

Exploration of critical influences for adopting circular economy and sustainable construction and demolition waste management practices: A systematic review[☆]

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ARTICLE INFO

Keywords:

Circular economy
Construction and demolition waste (C&D waste)
Landfill diversion
Sustainable waste management
Recycling infrastructure

ABSTRACT

Construction and demolition (C&D) waste is one of the largest global waste streams, posing significant environmental, economic, and health challenges. Despite this, management approaches are often applied uniformly, with limited consideration of stakeholder perspectives, local contexts, and material variability. This review challenges this one-size-fits-all approach by applying a multi-dimensional circular economy perspective to examine the spatial, institutional, and behavioral heterogeneity that shapes C&D waste management decision-making. A systematic review was conducted following PRISMA guidelines, drawing on both peer-reviewed literature selected through major academic databases, including Web of Science and ScienceDirect, and relevant grey literature to provide industry and regulatory context. Evidence quality was assessed using the CASP framework. Studies published between 2004 and 2025 were included based on predefined eligibility criteria. The synthesis of 64 publications identified the availability and accessibility of C&D waste recycling facilities as a fundamental yet under-recognized determinant shaping stakeholder engagement and waste diversion outcomes, distinguishing it from the broader market, cultural, and regulatory barriers commonly emphasised in existing circular-economy frameworks. The findings also highlighted the importance of understanding material characteristics and generation dynamics to inform effective long-term strategies. International experience, particularly from Sweden, demonstrates how coordinated governance, mandatory on-site sorting, sustained infrastructure investment, and continuous policy refinement can overcome structural barriers and enable high-performing circular systems. Although the economic viability of C&D recycling facilities remains region-specific, the strategies identified are broadly transferable, highlighting the need for context-sensitive strategies that align infrastructure, policy, market conditions, and stakeholder engagement to accelerate circular-economy adoption in the construction sector.

1. Introduction

Construction and demolition (C&D) waste refers to waste generated during the construction of new buildings and civil engineering structures, as well as the renovation, demolition, and deconstruction of existing ones (EPA, 2018; Rayhan & Bhuiyan, 2024). C&D waste is a global waste stream that poses significant environmental and human health risks. Annual generation is estimated to exceed 3 billion tons (2.72 billion MT), representing approximately 50% of the total waste burden in urban cities worldwide (Wang et al., 2022). In the United

States, C&D waste contributes around one-third of all waste generated and 67% of the total solid waste stream (López Ruiz et al., 2020). In 2021 alone, the US C&D sector produced >600 million tons (544 million MT) of waste, approximately twice the volume of municipal solid waste produced nationally (EPA, 2020, 2019). The amount of C&D waste continues to rise globally (Akhtar & Sarmah, 2018; Rayhan & Bhuiyan, 2024), with >35% of this waste disposed of in landfills without any form of treatment (Menegaki & Damigos, 2018; Chen et al., 2022). Despite the scale of waste generated and the opportunities offered by circular economy approaches, a substantial gap still exists worldwide in the

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<https://doi.org/10.1016/j.scsadv.2026.100100>

construction sector's commitment to sustainable C&D waste management practice (Ossio et al., 2023; Hoang et al., 2020).

The construction industry ranks high among sectors that contribute significantly to environmental degradation and impacts (Menegaki & Damigos, 2018). For decades, landfilling has been the preferred method for managing C&D waste. These landfills typically consist of compacted layers of earth and rock, forming large, natural mountain-like structures in both appearance and composition (Wu et al., 2024).

Reliance on landfill disposal has significant environmental and human health ramifications and is increasingly unsustainable over the long term. In the United States, for example, the City of Nashville is experiencing growing pressure due to landfill closures and diminishing disposal capacity (Metropolitan Nashville & Davison County, 2023). A study conducted in Shenzhen, China, reported that about 70% of the 52 assessed C&D landfills were classified as high-level for landslide, highlighting the potential hazards associated with landfill-based waste management (Wu et al., 2024). These findings reiterate the urgency of transitioning to more sustainable approaches for addressing C&D waste challenges.

Such a transition requires coordinated action from the construction sector and its stakeholders, who are both intensive consumers of materials and primary generators of C&D waste. Moving towards sustainable management practices aligns with broader calls for systemic change in production and resource use (Geissdoerfer et al., 2017; Meadow et al., 2005). Implementing C&D waste recycling and the circular economy principle has been identified as critical for waste minimisation and natural resources conservation (Liu et al., 2020). This position is supported by evidence showing that C&D waste recycling facilities can deliver outcomes that are both economically viable and environmentally beneficial (Contreras et al., 2016). Studies have shown that the availability of C&D recycling facilities can support recycling efficiency up to 95% (Karaca & Tleuken, 2023). This is demonstrated by a study of C&D waste recycling facilities in Kazakhstan.

Circular economy utilizes a closed-loop system in contrast to the linear take-make-waste model. It maximizes material utilization and reuse efficiency in contrast to the conventional final destination in landfill model. The availability of modern C&D waste recycling facilities and the implementation of well-articulated strategies are potent solutions for the construction industry transition toward a circular economy (Karaca & Tleuken, 2023).

Circular economy represents a cradle-to-cradle approach and a strategic framework aimed at transforming the entire chain of material production, consumption, distribution and recovery (Ghisellini et al., 2018). By prioritizing resource efficiency and material retention, it offers a targeted and effective pathway for diverting C&D waste away from landfills. In contrast, conventional waste management practices have historically considered surplus or unwanted C&D materials as valueless waste, limiting the opportunities to recover value and achieve circularity (Papastamoulis et al., 2021). Reusing, repurposing, and recycling C&D materials extends their functional lifespan and retains them within productive cycles. Understanding the continued value of construction materials at the end-of-life stage is therefore critical. This can be achieved by re-envisioning material life cycles, whereby materials that have completed their original function are transformed and repurposed into new applications, creating additional life cycles (Lauritzen, 2018). Crucially, decisions made at the design phase influence not only the material used during construction but also the type and quantity of waste generated. Integrating circular economy consideration into early design and construction planning enables more effective waste management and maximizes environmental benefits (Coelho & de Brito, 2012).

