of work". Such measures are crucial for adopting a strategic approach to improve waste management rates, particularly in remote areas.

These points align with the literature, emphasising the significance of regional recycling hubs and advanced technologies to enhance recycling efficacy. Ferronato *et al.* (2023) outlined that increasing waste disposal is associated with limited recycling infrastructure. Additionally, Blaisi (2019) addressed the need for strategic investments and technical improvements to boost waste management capabilities. The literature further highlights the challenges associated with waste transportation, particularly in remote areas, thereby emphasising the need for efficient logistics planning and active community participation (Brown and Milke, 2016). Furthermore, Brown and Milke (2016) suggested that providing specialised training for workers managing hazardous materials is critical, advocating for the establishment of stricter regulations to ensure compliance with environmental safety standards. Collectively, these findings illuminate the urgent need for comprehensive solutions that address the intertwined concerns of infrastructure, logistics, and safety within construction waste management practices.

3.1.4 Market availability and demand. Market barriers encompass constraints that affect both the availability and demand for construction waste (Caldera *et al.*, 2020). For instance, the underdevelopment of a recycled construction materials market and the negative perceptions about reusing construction materials influence stakeholder market demand (Park and Tucker, 2017). Additionally, a notable challenge is the lack of financial incentives to engage in the circular economy, as circular building design techniques typically involve larger initial investments (Hart *et al.*, 2019). For example, the deconstruction technique which requires substantial time and labour, thereby increasing project costs and extending timelines, ultimately delaying the estimated return on investment for the building owners (Rakhshan *et al.*, 2020).

E7 noted that there is reluctance when selecting recycled materials due to performance concerns, stating, "We stick to materials that have actually shown performance for over 50 years in real-world conditions." Furthermore, E6 pointed out that "our goal is to be more of a circular economy," indicating that implementing this strategy when selecting materials improves waste diversion rates and ultimately reduces waste to landfills.

3.1.5 Culture and education. These findings highlight the need to cultivate a sustainability-oriented culture across the construction workforce; however, they also reveal a pervasive resistance to change within the construction industry, which is fundamentally entrenched in existing practices and attitudes. E7 perceived the culture as "having that understanding of what needs to be done and taking the effort to implement it on site". As E9 described the resistance to change as "perception that there is nothing that can be done apart from chucking stuff in the skip bin". E5 noted the "industry's traditional practices" as a significant barrier to cultural change. According to E10, the refusal to change traditional methods is because "they are not well-informed about their role and what they can do". Furthermore, E5 underscored the critical role of "workforce training", which equips construction site workers to identify recyclable materials and proficiently implement effective waste reduction techniques.

Yu *et al.* (2021) proposed investments in professional training and improving policies to encourage the adoption of best practices. However, Blaisi (2019) highlighted a deficit in clearly defined objectives, a lack of awareness regarding the importance of waste

management, and insufficient benefits associated with effective resource conservation and utilisation as existing challenges in managing construction waste. Nevertheless, Li *et al.* (2022) revealed that understanding the attitudes and behaviours of practitioners towards waste reduction with interpersonal factors becomes crucial in construction waste management.

3.1.6 Financial constraints. Numerous interviewees highlighted financial constraints as a barrier to effective management of construction waste. For example, E1 indicated that costs and tight budgets hinder the implementation of innovative technologies due to "real-world financial challenges faced by construction companies". "Limited budgets" was identified by E5 as a significant impediment, which "hinders investments in advanced waste management technologies". A further note by E2 highlighted that smaller enterprises face considerable difficulties in designating financial resources to improve waste management practices.

E3 revealed that "companies actively seek financial assistance from government initiatives and collaborate with waste management organisations" to navigate financial constraints and resistance to change. Additionally, E4 emphasised that the multitude of challenges faced necessitates the development of tailored "financial support mechanisms and collaborative efforts with government initiatives" and industry's partnerships to accelerate the adoption of sustainable waste practices.

The literature highlights that financial constraints pose significant challenges to implementing advanced waste management practices for construction companies (Ma *et al*., 2020). Additional research underscores the tight budgets, particularly for smaller companies, which restrict investments in sustainable technologies and workforce training. Scholars stress the importance of developing innovative financing models and affordable solutions to motivate businesses. For instance, Hart *et al*. (2019) emphasise that the industry faces resistance to change due to established traditional practices, which complicate the implementation of new waste management techniques. To overcome these challenges, strategic planning, stakeholder collaboration, and financial support are crucial to incentivise the waste management system (Al-Otaibi *et al*., 2022). Table 2 summarises the main challenges identified across the six thematic areas discussed above.

