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The state of circular economy implementation in the building and construction sector in Aotearoa New Zealand

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ABSTRACT

The building and construction sector places immense pressure on the environment, contributing significantly to resource extraction, global greenhouse gas emissions, and the loss of ecosystems and biodiversity. In this context, the B&C sector can both contribute to, and benefit from, a global shift towards a circular economy (CE), moving away from unsustainable linear consumption patterns that degrade vital ecosystem services. However, little is known about the extent to which B&C businesses implement circular strategies in many countries. This study aimed to assess the current level of implementation of circular strategies among businesses within Aotearoa New Zealand's B&C sector. An exploratory sequential mixed-methods research design was utilised. Experts from seven business types (manufacturing, architecture and engineering, construction, design-build, fit-out, demolition, and waste management companies) were interviewed to explore the relevance and uptake of circular strategies from the literature. This informed a survey distributed to professionals across the seven business types. Most circular strategies were considered relevant by interviewees and were subsequently included in the survey. Interviewees suggested that CE implementation is currently insufficient, inconsistent, uncoordinated, and limited to a narrow focus on recycling. According to survey responses from 213 professionals, most businesses are at a 'beginner' stage of maturity regarding CE implementation, and most circular strategies receive minimal to moderate levels of implementation. In particular, service-based models, sharing platforms, material passports, remanufacturing, take-back schemes, organic recycling, and regenerating nature require greater attention. These findings suggest that CE implementation in Aotearoa New Zealand's B&C sector is still nascent, with significant potential to increase engagement in circular strategies. Findings also underscore the necessity for greater education, a stronger emphasis on the design phase, and a systemic, collaborative approach to accelerate the transition towards a CE.

1. Introduction

Since the beginning of industrialisation, the global economic model has primarily adhered to a linear 'take-make-dispose' pattern of production and consumption, causing unnecessary resource exploitation, high and volatile commodity prices, diminished natural capital, and degradation of vital ecosystem services (EMF, 2013). Under this linear approach, the building and construction (B&C) sector is responsible for about 40 % of GHG emissions, 25 % of land system change, 20 % of nitrogen emissions, over 50 % of aerosol loading, and 30 % of energy consumption, material consumption, and waste generation (Circle Economy, 2023, 2024). Consequently, the global B&C sector is a primary driver of climate change, ocean acidification, water stress, altered hydrology, habitat destruction, and biodiversity loss. In Aotearoa New Zealand, the B&C sector accounts for 20 % of carbon emissions (MBIE, 2020), and construction and demolition (C&D) waste represents 69.4 % of all waste disposed of at levied facilities, excluding cleanfill (Beca Limited, 2025). Like in many countries around the world, New Zealand's rapid urbanisation and demand for infrastructure exacerbate environmental challenges (Purchase et al., 2022).

The significant environmental externalities associated with the B&C sector highlight its pivotal role in promoting cleaner production, addressing climate change, and reversing the overshoot of planetary boundaries (Circle Economy, 2023; Norouzi et al., 2021). Globally, the circular economy (CE) concept has garnered considerable attention among industries, policymakers, and academia as a promising alternative to the linear model and a pathway to sustainable development (Geissdoerfer et al., 2017; Ghisellini et al., 2016). The concept

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encompasses various related theories, principles, and definitions (Kirchherr et al., 2017; Blomsma and Brennan, 2017). However, a CE can be succinctly defined as an "economic system that uses a systemic approach to maintain a circular flow of resources by recovering, retaining or adding to their value while contributing to sustainable development" (ISO, 2023b). 'Circular flow of resources' involves eliminating waste by continuously cycling resources in biological or technical cycles, aligning with 'cradle-to-cradle' thinking (McDonough and Braungart, 2002). A CE in the built environment requires significantly reducing resource consumption, regenerating nature, optimising material and product lifespans, and eliminating waste through design for disassembly, reuse, and recycling (World Green Building Council, 2023).

Shifting to a CE presents a significant challenge, with a considerable gap between CE theory and practice, particularly at the micro level (i.e., individual businesses, products, and consumers) (Barreiro-Gen and Lozano, 2020). This disconnect is also evident, given the decline of global circularity, which dropped from 9.1 % in 2018 to 7.2 % in 2023, with escalating rates of virgin material extraction, fossil fuel combustion, and the accumulation of in-use stocks (Circle Economy, 2023). In New Zealand, progress towards a CE is occurring at a slow pace, with much of the focus in the B&C sector still on end-of-life solutions (Sustainable Business Network, 2021). Additionally, the literature on the intersection between CE and the B&C sector in New Zealand is relatively sparse (e.g., Berry et al., 2022; Finch et al., 2021; Low et al., 2020; Purchase et al., 2022). Although these studies investigate a range of relevant issues, no research explores the state of CE implementation across the B&C sector in New Zealand. Moreover, New Zealand's small, geographically isolated market with high C&D waste rates offers a valuable context, providing insights to inform CE transition pathways at both regional and national scales in similarly constrained or high-waste economies.

To address this gap, this study aims to assess the current level of implementation of the CE concept among businesses in the B&C sector, drawing on data collected in New Zealand. It reveals expert perceptions of CE implementation and professionals' perceptions regarding the maturity of CE implementation in their respective businesses, including manufacturing, architecture and engineering, construction, design-build, fit-out, demolition, and waste management companies. It provides insight into the extent to which key circular strategies are adopted and which require greater attention to accelerate the shift towards a circular sector. Section 2 discusses existing literature on the state of CE implementation and circular strategies. Section 3 then outlines the methodology. Next, Sections 4 and 5 describe and discuss the interview and survey results. Finally, Section 6 draws conclusions and suggests future research directions.