Achieving such outcomes requires a deeper understanding of the roles, responsibilities, and influence of different actors associated with C&D waste management (Liu et al., 2020; Caro et al., 2024). Given the sector's complexity and heterogeneity, effective solutions must adopt

multi-dimensional approaches that account for geographic, operational, and material differences. A persistent knowledge gap among construction industry practitioners remains a significant contributor to rising C&D waste volumes across the construction, operation, and demolition phases of buildings, particularly in the absence of context-specific guidance (Liu, 2022). Against this backdrop, this review provides a comprehensive overview of C&D waste management and identifies the key factors influencing the adoption of sustainable and circular economy approaches within the construction sector.

2. Methodology

This review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The review aimed to identify and critically evaluate factors influencing the adoption of circular economy principles and sustainable C&D waste management practices across different geographical, regulatory and operational contexts.

2.1. Search strategy and selection criteria

Literature search was conducted using Sage Journals, Web of Science, Science Direct and Google Scholar. Search combined keywords and Boolean operators to identify studies relating to circular economy implementation and C&D waste management. Searches were conducted using combinations of the following keywords and phrases: "construction and demolition waste", "circular economy", "recycling infrastructure", "stakeholder engagement", "landfill diversion", "sustainable waste management" and "policy and governance". These terms were searched independently and combined in multiple combinations of increasing complexity using Boolean operators (AND/OR), where supported by the database platform, to identify publications relevant to circular economy adoption and C&D waste management.

Reference lists of relevant publications were also reviewed to identify additional sources. The search covered publications produced between 2004 and 2025. Publications were included if they provided empirical evidence, policy analysis, review findings, or industry-relevant information. Publications were excluded if they were unrelated to C&D waste management, focused exclusively on other waste streams, represented duplicate records, or lacked sufficient methodological or contextual information.

Relevant grey literature, official reports, policy documents, and industry publications were identified through Google Scholar searches, citation tracking, and targeted searches of institutional and government sources where they provided important contextual, regulatory, or operational insights into C&D waste management and circular economy implementation.

2.2. Study selection, quality assessment and data synthesis

The study-selection process followed PRISMA guidelines. An initial search identified 150 records. Following the removal of duplicate and ineligible records, 119 records were screened by title and abstract. Seventy-eight publications subsequently underwent full-text assessment, of which 14 were excluded because they did not satisfy the inclusion criteria. A final dataset of 64 publications was included in the review and formed the evidence base for the synthesis presented in this study (Fig. 1).

The quality of included publications was assessed using the Critical Appraisal Skills Programme (CASP) framework. Sources were evaluated according to methodological rigour, clarity of research objectives, appropriateness of study design, transparency of data collection and analysis procedures, and relevance to the review objectives. This appraisal process informed the interpretation of evidence and ensured that greater weight was given to robust and well-documented sources.

The included publications were subsequently categorised according

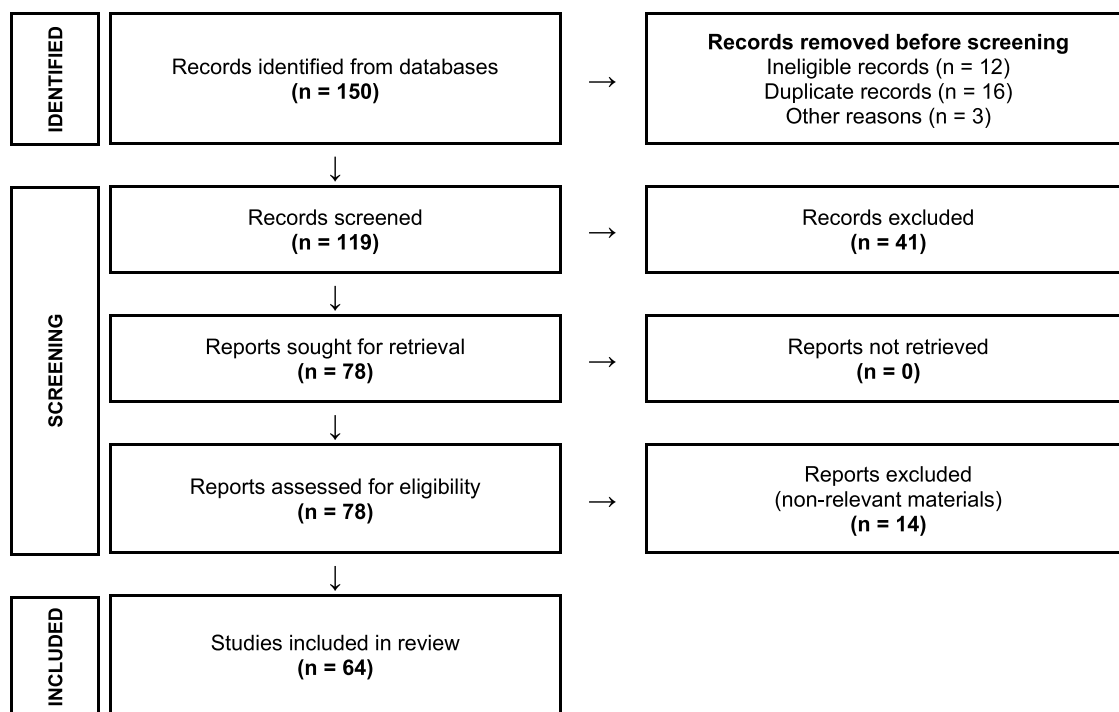


Fig. 1. The Preferred Reporting Items for Systematic Review & Meta Analysis (PRISMA) process adopted for this review.

to publication year, thematic relevance, and contribution to circular economy and C&D waste-management research. The evidence was synthesised to identify recurring barriers, enabling factors, stakeholder influences, policy implications, and opportunities for advancing circular economy adoption within the construction sector.