Although the six challenge domains in Table 2 are reported in both the literature and the interviews, the interviews clarify how these challenges manifest in the New Zealand building context. Interviewees emphasised constraints associated with uneven infrastructure and service coverage, which can limit diversion options outside major centres and increase reliance on disposal pathways. They also highlighted practical site conditions (for example, limited space for segregation and variable capability) that hinder consistent implementation of waste plans. In addition, interviewees stressed that waste outcomes depend strongly on early-stage planning and baseline measurement, yet these are not consistently embedded in project delivery. These New Zealand-specific manifestations indicate that implementation barriers are shaped by local service capacity, market conditions, and organisational capability, which in turn influence the feasibility of improvement efforts. Across the six domains, the findings indicate overlapping behavioural and organisational mechanisms. Behaviour-related challenges are most evident in culture and education (for example, norms, skills, and routine decision-making). Organisational and institutional challenges are most evident in governance and compliance, infrastructure and resource capacity, and market availability and demand, which shape the enabling conditions for diversion. Waste management planning is common to both dimensions because it depends on organisational systems (roles, measurement, procurement and logistics) as well as consistent behavioural adherence and coordination across stakeholders.

3.2 Integrated strategies for effective construction waste management

3.2.1 Public-private partnerships (PPPs). A pivotal strategy for improving construction waste management is promoting stakeholder collaboration and developing PPPs. E1 highlighted the need for collective efforts among industry stakeholders and government bodies, indicating that

Table 2. Summary of the challenges to construction waste management

Theme category	Challenges	Interviews	Experts	SLR	Reference(s)
Governance and compliance	Lack of standardised practices and strategic planning	✓	E1, E2	✓	Duan *et al*. (2019), Esa *et al*. (2017), Hoang *et al*. (2020), Lu *et al*. (2011), Blaisi (2019), Clark *et al*. (2006), Ossa *et al*. (2016)
	Collaboration and proactive engagement gaps among stakeholders	✓	E5, E4	✓	Blaisi (2019), Clark *et al*. (2006), Ossa *et al*. (2016)
	Waste incentives and taxes	✓	E8, E6	✓	Bao and Lu (2021)
	Lack of accountability and awareness among waste generators	✓	E1, E2, E5, E6	✓	Esa *et al*. (2017), Yu *et al*. (2013)
	Inadequate regulatory action and enforcement measures	✓	E6, E9	✓	Duan *et al*. (2019), Esa *et al*. (2017), Al-Otaibi *et al*. (2022)
Infrastructure and resources capacity	Limited infrastructure for waste sorting and processing	✓	E2, E4, E5	✓	Alshdiefat *et al*. (2025), Brown and Milke (2016), Yu *et al*. (2013), Caldera *et al*. (2020)
	Effective logistics planning and active community participation	✓	E1, E4, E8, E2, E5	✓	Brown and Milke (2016), Al-Otaibi *et al*. (2022)
	Human resource constraints	✓	E3, E6, E7	✓	Willar *et al*. (2021), Al-Otaibi *et al*. (2022)
	Technology gaps	✓	E1, E3, E7, E8, E9	✓	Ferronato *et al*. (2023), Likita *et al*. (2022), Yu *et al*. (2021), Al-Otaibi *et al*. (2022)
Financial constraints	Costs of waste management and tight budgets	✓	E1, E2, E5	✓	Ma *et al*. (2020), Hart *et al*. (2019), Al-Otaibi *et al*. (2022)
Waste management planning	Waste minimisation as a low-priority goal in the project plan	✓	E10, E6, E4, E7, E8	✓	Frempong-Jnr *et al*. (2023), Mbadugha *et al*. (2021)
	The need for a comprehensive waste categorisation and estimation management system	✓	E8	✓	Domingo and Batty (2021), Hernandez *et al*. (2023), Lam *et al*. (2019), Islam *et al*. (2019)
Culture and education	Resistance to change and training requirements	✓	E7, E9, E5, E10	✓	Kabirifar *et al*. (2021), Blaisi (2019), Rašković *et al*. (2020), Yu *et al*. (2021), Li *et al*. (2022)
Market availability and demand	Underdeveloped market for recycled or reused materials	✓	E7	✓	Caldera *et al*. (2020), Park and Tucker (2017)
	Lack of investment in circular design	✓	E9	✓	Rakhshan *et al*. (2020), Hart *et al*. (2019)

Source(s): Authors' own work

"promoting eco-friendly construction practices is not just a choice but a necessity". Shooshtarian *et al*. (2020) acknowledged that the critical role of stakeholder collaboration is fundamental in advancing sustainable construction practices. Such collaborative endeavours are essential for ensuring that industry practices are aligned with sustainability goals.