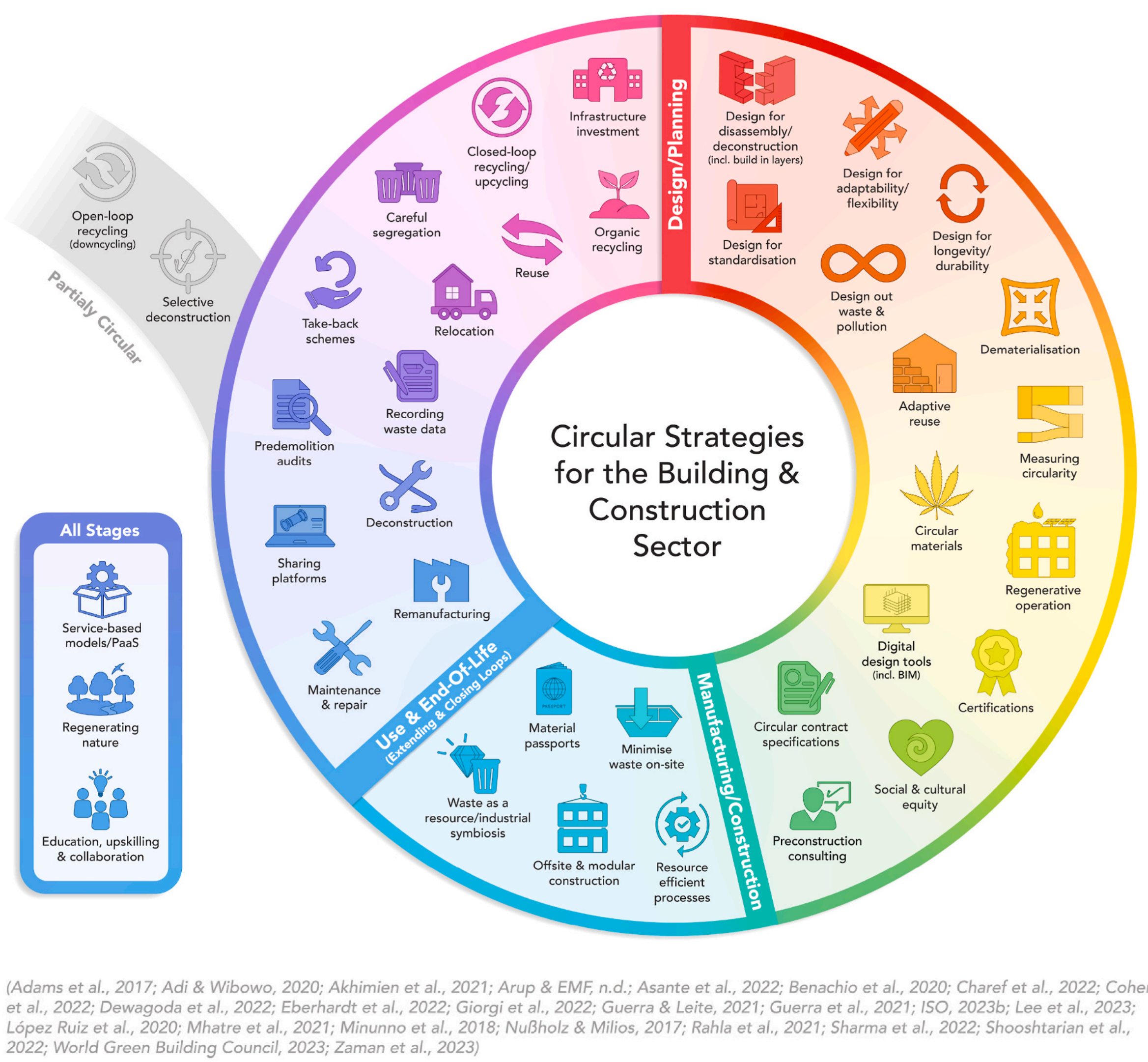

Fig. 1. Circular strategies for the Building and construction sector, showing key approaches that support A circular economy (Dewagoda et al., 2022; Minunno et al., 2018; Nußholz and Milios, 2017; Arup and Ellen MacArthur Foundation).

2. Literature review

2.1. Circular strategies

Numerous circular strategies for the B&C sector have been identified in the literature. For example, Charef et al. (2022) identified over 100 strategies. Authors often categorise circular strategies into the life cycle stages of a product or building (e.g., Adams et al., 2017; Benachio et al., 2020; López Ruiz et al., 2020). Fig. 1 illustrates frequently cited circular strategies across the lifecycle stages. Similar strategies are combined; for example, strategies relating to rating tools or life cycle assessment are combined under 'measuring circularity'.

It is worth noting that circular strategies do not always equally contribute to core CE principles or actions, particularly the regeneration of natural systems (ISO, 2023b; Zaman et al., 2023). Analysing the environmental performance of buildings is challenging due to variations in material composition and building design (Eberhardt et al., 2022). Çimen (2021) recommends a dynamic approach that embraces adaptive solutions and prioritises circular strategies according to the specific situation. The waste hierarchy and 'R-imperatives', such as the '9Rs' (i.e. refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recover (Potting et al., 2017)), can help identify the actions that should be prioritised (Çimen, 2021; Rahla et al., 2021).

2.2. CE implementation internationally

The adoption of circular strategies in the B&C sector tends to be unsatisfactory, fragmented, uncoordinated, and unbalanced, with a tendency to focus on easy wins such as downcycling and overlook more effective strategies and the crucial design stage (Benachio et al., 2020; Eberhardt et al., 2022; Giorgi et al., 2022). CE implementation is hindered by numerous challenges in the B&C sector, as exemplified by Bilal et al. (2020), who identified 79 barriers, most notably an absence of environmental regulations and laws. A global scan of CE adoption in the B&C sector revealed that while companies are beginning to adopt circular principles, early adopters must pursue unexplored opportunities, particularly in regions where CE is just gaining momentum (Guerra et al., 2021).

Several other scholars have surveyed professionals in the B&C sector in specific geographic contexts, revealing low to moderate levels of implementation of circular principles and strategies in Argentina (Cohen et al., 2022), the United States (Guerra and Leite, 2021), Taiwan (Lee et al., 2023), Indonesia (Adi and Wibowo, 2020), Ghana (Asante et al., 2022; Amudjie et al., 2022), Sri Lanka (Wijewansha et al., 2021), and across 16 developing countries (Bilal et al., 2020). Further studies have indicated that CE implementation and addressing C&D waste are challenging or at the early stages, including in India (Sharma et al., 2022), Malaysia (Esa et al., 2017), Santiago de Cali (Maury-Ramírez et al., 2022), Denmark and Sweden (Buser et al., 2021), Serbia (Petrovic et al., 2022), and Australia (Shooshtarian et al., 2022). Taken together, these findings further indicate that barriers to circularity are not confined to particular regions or levels of economic development, but are widely experienced. However, no research has been conducted that specifically explores the state of CE implementation in B&C businesses in New Zealand. As such, this research provides a novel contribution by enabling a better understanding of the state of CE implementation in New Zealand and informing discussion about possible policies and programmes to advance this.