3. Results and discussion

3.1. An overview of C&D waste composition and its recycling

The included publications span a range of study types and methodological approaches. A total of 64 key sources published between the years 2004 to 2025 were examined in detail, including 41 studies published between 2020–2025, ensuring strong representation of contemporary evidence. The reviewed studies were conducted in different parts of the world, especially in Europe and Asia.

Construction activities produce a wide range of C&D waste materials, which, in general, are predominantly non-hazardous. However, the composition, volume and quality of these wastes can vary significantly from site to site, and also across counties and regions (Dahlbo et al., 2015). Table 1 shows the diverse materials and forms in which C&D waste may be generated, depending on the construction or demolition activities being undertaken. New-build construction,

renovation, remodeling and demolition each produce distinct quantities and characteristics of C&D materials, making it important to understand the differences to identify appropriate management strategies and opportunities for material recovery and reuse.

3.2. C&D waste recycling trends

The reviewed literature indicates that the construction sector continues to rely heavily on the linear take-make-dispose model, significantly contributing to the volume of C&D waste sent to landfills (Oluleye et al., 2022). Currently, there are calls for more innovative and sustainable approaches to manage C&D waste, particularly those involving emerging technologies and intelligent decision-support tools. Over the past decade, C&D activities have grown exponentially worldwide, intensifying the waste-generation pressure. For example, in the United States, the City of Nashville has experienced a disproportionately high increase in C&D waste due to rapid expansion in construction activities. Fig. S1 shows the amount of C&D waste landfilled versus the amount recycled in Nashville between 2008 and 2020. In 2008, approximately 220,000 tons of C&D waste were generated, of which 180,000 tons (163,293 MT) were landfilled and 40,000 tons (36,287 MT) recycled. However, since 2012, there has been a marked decline in recycling, with over 95% of C&D waste generated between 2014 and 2020 sent to landfills. This negative trend corresponds closely with the city's construction boom (Main Street Nashville, 2023).

Unlike household waste and other municipal waste streams, an estimated 50 to 90% of C&D waste can be recovered and used as a resource or as a substitute for virgin construction materials (Lauritzen, 2018). Countries such as Germany and the Netherlands operate diverse, high-capacity C&D recycling facilities, achieving recycling rates of up to 85%, compared with <10% in Portugal and Greece (Nunes & Mahler, 2020; Coelho & de Brito, 2013; Menegaki & Damigos, 2018).

Table 2 summarises the European Union (EU) recycling, reuse and materials recovery potentials for key C&D fractions. Despite this high potential for recyclability, only a small proportion of C&D waste is reused or repurposed as secondary materials, indicating a persistent gap between technical potential and practical implementation.

Table 1

Typical Components of Construction and Demolition Waste. (Source: EPA, 1998; Lauritzen, 2018).

Material Component	Content Examples
Metal	Pipes, rebar, flashing, steel, aluminum, copper, brass,
Rubble	stainless steel
Roofing	Concrete, cinder blocks, rock, earth, bricks
	Asphalt, wood shingles, slate, tile, roofing felt
Drywall	Sheetrock, gypsum, plaster
Plastics	Vinyl sidings, doors, windows, floors tiles, pipes
Wood	Forming, framing lumber, stumps, plywood, laminate
Glass	Window, mirror, lights
Miscellaneous	Carpeting, fixture, insulation

Table 2

Major Fraction of C&D Waste, EU-Estimates of Distribution/Potential Recycling, Reuse. (Source: [Monier et al., 2011](#); [Lauritzen, 2018](#)).

C&D Fraction	Type of Material	Min-Maximum Weight %	Potential Recycling, Reuse and Recovering
Concrete; plain and re-enforced	Inert, ceramics	50–90	Recycling of crushed concrete, bound, unbound aggregates
Mason bricks, tiles	Inert, ceramics	35–50	Reuse of bricks, recycling of crushed materials
Stones	Inert, ceramics	1–2	Reuse of granite blocks, recycling crushed aggregates
Asphalt	Mixed, inert, combustible	1–5	Recovery, recycling in new asphalt layer
Wood, timber, plants, doors, windows	Bio-degradable, combustible	1–10	Reuse of doors and windows, timber and plants, production of chipboards, energy
Scrap iron, steel, metal	Inert, metal	1–5	Recovering
Gypsum		0.2–0.4	Recovering
Glass	Inert	0.1–10	Recovering
Insulation Materials	Inert	1–10	Recovering
Paper, cardboard, plastics	Combustible		Recovering
Hazardous substance			Disposal, treatment

Approximately 50 to 90% (by weight) of C&D waste consists of plain and reinforced concrete ([EPA, 2020](#)), a fraction that presents significant opportunities for material recovery and high-value recycling. Substituting virgin raw materials for recycled aggregate concrete (RAC) promotes and contributes to resource conservation, landfill diversion and carbon footprint mitigation ([Akbulut et al., 2025](#)). Studies have shown that utilizing recycled aggregate concrete presents environmental benefits, viable economic cost saving opportunities and promotes sustainable construction and waste management principles.