PPPs are primarily recognised for addressing infrastructure and compliance challenges. As noted by E5, "collaboration between government and private companies can lead to the expansion of recycling facilities and the development of new technologies". According to E9, "find people interested in waste and work with them to get action to get change". These partnerships are crucial for tackling the existing limitations in waste management infrastructure, as supported by other sources that advocate for targeted investments in recycling infrastructure through public-private collaborations (Blaisi, 2019). Moreover, Newaz *et al*. (2022) pointed out the importance of integrated waste management plans that rely on stakeholder collaboration to ensure regulatory compliance. Likewise, Bao and Lu (2021) demonstrated various case studies on the advantages of PPPs and community engagement initiatives on construction waste management worldwide. By joining forces, the public and private sectors can facilitate the creation of regional recycling hubs and the implementation of advanced waste processing technologies.

3.2.2 Education and awareness. The remarkable natural beauty of New Zealand requires preservation, starting with effective waste management at construction sites. The culture is shifting towards more positive attitudes, and awareness is growing about reducing waste and enhancing waste management initiatives. E1 pointed out that "collaboration is key; sharing knowledge and experiences among engineers can significantly influence the industry's overall attitude toward sustainable waste management". Several interviewees emphasised integrating sustainability into the overall construction process from design to delivery by establishing platforms for regular knowledge sharing and collaboration. Public awareness campaigns and workforce training are critical to a comprehensive, sustainable construction waste management strategy. According to E6, "from a site perspective, there is the willingness and a drive to educate the site team to start putting duty key performance indicators".

E4 advocated for the inclusion of "public participation in waste management initiatives", emphasising the community engagement through outreach programs and workshops to cultivate a culture of sustainability. The benefits of public engagement enhance awareness and encourage a shared sense of responsibility in waste management efforts (Aslam *et al*., 2020). Furthermore, such initiatives promote positive behaviour towards sustainability within communities, thereby fostering a more collaborative approach to environmental stewardship.

Additionally, E5 underscored the necessity for targeted workforce training to address challenges, such as the constraints associated with "limited space for waste segregation stations". This training is essential to equip site workers with the knowledge and skills necessary to implement waste reduction techniques effectively. Comprehensive educational and training programs are vital in bridging the divide between policy and practice, thus empowering workers to adopt sustainable practices *in situ*. Similarly, E4 highlighted the imperative for construction workers to receive education regarding the significance of sustainability, alongside training in contemporary waste management techniques, to facilitate successful implementation. The importance of such training programs is further reinforced by Rašković *et al*. (2020), pointing out the critical role in empowering workers to effectively implement sustainable practices within the construction industry.

3.2.3 Logistics and site management planning. E1 emphasised the necessity of standardised waste sorting facilities, which streamline waste management processes by establishing rigorous protocols for waste sorting at construction sites. Such measures ensure that recyclable materials are systematically processed, thereby significantly reducing the overall environmental impact of construction waste. E2 proposed creating "detailed waste management plans tailored to each project" to ensure waste reduction targets are met. E7 suggested coupling the waste management plan with a "performance bonus if a percentage of waste reduction completed on-site". As noted by E2, adherence to these stringent protocols transforms construction sites into exemplars of environmental responsibility, ensuring that material waste is preserved and prevented from landfills.

Alternatively, E5 addressed the practical challenges encountered on construction sites, emphasising the challenges posed by "limited space for waste segregation stations". Thus,

extending the necessity for effective logistics planning aimed at ensuring the timely removal of waste, thereby preventing disruptions to the construction workflow. Additionally, E4 stressed the importance of utilising "locally sourced materials" to bolster the regional economy and minimise the carbon footprint associated with transportation. E4 further proposed the incorporation of "green roofs and rainwater harvesting systems", which contribute to promoting biodiversity and water conservation within the construction paradigm. Global standards such as Leadership in Energy and Environmental Design and Building Research Establishment Environmental Assessment Method demonstrated effectiveness in guiding sustainable construction practices and provided a comprehensive framework, encouraging the adoption of eco-friendly materials, energy-efficient designs, and waste reduction strategies (Shooshtarian *et al*., 2020).