3. Research methods

This study employed an exploratory sequential mixed-methods research design (Creswell and Creswell, 2018). First, 38 circular strategies identified from the literature (as summarised in Fig. 1) were examined to determine which business types within the B&C sector they are relevant to. Semi-structured interviews of experts were then conducted to gather qualitative data, which determined the circular strategies included in an online survey of a broad cross-section of professionals from across New Zealand's B&C sector to gain an understanding of the extent to which circular strategies are currently understood and implemented in the B&C sector more broadly.

3.1. Research ethics

This research was undertaken in accordance with Massey University's *Code of Ethical Conduct for Research Involving Human Participants*. Before commencing the data collection, a low-risk ethics application was submitted and approved. All participants were provided with information about the study and their rights as participants in the study, and informed consent was obtained from each interviewee and survey respondent. Participants' confidentiality was ensured through anonymised reporting of interviewees and a survey design that did not collect information that could directly identify a business or individual. All interview transcripts and survey data were stored securely.

3.2. Sampling procedures

There are more than 70,000 registered construction businesses in New Zealand, accounting for 12.6 % of all businesses (MBIE, 2022). Seven relevant business types were identified: manufacturing, architecture and engineering, construction, design-build, fit-out, demolition (including deconstruction), and waste management companies. For the interviews, purposive sampling was employed to identify the most relevant subjects (Denscombe, 2021; Sarantakos, 2013). Seven industry experts with CE knowledge and expertise in their field were selected, which led to the referral and selection of two more experts as a form of snowball sampling (Denscombe, 2021; De Vaus, 2014). In total, two experts were from manufacturing companies, two from architecture and engineering companies, and one from each of the other business types.

For the survey, businesses were identified through a non-probability purposive sampling strategy, a deliberate selection method commonly used when probability-based approaches are impracticable due to the absence of a sampling frame (De Vaus, 2014). Major players were prioritised, as they are more likely to contribute substantially to material consumption, waste generation, and environmental impact. Purposive sampling has also been adopted in similar research (e.g., Amudjie et al., 2022; Lee et al., 2023). As non-probability samples cannot be calculated precisely, the objective was simply to collect enough responses to enable meaningful analysis (May, 2011). Businesses were drawn from the residential, non-residential, and heavy and civil engineering sub-sectors, and invitations were directed to sustainability and environmental professionals or, where unavailable, to directors, general managers, or operational managers.

3.3. Data collection

Nine 30-min semi-structured interviews were undertaken, eight online and one in person. A PowerPoint slide was used to present circular strategies, and interviewees were asked which strategies were relevant, whether any should be excluded, and whether any were missing. Interviewees were then asked to describe CE implementation among their business types in New Zealand to gain insights into experts' perceptions of the current state of CE implementation.

The online survey was developed using Qualtrics. Participants were asked which sub-sectors their businesses contribute to, their business age and size, and how they would describe the maturity of CE implementation in their business, based on the categories of CE maturity in ISO 59010 (i.e., novice, beginner, established player, well-engaged, and mature) (ISO, 2023a). They were asked which of the seven business types best described their business, which determined the circular strategies shown in the next question. Participants were then asked the extent to which their business implemented circular strategies, using a

5-point Likert scale of 0–4 (not at all to completely/always) and the categories 'not applicable' and 'unsure'. Short descriptions of each strategy were provided to avoid confusion or assumptions (for the full survey, please see Supplementary Material). The survey was pilot-tested before the final administration, and minor improvements were made before being distributed to 1115 professionals via personal and general enquiry emails and LinkedIn messages. It was open for three weeks, and follow-up emails were sent after ten days. The survey received 239 responses, of which 213 were complete and included in the analysis, obtaining a response rate of 19 %.

3.4. Data analysis

The interview recordings were transcribed with voice-to-text transcription software and then reviewed to correct any errors. Circular strategies from the literature were used as themes to guide data analysis and subsequently inform which strategies to include in the survey. Data from the interview question regarding CE implementation was manually organised into themes through open coding. The survey data was analysed using Qualtrics and Microsoft Excel. Descriptive analysis included calculating means and standard deviation. Due to the non-probability sampling method, inferential statistics were not used to make inferences about the wider population or draw conclusive generalisations about the sector as a whole. However, the broad cross-section of survey participants, including businesses from all seven sub-sectors, provides valuable insight into CE implementation. In this context, chi-squared tests of independence were calculated to determine any associations between business age, size, and sub-sector with the maturity of CE implementation and implementation of circular strategies. Although this study focuses specifically on the B&C sector in New Zealand, the analysis of the survey findings in the context of international literature contributes to the broader discussion about the implementation of CE concepts and strategies beyond New Zealand.

4. Results

4.1. Interview results

4.1.1. Relevant circular strategies

Interviewees broadly affirmed the relevance of the circular strategies presented, though their responses highlighted varying emphasis and interdependence among them. Education, upskilling, and collaboration were consistently identified as the essential foundation upon which other strategies depend. As one interviewee noted, "Without education, you really have no leg to stand on. People aren't going to get on board". This view reflected a shared perception that strengthening capability and collaboration are essential for advancing circular practices. Beyond these enablers, interviewees highlighted several strategies as particularly valuable for driving transformation, including adaptive reuse, dematerialisation, circular materials, design for disassembly/deconstruction, take-back schemes, minimising waste on-site, offsite and modular construction, deconstruction, service-based models, and regenerating nature. Interviewees also emphasised the importance of keeping materials at their highest value by adhering to the waste hierarchy. The design stage, in particular, was viewed as a pivotal intervention point, captured by one interviewee's analogy of "an overflowing bath", where "if you turn off the tap in the design stage, you don't have quite as many problems at the end-of-life stage". A small number of strategies were excluded from the survey based on interviewee feedback. Most notably, designing out waste and pollution and designing for longevity were excluded for all business types, as their broad, overarching nature meant they were already captured through other strategies.