China generates >2 billion tons C&D waste annually ([Wang et al., 2022](#); [Elshaboury et al., 2022](#)). The volume of C&D waste increased steadily between 2005 and 2009, reflecting rapid construction growth during this period. In Beijing, approximately 80% of C&D waste is disposed of in landfills ([Elshaboury et al., 2022](#)). Nationally, C&D waste accounts for around 40% of China's urban solid waste, yet the recycling rate remains below 5%. This low recovery rate poses significant environmental, public health and economic risks. These challenges highlight the pressing need for China's construction sector to transition toward a more sustainable sociotechnical system ([Geissdoerfer et al., 2017](#); [Meadow et al., 2005](#); [WBCSD, 2021](#)). Although the adoption of circular economy principles and sustainable practices in the construction industry is influenced by multiple contextual, institutional, and economic factors, research focusing on stakeholder perspectives and decision-making processes in C&D waste management remains limited. Furthermore, countries interpret and implement circular economy concept differently ([Finamore & Oltean-Dumbrava, 2024](#)). These differing interpretations influence national priorities, shape intended outcomes, and guide policy alignment around issues such as resource scarcity and material efficiency.

3.3. Linear economy vs circular economy for C&D waste management

[Lacy et al. \(2020\)](#) defined the linear economy as the conventional take-make-waste model, in which raw materials are extracted, manufactured, consumed and discarded as non-recyclable waste. However, >75% of the waste generated from C&D activities retains residual value ([Purchase et al., 2022](#)). Recovered C&D waste also offers substantial

technical and economic benefits. [Tam \(2008\)](#) found that recycled concrete aggregates can replace natural aggregates in new concrete with good technical performance and cost efficiency. Recycled red brick aggregates have been used to produce new bricks and mortar, while recovered glass can be reused to produce new flat glass products. Studies by [Coelho and de Brito \(2013\)](#) and [Mulder et al. \(2007\)](#) confirmed that higher-grade recycled materials can perform comparably to their virgin counterparts, enabling closed-loop construction cycles. Reintroducing recovered materials reduces reliance on virgin resources and supports circular economy objective by lowering material costs. Materials such as aluminum, which have a strong secondary market, further strengthen the economic case for recycling.

However, much of this material is neither reused nor recycled ([Purchase et al., 2022](#)), resulting in substantial quantities of materials being sent to landfills. Even when materials are recovered, they are often downcycled, meaning they are converted into products of lower quality or reduced functionality. In contrast, the Ellen MacArthur Foundation defines circular economy as an industrial system that is restorative and regenerative by design ([Geissdoerfer, 2017](#)). [Geissdoerfer et al. \(2017\)](#) further describe it as a regenerative system in which resource inputs and waste generation, emissions and energy leakage are minimized by slowing, closing, and narrowing materials and energy loops. Circular economy presents suitable strategies for decarbonization of environmentally intrusive resource utilization practices. It offers potent solutions to decouple economic growth from natural resource extraction and waste generation ([Bresanelli & Saccani, 2025](#); [Lara et al., 2025](#)).

Unlike the linear economy, circular economy aims to retain materials and products in productive use for as long as possible. This closed-loop model recognizes the full life cycle of materials and effectively recirculates them back into the system using restorative and regenerative strategies. It is worth noting that waste management alone does not equate to circular economy, nor is circularity synonymous with recycling. However, sustainable waste management practice and high-quality recycling are essential to achieving circular economy goals ([Varsha et al., 2025](#)). On a broader scale, the transition to an impactful and fully functioning circular economy depends on supportive legislative and policy frameworks that encourage sustainable practices and deter unsustainable behaviors. Well-designed regulations, incentives, and enforcement mechanisms can promote the shift toward circularity by guiding industries, organizations, and individuals toward more resource-efficient practices.

3.4. Barriers to recycling C&D waste

The barriers to recycling, reuse and the wider implementation of a circular economy include price (cost), quality and availability of secondary raw materials ([Purchase et al., 2022](#)). For a circular economy to be sustainable, secondary materials must meet high-quality standards to ensure they can substitute for virgin materials without compromising performance. [Table 3](#) presents the key barriers and constraints to circular economy adoption identified across the reviewed literature.

Early conceptual work ([van Eijk, 2015](#)) identified a wide range of barriers to circular-economy implementation, and subsequent empirical studies have consolidated these into broader categories: cultural, market, regulatory, and technological ([Kirchherr et al., 2018](#)). In contrast, this review, drawing on a synthesis of C&D-specific literature, found that infrastructure, market, culture, legislation, and knowledge are the key factors constraining the transition to a circular economy for C&D waste ([Fig. 2](#)). A notable point of divergence concerns the role of technology. Unlike earlier conceptual frameworks such as [van Eijk \(2015\)](#), technological limitations did not emerge as a critical barrier in this review, a finding that aligns with empirical evidence from [Kirchherr et al. \(2018\)](#). Instead, the recurring challenges identified in the C&D waste literature relate more strongly to systemic, institutional and knowledge-based constraints than to technological shortcomings.

While existing frameworks consistently identify market, cultural,

Table 3

Key barriers and constraints to the adoption of circular-economy implementation in C&D waste management identified across the literature.