3.2.4 Technology advancements. Embracing cutting-edge technologies and promoting continuous research and innovation are essential for unlocking sustainable construction waste management. E3 proposed using "waste sorting robots" and digital tracking systems to enhance the accuracy and efficiency of waste sorting and "enable real-time monitoring of waste flows, facilitating data-driven decision-making". These advancements can contribute to effective waste management by minimising errors and maximising resource recovery rates. Furthermore, partnerships with research institutions are crucial, as E3 highlighted the necessity for the industry to remain informed about the latest waste management technology advancements. This perspective aligns with the findings of (Likita *et al*., 2022), which underscores the necessity of ongoing research and development to introduce innovative waste management solutions tailored to the unique challenges faced by the construction industry.

Similarly, E1 noted that the industry is "increasingly looking at innovative solutions, such as reusing materials onsite and exploring local recycling facilities". The potential of prefabrication methods in reducing on-site waste generation was also highlighted. E7 emphasised that the market expansion of prefabricated materials is driven by industry demand, which will "have an impact on the waste profile of the construction market". E9 further highlighted the need for "new innovative products from companies with a different perspective on waste", while E8 described it as "more environmentally friendly or waste-effective materials".

3.2.5 Financial incentives and policy frameworks. The introduction of financial incentives and certification programs is crucial for promoting the adoption of sustainable practices in construction waste management. E2 advocated for "tax benefits for companies implementing eco-friendly practices", which would serve as a significant incentive for companies exploring investment opportunities in sustainable waste management strategies. Likewise, E10 proposed "government incentives to enhance performance as penalties are already introduced". Moreover, E4 suggested the implementation of third-party certifications to standardise sustainable practice, thereby enhancing the project's market value. These certifications provide the industry with clear guidelines and a competitive advantage, driving broader industry adoption of sustainable practices. This perspective is further supported by Kolaventi *et al*. (2017), who emphasised the role of certifications in advancing waste reduction strategies and utilising environmentally friendly materials.

E3 and E9 underscored the imperative for robust policy advocacy, urging government bodies to incentivise the adoption of innovative waste management solutions. E2 proposed that financial incentives must provide tax benefits for companies engaging in environmentally sustainable practices, as well as subsidies for the utilisation of sustainable materials. The endorsement of policy support is deemed essential for successfully implementing these initiatives. E3 emphasised the need for government intervention, stating that "governments should incentivise the adoption of innovative waste management solutions through supportive regulations and financial incentives". Effective policy frameworks have the potential to mandate waste management practices and facilitate the adoption of sustainable practices across the industry.

This strategic perspective aligns with relevant literature that discusses the significance of financial incentives and regulatory enforcement in achieving compliance with waste

management practices (Jain *et al*., 2020; Shooshtarian *et al*., 2020). The literature highlights the challenges associated with illegal dumping and underscores the need for monitored enforcement measures. This perspective is supported by interviewees who emphasise the importance of transparency and standardised procurement processes in addressing these issues collaboratively. Additionally, the significance of governmental involvement lies in the implementation of effective subsidy policies and structured landfill fees (Cheng *et al*., 2022; Wang *et al*., 2019).

4. Conceptual framework and discussion

Figure 2 presents a conceptual framework for advancing sustainable construction waste management in New Zealand by linking the six challenge domains identified in Section 3.1 with the five strategy themes synthesised in Section 3.2. In this study, integrated strategies refer to the coordinated implementation of multiple strategy types, recognising that construction waste management barriers are interdependent. Accordingly, a single strategy theme can influence more than one challenge (for example, policy and incentives shaping compliance, market demand, and investment decisions), while any single challenge typically requires aligned responses across several strategy themes (for example, planning improvements depending on capability, logistics arrangements, and measurement practices).

Across the six domains, the challenges reflect overlapping behavioural and organisational mechanisms. Behaviour-related challenges are most evident in culture and education (for example, norms, skills, and routine decision-making), while organisational and institutional challenges are most evident in governance and compliance, infrastructure and resource capacity, and market availability and demand. Waste management planning is common to both behavioural and organisational dimensions because it depends on organisational systems (roles, measurement, procurement, and logistics) as well as consistent behavioural adherence and coordination across stakeholders. In this sense, integration in this study refers to combining organisational levers (for example, policy and incentives, PPPs, logistics planning, and technology adoption) with behavioural levers (education and capability-building). This combination is necessary to address barriers that co-occur in practice. This framing moves beyond listing barriers and responses by explaining why isolated interventions often produce limited change in practice, and why coordinated action is needed to translate waste objectives into consistent implementation outcomes. For clarity and readability, Figure 2 presents the challenge and strategy domains without drawing all cross-links between them, while the many-to-many logic is articulated in the accompanying discussion.