4.1.2. Expert perceptions of CE implementation

Several interviewees argued that CE implementation in New Zealand's B&C sector is poor and unsatisfactory. Many characterised current efforts as "really behind", "still very new", or "almost non-existent", noting that circular practices have yet to gain meaningful traction. One interviewee questioned New Zealand's environmental reputation, remarking, "We're a 'clean, green country', yet we just bury construction waste constantly". An expert in demolition and deconstruction observed minimal uptake of circular methods, noting that only a single company in New Zealand consistently undertakes complete manual deconstruction. Similarly, manufacturing experts described take-back schemes as immature and largely absent, attributing this in part to products' limited disassembly capacity. Across sub-sectors, interviewees highlight multiple systemic constraints, including limited nature regeneration, a lack of non-financial metrics, low client ambition, inadequate onsite segregation and waste-stream solutions, insufficient time and capital investment, and siloed capital and operational budgets.

Interviewees also reported that CE implementation is inconsistent and varied. For example, an interviewee noted that CE implementation overall is "really patchy". Similarly, an interviewee from a design-build company argued that it ranges across "a really big spectrum", from first movers with contractual obligations to divert waste to laggards who lack basic site waste management controls, such as fences and skip bins. Similarly, an interviewee from a waste management company described CE implementation as "a complete mixed bag". Some businesses prioritise sustainability, some focus exclusively on financial outcomes, and others, between these extremes, are willing to explore alternative options if they are cost-effective.

Several interviewees indicated that where advancements towards a CE occur, they are confined within isolated pockets, requiring systems thinking and collaboration. For example, one interviewee stressed the importance of systems thinking in overcoming siloed thinking. They also explained that it is difficult for individual organisations to shift when the broader system remains unchanged, including financial structures and the building code. Thus, a need arises for "coordination of the system to shift", which can be facilitated by introducing transition broker roles. Interviewees also identified several barriers hindering a systemic CE shift, including transport costs associated with New Zealand's unique geography and the lack of economies of scale outside city centres.

Four interviewees used the metaphor of an 'ambulance at the bottom of the cliff' to highlight the reliance on ineffective, low-value solutions at the end-of-life due to poor implementation of circular strategies during the design and planning stages. For instance, an interviewee from a manufacturing company noted that "design for disassembly and deconstruction is generally extremely poorly considered". At the end-of-life phase, interviewees from demolition and waste management companies agreed that there is an overfocus on recycling, notably open-loop recycling/downcycling, with insufficient emphasis on deconstruction and reuse. Moreover, the interviewee from a waste management company noted that stakeholders are satisfied with such outcomes, despite not necessarily being circular: "The majority of the B&C sector goes, is this material being sent to landfill? No. Is it being recycled? Yes, okay, great. I've done my job. Whereas if we're promoting a true circular economy, that is not the pathway to success".

Another theme that arose from interviews was greenwashing. An interviewee from a manufacturing company believed that poor CE implementation is "disguised in a little bit of greenwashing" as their messaging is not "landing as it should", despite businesses beginning to display positive steps towards sustainability. An interviewee from a waste management company also described deliberate "smoke and mirrors", while an interviewee from an architecture and engineering company noted that measuring circularity and certifications is increasingly important due to greenwashing and misleading claims.

Several interviewees mentioned a need for more education and accessible information to build awareness and knowledge to support informed decision-making. One interviewee noted the urgency of this need, stating, "There's a huge knowledge gap in that space, and we need to get a lot better very fast". Two interviewees also discussed a lack of awareness regarding recycling and take-back options available. On the other hand, most interviewees also identified increasing awareness and interest in the CE concept, C&D waste reduction, or sustainability initiatives. For example, one interviewee described sustainability as "the cool thing to do", and another noted "a general raising of awareness" for C&D waste, suggesting that CE is increasingly seen as "the next step". Another interviewee has already observed "some appetite in some of those leading-edge thinkers" towards a CE. Interviewees also acknowledged increasing interest in specific circular strategies, such as circular materials, offsite and modular construction, and BIM-aided design.

4.2. *Survey results*

4.2.1. *Profile of businesses*

Most respondents were from architecture and engineering (33 %), construction (26 %), and manufacturing companies (23 %), with smaller numbers from design-build, demolition, fit-out, and waste management companies (see Fig. 2). Their businesses operate primarily within residential (73 %) and non-residential construction subsectors (64 %), as opposed to heavy and civil engineering construction (28 %). Overall, 12 % of businesses were 0–5 years old, 15 % were 6–10 years old, 23 % were 11–20 years old, 37 % were 21–50 years old, and 15 % were 51+ years old. Most businesses were small (<20 employees, 44 %) or medium-sized (20–100 employees, 38 %).

4.2.2. *Professionals' perceptions of CE maturity*

Of the responses, 40 % considered their business to be at a beginner level of CE implementation, 25 % characterised their business as novice, and 21 % as established players. Only 10 % of respondents characterised their business as well-engaged, and 4 % as mature. When quantified on a scale of one to five, the average score across all respondents was 2.6 ($SD = 1.1$), positioning businesses between the beginner and established player stages of CE maturity. Respondents from demolition and waste management companies had the highest perception of CE maturity in their business, with averages of 3.6 and 3.4, respectively, positioning their businesses among the established player and well-engaged categories. The other business types aligned more closely with the beginner category, with the average perception of maturity for other business types, ranging between 2.0 and 2.5 (manufacturing ($M = 2.5$, $SD = 1.1$), design-build ($M = 2.3$, $SD = 1.3$), fit-outs ($M = 2.1$, $SD = 1.2$), construction ($M = 2.1$, $SD = 1.0$), and architecture/engineering ($M = 2.0$, $SD = 0.9$)).