Barriers	Comments	Literature Sources
Infrastructure: Lack of C&D Recycling Facilities	Stoeva and Alriksson (2017) affirmed that the absence of waste separation conditions prevents recycling behavior and positive outcomes.	Contreras et al. (2016) , Letelier et al. (2021) , Liu et al. (2020) , Karaca and Tleuken (2023) , Nunes and Mahler (2020) , Coelho and de Brito (2013) , Stoeva and Alriksson (2017)
Knowledge	Benachio et al. (2020) concluded that the lack of standard circular economy concepts is prevalent in the construction industry.	Benachio et al. (2020) , Donmez-Turan and Kiliclar (2021) , Papastamoulis et al. (2021) , Shooshtarian et al. (2022) , Falk and McKeever (2012)
Market; Lack of existing market, cost	Liu et al. (2020) reinforced that the presence of existing market is critical for economic viability.	Bohm et al. (2010) , Liu et al. (2020) , Mulder et al. (2007) , Patel et al. (2020) , Purchase et al. (2022) , Tam (2008) , Tonglet et al. (2004)
Legislation	Kyriakopoulos (2021) identified that several legislative constraints affect the circular economy.	Kyriakopoulos (2021) identified that several legislative constraints affect circular economy.

and regulatory barriers to circular economy implementation ([van Eijk, 2015](#); [Kirchherr et al., 2018](#)), this review highlights the availability of appropriate infrastructure as a critical, domain-specific constraint that is

not explicitly addressed within these broader categories. As noted by [Wuni \(2022\)](#), infrastructure encompasses not only the presence of C&D recycling facilities but also sectoral readiness, operational capacity, and adaptability to evolving waste-management demands. This perspective is reinforced by recent construction-focused studies, which highlight infrastructure and operational constraints as key challenges in achieving effective C&D management ([Islam et al., 2024](#)). Without such infrastructure, diverting materials away from landfills becomes markedly difficult, regardless of other enabling conditions such as favorable market, supportive cultural attitudes, and strong legislation.

Knowledge-related barriers further impede circular economy progress. These include limited understanding of circular economy and sustainability principles, insufficient stakeholder awareness, inadequate data and information, shortages of skilled personnel, and gaps in technical capabilities. These factors constrain the sector's ability to implement circular economy effectively.

3.4.1. Legislation

Legislation plays a crucial role for regulating activities and promoting sustainability. However, its effectiveness can be undermined by political influences, such as lobbying in the United States. [Kyriakopoulos \(2021\)](#) identified several legislative constraints to circular economy adoption, including the lack of harmonized definitions of operability, conflicting interests, inadequacy of controlling and monitoring mechanisms, limited access to transparent information, and challenges in internalizing recycling costs.

According to [Tleuken et al. \(2022\)](#), circular economy practices are

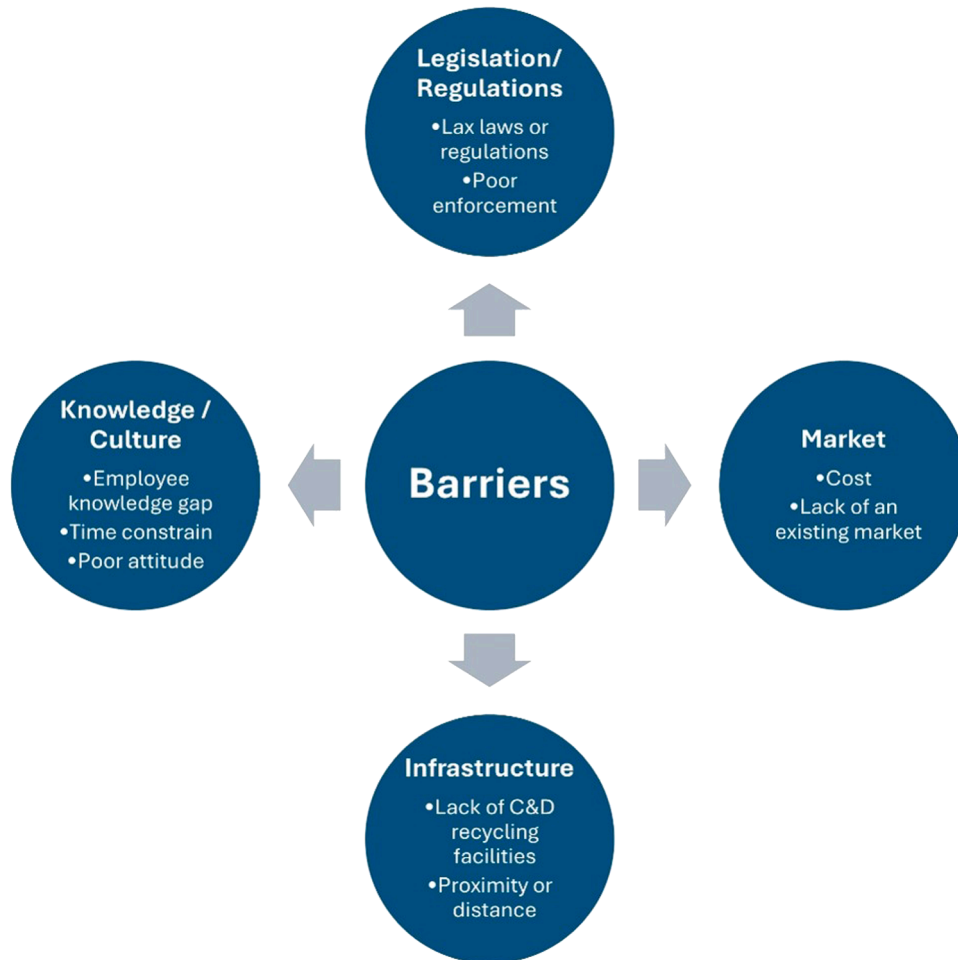


Fig. 2. Key barriers to the adoption of circular-economy practices in C&D waste management, including infrastructure, market conditions, legislation, and knowledge- or culture-related constraints. (Author's Model).

often adopted at the micro-level because their development is driven through top-down approaches. Broader, cross-sectoral participation requires enabling legislation, clear policy direction, and supportive conditions. Effective policies and legally binding regulations can strengthen stakeholder participation, while government-provided financing and incentives can accelerate the transition. Establishing common frameworks and clear, consistent definitions is equally important for identifying both barriers and opportunities across the circular economy landscape.