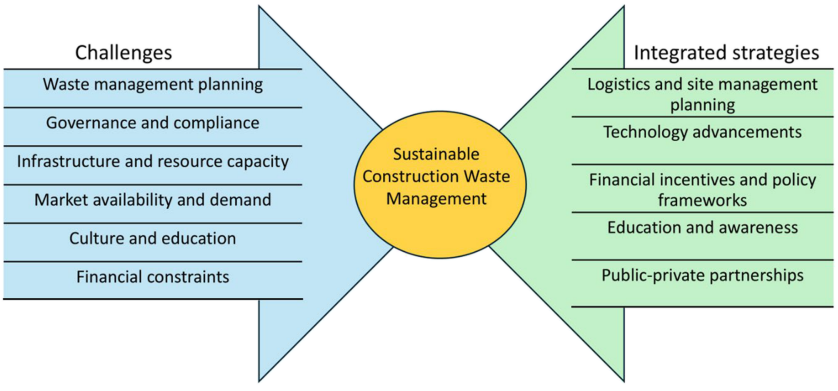

Figure 2. Integrated challenge–strategy framework for advancing sustainable construction waste management in New Zealand. Source: Authors' own work

In the New Zealand building sector, the interview evidence indicates that these domains operate as a coupled system in which project-level intentions are highly sensitive to enabling conditions beyond the site boundary. In particular, governance expectations, downstream capacity, and market demand jointly shape whether waste objectives become routine practice or remain aspirational. Although some of these constraints have been reported previously, this study contributes by triangulating systematic review evidence with expert accounts to identify the most binding constraints and explain how they interact across domains, thereby justifying why integrated strategy packages are required rather than isolated interventions. Consistent with prior research, effective policy mixes rely on cooperation and enforcement, supported by capability-building and implementation mechanisms (Li *et al*., 2024), and system-wide integration remains necessary to maximise benefits from smart waste technologies and related innovations (Cheah *et al*., 2022).

The framework supports actionable implementation by showing how project-level practices depend on system conditions such as service availability, logistics feasibility, and end-market certainty. For example, although waste sorting may be constrained by limited onsite space, it can be enhanced through advanced technologies such as waste sorting robots, improving efficiency and accuracy (Satav *et al*., 2023). However, interviewees emphasised that the effectiveness of such technological measures in New Zealand is contingent on whether regional recovery services and end-markets are sufficiently available to absorb and valorise the sorted material streams.

Moreover, recent research in New Zealand shows that a waste processing facility is vital in managing construction waste, with a diversion rate of up to 75% (Tong *et al*., 2025). The findings highlighted the importance of educational programs and community engagement in fostering collective work and shared responsibility for waste management in the building industry. Investments in research and development are fundamental, particularly in advanced waste technologies, contributing to enhancing waste management capacity and capability. Collaborative research has led to innovative solutions, such as environmentally accredited construction materials and prefabrication, which enable sustainable practices and support a circular economy (McCormick *et al*., 2016). These innovations contribute to resource preservation and position the construction sector for a future where sustainability becomes a culture, making waste management an opportunity for innovation.

Several challenges identified in this study are consistent with those reported in other developed contexts, including fragmented responsibilities, contamination and quality-control issues, and the need for early-stage planning and capability-building. New Zealand experiences distinct contextual challenges in waste management compared to many peer jurisdictions, primarily due to the state of the regulatory environment, market dynamics, and geographical context. New Zealand's regulatory and economic settings can provide weaker diversion signals than in some peer jurisdictions, with a lower landfill tax compared to Australia, the US, and the UK, which limits financial incentives to divert waste from landfills (Roy and Tarafdar, 2022; Shooshtarian *et al*., 2024). Additionally, the market for construction materials is dominated by imports with limited local production, leading to economic challenges for recycling (Bui *et al*., 2023). Furthermore, New Zealand's elongated geography and dispersed settlement pattern hinder the efficiency and practicality of centralised waste management facilities. In contrast, countries with dense populations and robust infrastructure, like the UK, can support more effective waste processing systems (Ng and Yang, 2023).