4.2.3. *The implementation of circular strategies*

As shown in the Appendix, businesses implement circular strategies at a moderate level of 1.9 out of 4 on average ($SD = 0.5$). Respondents from demolition and waste management companies rated the implementation of circular strategies higher than other types of businesses, with averages of 2.8 and 2.2, respectively (i.e. between 'Moderately/Sometimes' and 'Significantly/Frequently'). The averages for other business types ranged between 1.4 and 1.8 (i.e. between 'Minimally/Rarely' and 'Moderately/Sometimes'). The average score is 1.7 out of 4 when excluding demolition and waste management companies. The highest-ranking strategies and the only strategies averaging between 3.0 and 4.0 (i.e. Significantly/Frequently and Completely/Always) were pre-demolition audits ($M = 3.5$, $SD = 0.0$), selective deconstruction ($M = 3.5$, $SD = 0.0$), and careful segregation ($M = 3.1$, $SD = 0.7$). In contrast, the lowest-ranking strategy is service-based models ($M = 0.5$, $SD = 0.1$), with a score between no to minimal levels of implementation. Other low-ranking strategies include sharing platforms ($M = 1.0$, $SD = 0.8$), material passports ($M = 1.0$, $SD = 0.3$), remanufacturing ($M = 1.2$, $SD = 0.0$), take-back schemes ($M = 1.3$, $SD = 0.0$), organic recycling ($M = 1.3$, $SD = 0.4$), and regenerating nature ($M = 1.3$, $SD = 0.3$).

Chi-squared tests of independence were performed to evaluate the relationship between the perceived maturity of CE implementation and sub-sector, business age, or business size. No significant associations were found between these variables ($\alpha = 0.05$). Chi-squared tests of independence were also conducted to evaluate the relationship between the implementation of circular strategies and sub-sectors, business age, and business size. The results showed that there is generally no

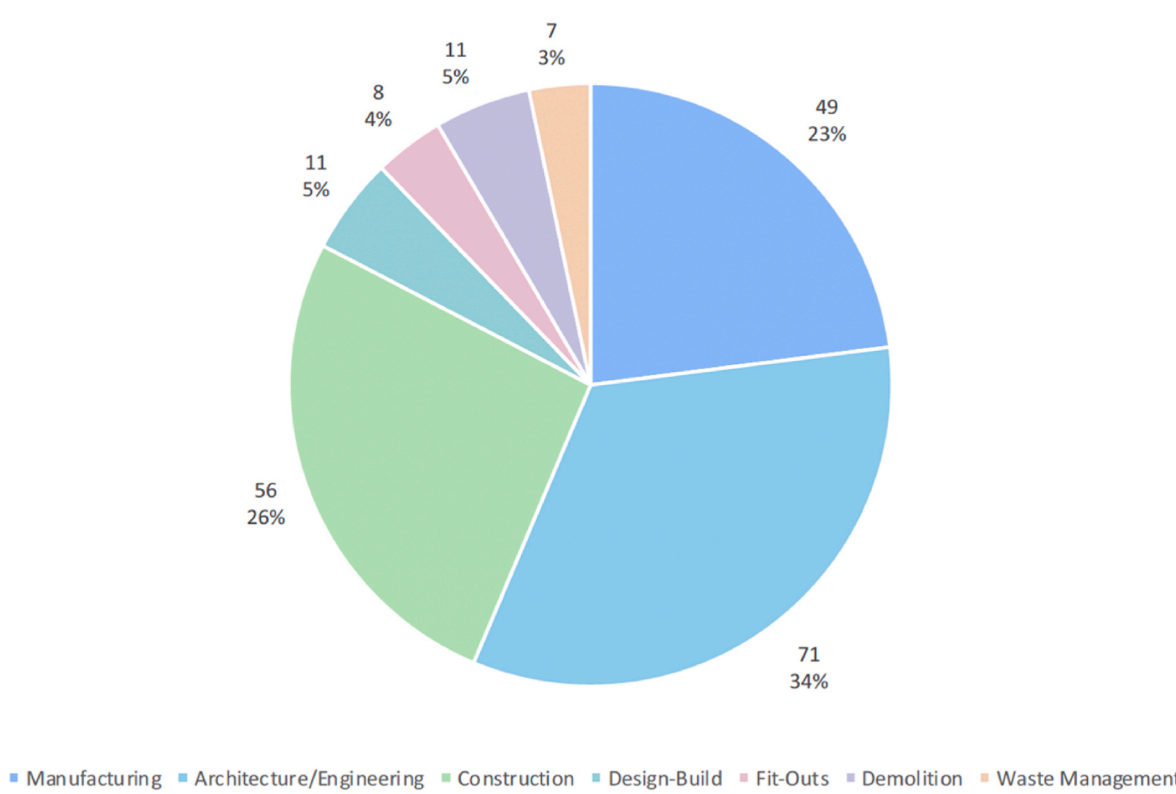

Fig. 2. The number of survey respondents from each business type.

association between these factors. However, a limited number of significant relationships between these variables were found, generally revealing a slightly higher level of implementation among larger and newer businesses.

5. Discussion

5.1. Perceptions of CE implementation

Interviewees indicated that CE implementation in New Zealand's B&C sector is immature, insufficient, inconsistent, and under-prioritised, with instances of greenwashing and siloed thinking. CE efforts are seen as an ‘ambulance at the bottom of the cliff’, focusing mainly on the end-of-life stage with ineffective solutions like downcycling and neglecting the design and planning phases, deconstruction, and material reuse. The reported lack of construction waste stream solutions and the continual landfilling of C&D waste highlight the widespread use of linear materials incompatible with a CE and New Zealand's ‘clean, green’ image. This aligns with observations of the prevailing construction approach, which demonstrates poor CE performance despite New Zealand's emphasis on its natural environment (Finch et al., 2021). Rather than the systemic adoption of CE principles and designing out waste, the emphasis remains on waste diversion and recycling (Sustainable Business Network, 2021), reinforcing a narrow interpretation of CE.