Policy constraints also contribute to barriers affecting recycling (Oluwadipe et al., 2022, 2025). The presence of legislation strengthens the factors required for sustainable environmental practices. However, infrastructure alone, such as the availability of C&D waste recycling facilities, will not yield expected outcomes without enforceable legislation that requires industry compliance. Policies aimed at sustainability must therefore be legally binding to be effective. Sweden's extensive network of recycling facilities demonstrates how coherent legislation, strong stakeholders' commitment, and a well-structured national strategy can successfully overcome barriers to C&D waste management.

3.4.2. Market

Cost can affect the outcome of circular economy positively or negatively. When recycling processes such as separation, sorting and selective demolition become more expensive than landfilling, they can negatively affect circularity (Caro et al., 2024). Low disposal and tipping costs for C&D waste can act as a barrier to sustainable waste management, as they make landfill disposal a more economically attractive option. Conversely, higher disposal costs can act as a deterrent, encouraging waste diversion and more sustainable practices (Nygaard, 2022; Bartolacci et al., 2017). Lack of existing market for C&D waste materials poses a barrier to the adoption of circular economy practices (Shooshtarian et al., 2020; Buchard & Christensen, 2024). A well-developed and consistent local market is essential for an effective circular economy. As with most business ventures, C&D waste recycling facilities must remain financially viable to ensure their sustainability. While these facilities have obligations to protect public health and the environment, profitability remains essential for long-term stability and investor confidence (Patel et al., 2020). The closure of all C&D waste recycling facilities in Nashville highlights the need to understand the underlying causes, despite evidence from other regions, including parts of the United States, that such facilities can be economically successful.

Economic viability is highly region-specific and depends on a combination of physical, economic and social factors (Coelho & de Brito, 2013; Duran et al., 2006; Saha et al., 2023). Supporting strategies may range from taxing recyclable materials sent to landfill, restricting or banning landfilling of C&D materials, offering financial incentives or subsidies, taxing virgin materials, and reducing taxes on products containing recycled materials. Successful examples, such as a high-profit potential recycling operation in Lisbon, Portugal (Coelho & de Brito, 2013), demonstrate that well-designed business models can be replicated elsewhere. Scaling up C&D waste recycling presents significant positive environmental benefits and economic opportunities for construction stakeholders (Charnley et al., 2024). There is a need for enabling conditions such as infrastructure and economic incentives to support and efficiently address scaling up any closed-loop system. In addition, a business case that identifies value retention in waste materials and incorporates economic and environmental benefits helps compel stakeholders.

The presence of a functioning market is particularly critical. Liu et al. (2020) emphasized the importance of differentiating between recycling market scenarios, especially those involving shortages or surpluses in processing capacity. Their study examined profit dynamics between waste generators and recyclers under different conditions and identified a significant gap in the literature regarding these market interactions. They were the first to analyze the dynamic relationship between C&D waste generators and recyclers across contrasting market environments.

According to Liu et al. (2020), one scenario is the shortage of C&D waste processing capacity, where recyclers are unable to handle the full volume of waste due to limited infrastructure. This aligns closely with findings from this review, which identified inadequate recycling facilities as a major constraint on both waste management and circular economy progress (Section 3.4.3). The second scenario involves an excess of processing capacity, as currently observed in Sweden where facilities can handle more waste than is required. Their findings indicate that recyclers tend to generate greater profits when processing capacity is insufficient relative to waste generation. However, both waste generators and recyclers experience decreased profits in either extreme, shortage or surplus, due to rising disposal rates and investment cost burden. Importantly, the attitude and decisions of C&D waste generators significantly influence recycler profitability, highlighting the behavioral dimension of circular economy success.

3.4.3. Infrastructure

This review identified the lack or inadequacy of recycling facilities as a major barrier to diverting C&D waste away from landfills. This persistent shortfall threatens progress towards a circular economy, as the number and processing capacity of C&D waste recycling facilities in many cities have not kept pace with the rising volume of waste. Inadequate infrastructure often leads to environmentally damaging practices such as landfilling and illegal dumping, a challenge also noted in recent construction-focused studies (Islam et al., 2024).

Addressing this challenge requires expanding the availability of C&D waste recycling facilities and ensuring that affordable options are in place to encourage sustainable waste management behaviors. The shortage of recycling facilities is closely linked to cost-related barriers. Letelier et al. (2021) found that long travel distances discourage recycling, whereas proximity significantly increases individuals' willingness to engage in recycling and circular economy initiatives.

Holistic data analysis is essential for identifying patterns and understanding the factors that shape recycling behavior. Research shows that pro-recycling attitudes strongly influence recycling behavior, but only when supported by appropriate opportunities, facilities and knowledge (Karaca & Tleuken, 2023; Tonglet et al., 2004). Similarly, Stoeva and Alriksson (2017) showed that the absence of suitable waste-separation conditions can prevent recycling even when individuals have positive attitudes towards waste reduction. The relationship between annual C&D waste generation and the prevalence of recycling facilities is summarized in Table 4, revealing significant international differences. Together, these findings suggest a strong relationship between the availability of recycling infrastructure and engagement in sustainable waste management practices.

3.4.4. Knowledge and culture

Conventional waste management practices have historically placed little value on C&D materials, often categorizing them as unwanted and surplus rather than as resources with potential for recovery (Papastamoulis et al., 2021). This perception is reinforced by limited knowledge of circular-economy concepts within the construction sector

Table 4

Countries and existing C&D recycling facilities. (Source: Liu et al., 2020; Elshaboury et al., 2022 ; Nunes & Mahler, 2020).

Country	Tonnage	C&D Recycling Facilities Nos
China	2300,000,000	20
United States	540,000,000	3500
South Korea	NA	373
Sweden	14,200,000	NA
United Kingdom	55,000,000	100
Turkey	NA	3
Germany	38,000,000	1000
Netherlands	NA	120

NA = not available.