Rather than presenting these contextual factors as entirely novel, this study contributes by explaining how they combine to amplify transaction costs and uncertainty for project teams in New Zealand, thereby strengthening the case for coordinated policy, market-formation, infrastructure, and capability measures. This helps clarify why transferability from other developed countries is constrained. In higher-density settings with mature recovery infrastructure and deeper secondary markets, diversion pathways are often more reliable and can be delivered at lower unit cost, which reduces commercial risk and supports routine implementation. By contrast, New Zealand's dispersed geography, uneven regional service

coverage, and smaller market depth increase transaction costs and reduce certainty of off-take, meaning that effective strategies often need to be bundled (for example, pairing incentives and procurement requirements with infrastructure planning, education, and site logistics measures) to achieve consistent outcomes.

These findings contribute to achieving the United Nations Sustainable Development Goals (SDGs) by clarifying how specific strategy packages translate into environmental, social, and economic outcomes. In relation to SDG 11 (Sustainable Cities and Communities), improved governance, education, and logistics planning can reduce illegal dumping and nuisance impacts, improve service consistency across regions, and support cleaner, safer urban environments through more reliable collection and recovery pathways. For SDG 13 (Climate Action), increased diversion from landfill and improved material efficiency reduce emissions associated with disposal and virgin-material production, while coordinated planning and procurement can support lower-carbon construction practices. The identified market and policy measures (for example, demand signalling, procurement specifications, and incentives) support SDG 12 (Responsible Consumption and Production) by enabling reuse and recycling pathways, improving material circularity, and strengthening end-markets for recovered materials. Finally, the emphasis on technology adoption and infrastructure investment supports SDG 9 (Industry, Innovation and Infrastructure) by promoting innovation in sorting and tracking, strengthening recovery infrastructure, and enhancing industry capability for data-driven waste performance management.

5. Conclusion

This study adopted a life-cycle perspective across design, construction, and demolition to examine construction waste management in New Zealand by integrating an SLR and expert interviews, identifying key challenge domains and synthesising practical strategy themes into an integrated challenge–strategy framework. The framework indicates that these barriers are interdependent and cannot be effectively addressed through isolated measures. The key challenges spanned waste management planning, governance and compliance, infrastructure and resource capacity, market availability and demand, culture and education, and financial constraints. The study concludes that improving waste diversion performance in New Zealand requires integrated strategy packages rather than isolated interventions, combining PPPs and cross-stakeholder collaboration, policy and financial instruments, logistics and site planning improvements, technology-enabled solutions, and education and capability-building, supported by targeted innovation and research investment. Collectively, these strategy packages can strengthen waste governance and accelerate the transition towards a sustainability-oriented construction culture in New Zealand.

The findings of this study have both theoretical and practical implications. Theoretically, the proposed framework advances research on construction waste management and circular-economy implementation by integrating stakeholder collaboration, financial and policy instruments, and technological innovation within a single explanatory lens. It does so by mapping environmental (diversion and reduced impacts), economic (cost efficiency and value recovery), and social (capability, shared responsibility, and safer practices) outcomes to the organisational and behavioural conditions that determine implementation effectiveness. This integration strengthens understanding among scholars by clarifying how these drivers interact to shape implementation outcomes, rather than treating them as independent determinants. In particular, it highlights the behavioural and organisational mechanisms through which sustainability-oriented culture and stakeholder collaboration condition whether policy and financial instruments translate into consistent waste-minimising actions, and it specifies how technology-enabled solutions depend on supportive governance and organisational readiness to deliver measurable outcomes in contexts such as New Zealand's evolving regulatory environment. Practically, the framework provides actionable guidance for policymakers, industry practitioners, and educators by identifying leverage points to strengthen waste

governance, target investments in innovation, and cultivate a sustainability-oriented culture across the construction sector, supported by education, incentives, and technology adoption to achieve measurable waste reduction.

This research has several limitations. The scope was restricted to building construction waste and to publications in English retrieved from Scopus and Google Scholar, which may have excluded other relevant studies. As the study relied on qualitative methods, there remains a possibility of researcher subjectivity in data interpretation. Furthermore, the findings are specific to the New Zealand context and may not be directly transferable to regions with differing regulatory or industrial settings.

Future studies could extend the conceptual framework developed in this paper by exploring the role of emerging digital and artificial intelligence tools in automated waste sorting and materials tracking. Comparative analyses of international policy frameworks, such as landfill levies, circular economy incentives, and digital reporting systems, could also provide insight into best practices. Additionally, experimental case studies and pilot projects could be conducted to test integrated waste management strategies and to assess their scalability in the New Zealand context.

Disclosure of interests

The authors declare that some members of the author team are also part of the guest editorial team for this special issue. However, all efforts have been made to ensure an objective and unbiased review process.

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