While New Zealand may be falling behind international best practices, global CE implementation in the B&C sector is generally in its infancy (Akhimien et al., 2021). Adoption of circular strategies and principles tends to be fragmented, limited, and sparse (Eberhardt et al., 2022; Giorgi et al., 2022; Guerra et al., 2021). Recycling is the most common strategy in the EU (Mhatre et al., 2021) and globally (Morseletto, 2020), while greater focus on the design phase is needed (Asante et al., 2022; Bilal et al., 2020; Wijewansha et al., 2021). The strong focus on the end-of-life stage and recycling may stem from its perception as 'low-hanging fruit' (Guerra and Leite, 2021), extensive literature coverage (Akhimien et al., 2021; Norouzi et al., 2021), misinterpretation of the CE concept (Kirchherr et al., 2017), and policies that unintentionally encourage downcycling instead of higher-priority practices (Adams et al., 2017; Giorgi et al., 2022). This global tendency underscores the risks evident in New Zealand, as without a deliberate pivot from end-of-pipe recycling towards transformative upstream interventions, both policy and practice are likely to entrench a weak form of circularity that offers only marginal environmental gains.

Interview findings also indicate a lack of education and readily available information. This aligns with the findings of others studies that documented a lack of education, knowledge, and training within the B&C sector internationally (Adams et al., 2017; Charef et al., 2021; Eberhardt et al., 2022) and in New Zealand (Berry et al., 2022; Low et al., 2020; Purchase et al., 2022). This is exacerbated by fragmented supply chains, a siloed approach, and a lack of collaboration (Adams et al., 2017; Guerra et al., 2021; Wuni, 2022), suggesting that knowledge gaps are not simply individual but systemic in nature.

However, interviewees noted an increasing awareness and interest among leading-edge thinkers, alongside the emergence of specific strategies such as circular materials, off-site construction, and BIM, indicating growing momentum. The *Building and Construction Sector Trends: Annual Report 2022* supports this, referencing emerging trends such as waste-based construction materials, prefabrication, technologies including digital twins and BIM, and retrofitting (MBIE, 2022). In addition, the early adoption of circular principles globally (Guerra et al., 2021) suggests that the sector is at an inflexion point in transitioning from niche to mainstream. Although still nascent, these efforts show a cautious willingness to engage with circularity while pursuing operational efficiencies. Without deliberate scaling of knowledge, training, and collaboration, CE risks remaining a specialist pursuit or being reduced to incremental gains rather than systemic transformation.

To advance the CE transition in the B&C sector, transformative, coherent, coordinated, and integrative policy approaches are needed (Bucci Ancapi et al., 2022; Giorgi et al., 2022). Increased engagement in high-value circular strategies is critical, particularly in the design and planning phases, prioritising the highest tiers of the 9Rs in descending order before resorting to recycling. Awareness and education initiatives, enhanced collaboration, and systems thinking can facilitate a coordinated, system-wide CE transition. Transition brokers can coordinate such system-level change by serving as neutral intermediaries that prepare, negotiate, finalise, scale up, and mainstream circular initiatives (Cramer, 2020). Additionally, revision of competition law should be considered, as it can limit sustainable development to ad hoc efforts and impede crucial collaboration to overcome first-mover disadvantages, as observed in Europe (Malinauskaite, 2022). Furthermore, developers, government agencies, and architecture clients can foster cooperation between capital and operational teams, integrating non-financial knowledge into capital budgeting to promote sustainable building features (Frost and Rooney, 2021).

5.2. Perceived maturity of CE implementation

The results indicate that B&C stakeholders perceive the maturity of CE implementation in their businesses as moderate (2.6 out of 5), with a noteworthy absence of ‘well-engaged’ and ‘mature’ CE implementation. This suggests significant potential for growth and development in advancing a CE transition among the surveyed businesses. These findings align with Cohen et al. (2022), who reported that while 81 % of construction firms in Argentina indicate efforts to implement CE practices, only 10 % integrate them into daily operations. Higher average responses from demolition and waste management companies may suggest more advanced CE implementation, aligning with interview findings that circularity is predominantly addressed at the end-of-life stage. However, at this phase, materials are either recirculated into the economy or follow the linear pathway, allowing these businesses to make a more visible and tangible contribution. As such, their clients may focus on end-of-life outcomes and minimising landfill levy costs. However, businesses engaging in downcycling may overestimate their CE performance, given that the CE concept is often mistaken for recycling (Kirchherr et al., 2017) and the significant emphasis on downcycling, according to interviewees. In addition, CE adoption by other business types may be more challenging, as B&C businesses tend to have fragmented, complex supply chains (Wuni, 2022).

5.3. Implementation of circular strategies

Overall, the implementation of circular strategies across surveyed businesses is perceived as moderate (1.9 out of 4.0), indicating most circular strategies are not widely implemented and there are significant opportunities for improvement. While most respondents reported minimal to moderate implementation, respondents from demolition and waste management companies reported moderate to significant levels, suggesting either more advanced practices at the end-of-life stage or a potential overestimation of their contributions. Moderate implementation is comparable with similar studies conducted in other countries that report unsatisfactory implementation levels ranging from low to above moderate. For instance, reported averages include 2.9 out of 5.0 across 16 developing countries (Bilal et al., 2020), 2.5–3.3 out of 5.0 in Ghana (Amudjie et al., 2022), and 3.5 out of 5.0 in Indonesia (Adi and Wibowo, 2020). A lower average in this study may reflect differences in methodologies or respondent biases, alongside the slow adoption of CE in Australasia (Guerra et al., 2021). With the global circularity rate at just 7.2 % in 2023 (Circle Economy, 2023) and the B&C sector consuming 50 % of raw materials (UNEP, 2022) and generating 35 % of landfill waste (Chen et al., 2022), actual implementation levels are likely overstated. This underscores the need to enhance stakeholders' understanding of mature CE practices.

The strategies that appear to require the most attention are service-based models, sharing platforms, material passports, remanufacturing, take-back schemes, organic recycling, and regenerating nature. Similar studies also found that service-based models, sharing platforms, and material passports are implemented at low levels (Cohen et al., 2022; Giorgi et al., 2022; Guerra et al., 2021; Lee et al., 2023). The adoption of service-based models may remain low due to financiers' caution regarding unproven long-term performance (Fischer et al., 2020), a lack of understanding, perceived complexity, disruption to established business practices (Guerra et al., 2021), and general unfamiliarity. Sharing and leasing can be hindered by resistance to shifting from traditional notions of ownership (Lee et al., 2023). Material passports, though demonstrated in Europe through Project BAMB, have seen limited adoption as a recent innovation with scarce literature (Munaro and Tavares, 2021). The low adoption of take-back schemes in New Zealand is unsurprising, given that there is only one accredited construction-related product stewardship scheme in the country (Ministry for the Environment, 2023). The lack of organic recycling could be attributed to chemical modification, such as the extensive use of boron-treated radiata pine in residential buildings (Finch et al., 2021).