(Benachio et al., 2020). A significant barrier is the lack of training and sustainability awareness among employees and decision-makers, which undermines efforts to divert C&D waste from landfills and prevent the adoption of more sustainable waste management strategies (Shooshtarian et al., 2022).

A contributing issue is the misconception that C&D waste is homogeneous. C&D waste originates from distinct activities, such as construction, renovation, and demolition, and exhibits varied characteristics (Falk & McKeever, 2012). Without understanding this heterogeneity, stakeholders struggle to make informed decisions about sorting, separating, and recovering materials. Poorly informed decisions can lead to inefficient waste handling, environmental harm and missed opportunities for resource circularity.

Improving sustainability outcomes requires equipping those handling or managing C&D waste with the necessary knowledge to adopt best practices and respond effectively to the evolving demands of the construction industry. Research consistently shows that access to knowledge, opportunities and appropriate facilities fosters more sustainable behavior. For example, Stoeva and Alriksson (2017) found that the availability of proper waste-separation opportunities strongly influences recycling behavior, while Donmez-Turan and Kilicar (2021) demonstrated that individuals with environmental training are 4.7 times more likely to engage in pro-environmental actions. Providing training for construction workers, waste handlers, and transport operators, such as on proper material separation and the importance of diverting C&D waste from landfills, can therefore strengthen environmental awareness and support circular-economy goals. Time constraints can also play a significant role in the construction sector's limited adoption of sustainable practices. Construction projects operate on tight schedules, where delays in sorting, loading, or collecting C&D materials can disrupt workflows, increase labor costs, and jeopardize project deadlines (Ibadov, 2019). As a result, workers often default to faster, unsustainable practices, such as commingling waste in a single roll-off dumpster, to avoid slowing down operations. Strydom (2018) noted that lack of time is one of the major barriers to recycling, and this is evident in construction settings where sorting materials can interrupt time-sensitive tasks. The sequential nature of construction activities means that timely waste collection and the availability of disposal containers must be closely coordinated with material deliveries and site operations, otherwise, sustainable waste practices may be deprioritized.

In addition to knowledge and time pressure, poor attitudes and unsustainable organizational practices further impede circular economy adoption (Alzara et al., 2025; Shahid & Ali, 2025). These attitudes may stem from personal resistance to change, inadequate training, misaligned organization priorities, or entrenched industry norms (Graessler et al., 2024). When stakeholders are unwilling or unmotivated to adopt sustainable behaviors, the likelihood of effective waste separation, recycling, and resource recovery diminishes (Alzara et al., 2025; Shahid & Ali, 2025). Such attitudes have direct implications for circular economy performance and the successful diversion of C&D waste away from landfills (Alzara et al., 2025). Ghaffar et al. (2020) note that mindset shifts remain one of the major challenges in implementing circular construction models.

Knowledge gaps, limited sustainability awareness, time constraints, and unsupportive attitudes collectively undermine efforts to manage C&D waste sustainably. Addressing these interconnected barriers requires targeted education, improved training, well-designed site processes, and a cultural shift toward valuing resource recovery and circularity across all levels of the construction sector.

3.5. International lessons learned: sweden's high-capacity C&D recycling model

Building on the barriers identified in Section 3.4, particularly those related to inadequate infrastructure, weak policy enforcement, and limited stakeholder alignment, it is instructive to examine the context in

which these barriers have been effectively addressed. Sweden provides an exemplary case where long-term planning, strong institutional coordination, and robust infrastructure have enabled high-performing circular economy practices in the C&D sector. This example, reported by Liu et al. (2022), provides valuable insights into how systemic challenges can be overcome, and it serves as a practical bridge between barriers previously discussed and the recommendations that follow.

Sweden's C&D waste management system is characterized by a recycling processing capacity that significantly exceeds the volume of domestic C&D waste generated (Liu et al., 2020, 2022). As a result, Sweden imports nearly 80 million tons of C&D waste annually to maintain optimal operation of its extensive facilities. This surplus capacity reflects decades of investment in infrastructural and policy development, demonstrating how addressing infrastructural barriers can accelerate progress toward circular economy and deliver measurable environmental and human health benefits.

In contrast, countries such as China, Brazil, and Turkey continue to face critical infrastructural deficits. For example, China operates only around 20 professional C&D waste recycling facilities, while South Korea has 373 (Table 4; Liu et al., 2020). These disparities highlight the extent to which regional differences in investment, planning, and governance shape recycling outcomes. Sweden's model also shows that infrastructure alone is not sufficient, it must be supported by coherent legislation, market incentives, and coordinated stakeholder participation.

A key factor underpinning Sweden's success is the national commitment to clear role delineation between regulatory agencies and industry actors. Government agencies actively shape the country's sustainability vision and secure stakeholder buy-in through well-defined responsibilities and performance expectations (Swedish Construction Federation, 2019). This coordinated governance structure has encouraged widespread voluntary adoption of environmental building certifications and strengthened compliance with national waste-reduction goals.

Sweden's regulatory framework is equally critical. The Swedish National Board of Housing, Building and Planning, along with the Swedish Construction Federation, enforces mandatory on-site sorting of C&D waste, with exemptions granted only in specific cases (Zakrisson, 2024; Iimpcoll, 2024). Sorting at the source maximizes material recovery and reduces pressure on centralized facilities. Continuous policy refinement has also been instrumental: the national Resource and Waste Guidelines for Construction and Demolition have been revised eight times between 2007 and 2019 to improve clarity, efficiency, and implementation performance. Complementing this, the Swedish Planning and Building Act provides regulatory stability and a legal foundation that supports the economic viability of C&D recycling facilities.

3.6. Recommendations

Drawing on the reviewed literature, several strategic recommendations emerge for advancing circular economy adoption and improving C&D waste management practices. These recommendations are informed by barriers identified in Section 3.4 and are further supported by international insights from Sweden's high-performing C&D recycling system (Section 3.5).

3.6.1. Adopt a multi-dimensional and context-specific approach

C&D waste varies significantly by location, construction activity, and material types. Conventional 'one-size-fits-all' solutions fail because they treat C&D waste streams as homogeneous, limiting the effectiveness of treatment strategies. A multi-dimensional, site-specific approach is required, one that recognizes the dynamic nature of local construction practices and waste characteristics. Understanding these nuances enables stakeholders to better leverage technology, logistics, and economic resources to reduce landfilling and address environmental and human health impacts.

Future research should prioritize and recognize material heterogeneity that exists at different locations. This will help in customizing the most suitable material value retention action plan for specific waste materials and locations. It will guide policy framing in specific construction sector context that incorporates local construction waste realities.

3.6.2. Address key limiting factors: cost, infrastructure, and knowledge

Critical barriers, including high cost, inadequate C&D recycling facilities, and limited knowledge or training among employees, require targeted attention. These factors must be analyzed not only in terms of economic feasibility, but also in relation to their human health and environmental implications. A holistic assessment encourages both public and private stakeholders to invest in solutions that enhance C&D waste diversion and recovery rates. Combining circular economy knowledge with appropriate recycling infrastructure would help close the implementation gap and support the scaling up of circularity outcomes.

3.6.3. Strengthen legislation and policy enforcement

Legislation is a powerful driver of sustainable waste management behavior. Strong, enforceable regulations can limit landfilling, support recycling markets, and create incentives for circular economy practices. As evidenced in Sweden, well-defined roles, clear performance expectations, and mandatory practices (such as on-site sorting) significantly improve recycling outcomes. Regular policy reviews at organizational and sectoral levels are essential to identify gaps, refine targets, and ensure continuous improvements.

3.6.4. Promote awareness, capacity-building, and mindset change

The adoption of circular economy practices depends heavily on stakeholder attitudes and organizational culture. Training programmes targeting construction workers, site managers, waste handlers, and decision makers can build essential skills for material separation, recycling, and resource recovery. Awareness raising efforts should highlight the economic and environmental benefits of circular practices, encouraging behavior change at all levels of the construction value chain. Future research should address the circular economy knowledge gap that exists at various stakeholder levels and provide critical insights to help overcome such barriers and accelerate broader adoption of sustainable waste management practices.

3.6.5. Align national strategies with circular economy goals

Strategic initiatives can accelerate the transition to circular C&D waste management by establishing measurable landfill-diversion and recycling targets while providing a national framework that aligns regulatory, industrial, and infrastructure development efforts. Evidence consistently shows that closed-loop C&D waste management models outperform landfilling, offering measurable environmental and economic benefits. Aligning national and regional strategies with circular economy objectives promotes coherence across regulatory frameworks, industry actions, and stakeholder expectations.

3.6.6. Use successful international models to guide local action

Sweden's experience illustrates how well-planned infrastructure, stakeholder alignment, and policy coherence can overcome structural barriers. Although economic viability remains region-specific, several principles, such as mandatory sorting, continuous policy refinement, clear allocation of responsibility, and government-led coordination, are broadly transferable. Regions facing significant challenges, including the United States and emerging economies, can draw on these insights to develop tailored action plans and further research.

4. Conclusion

In conclusion, achieving a circular economy in the construction

sector depends on a context-sensitive approach that reflects regional variations in C&D waste generation, material heterogeneity, and varying stakeholder capacities, rather than relying on uniform solutions. Progress remains constrained by several interrelated barriers, including inadequate recycling infrastructure, cost considerations, knowledge gaps, time pressure, poor attitudes towards waste management, and underdeveloped markets for recycled materials. Among these, the availability of appropriate recycling infrastructure is particularly critical, as it underpins landfill diversion and the scaling of circular initiatives. Additional constraints such as limited stakeholder awareness, insufficient data, shortages of skilled personnel, and gaps in technical capability further hinder implementation, emphasizing the need for targeted capacity building and knowledge exchange. While partially aligning with existing framework, such as van Eijk's, particularly regarding market, cultural, and regulatory dimensions, this review highlights infrastructure as a fundamental but often underrepresented constraint. Furthermore, weak legislative support, limited political will, and insufficient stakeholder commitment continue to impede progress. Addressing these challenges requires integrated, multi-dimensional strategies that incorporate stakeholder perspectives, align infrastructure development, market mechanisms, policy enforcement, and capacity building to enable meaningful transition towards circularity in the construction sector. The effective implementation and adoption of circular economy and sustainable C&D waste management practices promote resource conservation and provide vital environmental benefits of reduction and mitigation of greenhouse gas emissions associated with the exploitation of virgin raw materials.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or non-for-profit sectors.

Declaration of generative AI use

During the preparation of this work, the authors used Microsoft Copilot to assist with language refinement, editing, and improving the clarity and structure of the manuscript. Following the use of this tool, the authors reviewed and edited all content as necessary and take full responsibility for the content of the published article.

CRedit authorship contribution statement

Obinna Benjamin Iwuchukwu: Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Simon McCarthy:** Writing – review & editing, Supervision. **Hemda Garelick:** Writing – review & editing, Supervision. **Diane Purchase:** Writing – review & editing, Supervision.

Declaration of competing interest

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.

Acknowledgements

The authors wish to thank Jeremy Hooper and David Sutton of the Division of Solid Waste Management at Tennessee Department of Environment and Conservation (TDEC) for their assistance and providing valuable C&D wastes records.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.scsadv.2026.100100](https://doi.org/10.1016/j.scsadv.2026.100100).

Data availability

No data was used for the research described in the article.

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