Coordinated efforts from industry, government, and society are essential to improve the implementation of these specific strategies. Supportive policy measures, tax incentives, stakeholder education and collaboration, Industry 4.0 technologies, and innovative financing can be leveraged to shift linear mindsets and increase systematic adoption. For instance, financial institutions can advance service-based models by adapting risk assessment methods, embracing innovative financing mechanisms, and fostering internal education to prioritise stable, long-term cash flow streams rather than traditional one-time sales (Ramirez Bañales, 2021). Mandatory Extended Producer Responsibility (EPR) can integrate circular design, take-back, and remanufacturing requirements. Revision of relevant New Zealand standards (i.e., NZS 3602 and NZS 3640), which specify minimum treatment levels for boron and CCA preservatives in timber, can facilitate closed bio-loops. Furthermore, policymakers might explore environmental taxation frameworks, like the Ex'tax model, which redistributes tax burdens from labour to resource consumption and pollution (Groothuis, 2022), but implementation would challenge political and commercial norms. Collectively, these measures reveal that systemic transformation is possible but contingent on coordinated, multi-level interventions rather than isolated initiatives. Fig. 3 summarises the current state of CE in the B&C sector based on the survey and interview findings in contrast to the requirements for a coordinated system-wide circular shift identified from the literature.

5.4. *Significant relationships*

There are no significant associations between business age, size, or sub-sector and the maturity of CE implementation. In instances where significant relationships were identified between these variables and the implementation of circular strategies, larger and more recently established businesses tended to demonstrate a slightly elevated level of implementation. Lee et al. (2023) found similar results, finding that the implementation of only one strategy (building-scale wastewater treatment and reuse system) was more prevalent among medium and large companies in Taiwan. However, a global scan of CE implementation found that the CE transition is primarily driven by newer and smaller companies, which may adopt innovative approaches for a competitive edge but may face insufficient capital and upfront costs (Guerra et al., 2021). Conversely, larger companies have greater access to resources but tend to be more conservative and cautious, favouring familiar and straightforward strategies (Guerra et al., 2021; Lee et al., 2023).

6. Conclusion

This study assessed the current level of implementation of the CE concept among businesses in the B&C sector in New Zealand, a context characterised by a small, geographically isolated market and relatively high C&D waste rates. Interviewees generally considered the circular strategies identified in the literature to be relevant, highlighting education, upskilling, and collaboration as foundational enablers. Other high-value strategies included adaptive reuse, dematerialisation, circular materials, design for disassembly/deconstruction, take-back schemes, minimising waste on-site, off-site, and modular construction, deconstruction, service-based models, and regenerating nature. The importance of the design phase and adherence to the waste hierarchy were emphasised. It was found that CE implementation is insufficient, immature, inconsistent, uncoordinated, and lagging behind international best practices. Efforts are largely concentrated on the end-of-life stage, often relying on low-value approaches that provide limited contributions to a CE, such as downcycling, while neglecting opportunities in the design and planning stages, manual deconstruction, and material reuse. There is extensive reliance on linear materials, instances of greenwashing, and insufficient education and information to support informed decision-making. Nevertheless, growing awareness and interest, particularly among forward-thinking stakeholders, indicate signs of

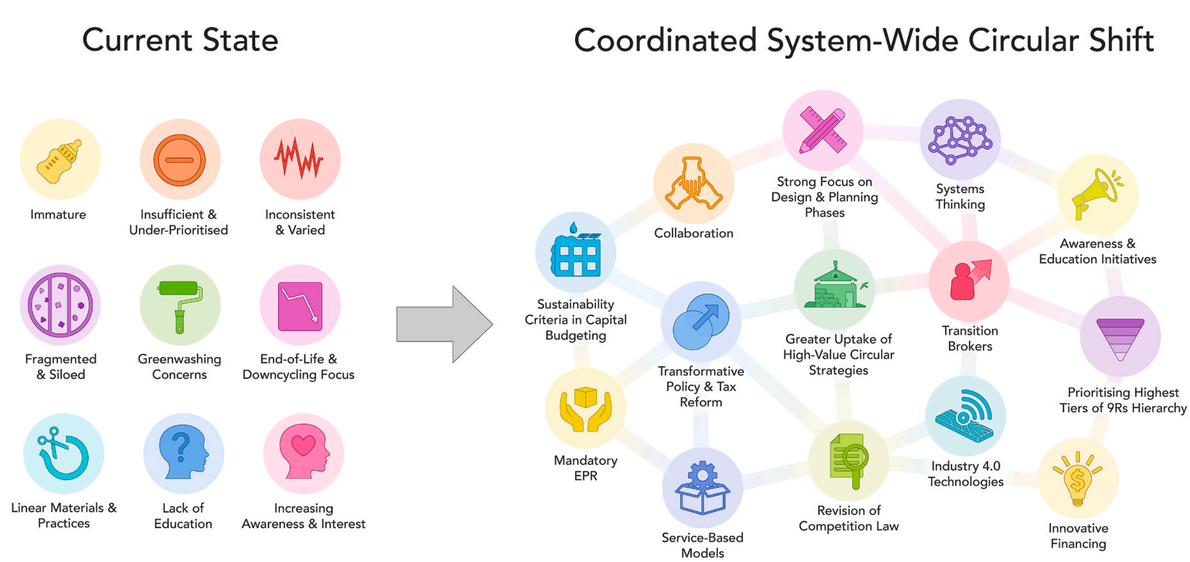

Fig. 3. The current state of circular economy in the building and construction sector versus the requirements for a coordinated system-wide transition.

progress.

Most of the professionals surveyed perceive CE implementation in their businesses as being at a ‘beginner’ stage of maturity. Current adoption of circular strategies is moderate on average among surveyed businesses, aligning with patterns observed in international studies, yet most strategies have not been implemented to a significant extent. This highlights considerable potential for businesses to strengthen engagement and accelerate the CE transition. Strategies requiring the most attention include service-based models, sharing platforms, material passports, remanufacturing, take-back schemes, organic recycling, and regenerating nature, suggesting targeted efforts in these areas could yield substantial impact. Overall, the findings of this research suggest that the current level of CE implementation among businesses in New Zealand's B&C sector is in its early stages. An effective CE transition will likely depend on prioritising education, integrating proactive interventions at the design phase, pursuing solutions that retain higher material value than recycling, and fostering a more systemic, collaborative, and coordinated approach.

This research contributes to the existing body of knowledge on CE in the B&C sector and addresses a research gap by providing insight into the state of CE implementation among B&C businesses in New Zealand. Findings highlight strategies that businesses should prioritise, as identified by interviewees, and those requiring greater attention, as the survey results indicate. Therefore, the practical implications of this research extend to stakeholders from the surveyed business types, as well as policymakers and researchers, who can leverage the findings to accelerate a CE shift.

A limitation of this research is that only a limited number of experts were interviewed, and surveying all companies in the B&C sector was unfeasible due to time and resource constraints. Moreover, given the anticipated lack of quantitative data on circular metrics, the survey relied on perceptions and self-reported responses. Consequently, it was not designed to yield precise or comprehensive sector-wide findings but rather to provide high-level insights into CE implementation among key business types and significant industry players. Future studies could conduct detailed investigations into the implementation of circular strategies, employ quantitative CE metrics, and engage a broader range of experts and stakeholders, including developers and clients. Furthermore, similar inquiries could focus on distinct industries, sectors, regions, or other nations to pinpoint the strategies that require greater implementation to accelerate a CE transition.

CRediT authorship contribution statement

Lucy C. Cossar: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Karen F. Hytten:** Writing – review & editing, Supervision. **Jonathon Hannon:** Writing – review & editing, Supervision. **Ferran de Miguel Mercader:** Writing – review & editing, Supervision.

Declaration of competing interest

I have nothing to declare.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clpl.2025.100115.

Appendix

Mean Responses from Each Business Type on the Implementation of Circular Strategies Within their Business, Measured on a 0–4 Likert Scale.

Circular Strategies	Manufacturers	Architecture/ Engineering	Construction	Design-Build	Fit-Outs	Demolition	Waste Management	Mean	SD	Rank
Pre-demolition audits						3.5		3.5	0.0	1
Selective deconstruction						3.5		3.5	0.0	2
Careful segregation						3.5	2.6	3.1	0.7	3
Minimise waste on-site			2.5	3.0	2.3	3.6		2.9	0.6	4
Infrastructure investment							2.7	2.7	0.0	5
Preconstruction consulting						2.6		2.6	0.0	6
Regenerative operation		2.3		2.4				2.3	0.0	7
Waste as a resource/industrial symbiosis	2.2							2.2	0.0	8
Efficient processes	2.4		2.0	2.5	2.1		2.3	2.3	0.2	9
Recording waste data			1.5	2.1	0.9	3.5	3.1	2.2	1.1	10
Deconstruction					1.7	2.7		2.2	0.7	11
Circular materials	2.4	2.1	1.7	2.4	2.5			2.2	0.3	12
Design for standardisation	2.7	2.1		2.4	1.6			2.2	0.5	13
Education, upskilling & collaboration	1.8	1.7	1.6	2.4	2.1	2.8	2.6	2.2	0.4	14
Relocation						2.1		2.1	0.0	15
Reuse	1.6		1.8	1.5	2.1	3.4	2.1	2.1	0.7	16
Dematerialisation	2.3	2.0	1.7	2.2	2.3			2.1	0.2	17
Design for adaptability/ flexibility	2.3	2.1		1.7	2.1			2.1	0.2	18
Circular contract specifications		1.6		2.4	2.1			2.0	0.4	19
Digital design tools		1.8	1.5	2.5	1.7			1.9	0.4	20
Adaptive reuse		2.3		1.4				1.8	0.6	21

(*continued on next page*)

(*continued*)

Circular Strategies	Manufacturers	Architecture/ Engineering	Construction	Design-Build	Fit-Outs	Demolition	Waste Management	Mean	SD	Rank
Open-loop recycling	1.2		1.5	1.4	1.8	3.0	2.1	1.8	0.7	22
Offsite & modular construction		2.0	1.6	1.5				1.7	0.3	23
Certifications	1.3	1.4		1.9	1.6			1.6	0.2	24
Design for disassembly/ deconstruction	1.9	1.3		1.0	2.1			1.6	0.5	25
Closed-loop recycling	1.5		1.4	1.9	0.8	2.2	1.3	1.5	0.5	26
Social & cultural equity	1.2	1.7		1.5	1.6			1.5	0.2	27
Measuring circularity	1.2	1.2		1.7				1.4	0.3	28
Regenerating nature	1.1	1.7	0.9	1.4	1.2	1.7	1.5	1.3	0.3	29
Organic recycling	0.8		1.0	1.4	1.2	1.9	1.7	1.3	0.4	30
Take-back schemes	1.3							1.3	0.0	21
Remanufacturing	1.2							1.2	0.0	32
Material passports	1.5	1.0	0.8	1.4	0.9			1.1	0.3	33
Sharing platforms			0.8	0.8	0.3	2.2		1.0	0.8	34
Service-based models	0.3	0.4	0.5	0.7	0.4			0.5	0.1	35
Average	**1.6**	**1.7**	**1.4**	**1.8**	**1.6**	**2.8**	**2.2**	**1.9**	**0.5**	

Note. Values are mean responses based on a 0–4 Likert scale (where 0 = not at all, 1 = minimally/rarely, 2 = moderately/sometimes, 3 = significantly/frequently, and 4 = completely/always) and exclude 'not applicable' and 'unsure' categories. Strategies not included in the survey for specific business types are shown as blank cells.

Data availability

Data will be made available on request.

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