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Review

Circular Business Models for Construction Companies: A Literature Review and Future Research Directions

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Abstract: The construction industry, being material-intensive, is a major target for sustainability initiatives due to its significant consumption of energy and resources. In response, circular economy principles are gaining interest from the construction industry, since they benefit the environment and promote sustainable societal development. Nevertheless, the implementation of these circular economy principles has not been widely adopted by construction companies within the construction industry, indicating substantial room for improvement in areas such as coordinating policies, market conditions, and business model development for different actors within the project-based construction industry. The objective of this research is to explore the content of circular business models for construction companies, as they play a critical role in promoting the implementation of circular economy principles to foster responsible consumption of raw materials and mitigate the environmental impact of the industry. Current research in this field lacks systematic views, which may enhance understanding and provide a theoretical basis for researchers and construction companies transitioning toward circular economy principles. This article employs a literature review method of including 53 journal articles, where the content of analysis reveals 34 aspects related to circular business models for construction companies. Additionally, the study outlines future research directions, focusing on the intersections between different elements within the business model. The findings of this study offer valuable insights for policymakers on how to strengthen external support and the development of circular value networks to promote the adoption of circular business models from the perspective of construction companies.

Keywords: construction; business models; circular business model; construction company; literature review

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1. Introduction

The construction industry (CI), as a material-intensive industry, is a major target for environmental sustainability since it consumes a significant proportion of resources and energy [1]. This issue can be attributed to the linear economic model based on the "take-make-dispose" approach, which contributes to the construction industry generating over 30% of the use of natural resources and 25% of solid waste worldwide [2]. This linear approach in construction results in excessive material consumption without significant adoption of more responsible practices such as reusing, recycling, or recovering materials to conserve raw resources [2,3]. To address this challenge and mitigate environmental issues (e.g., carbon emissions, natural resource depletion, etc.), the CI needs to adopt strategies aligned with circular economy (CE) principles, which are fundamental to achieving sustainability [4,5]. Guerra and Leite [6] describe CE as the goal of preserving resources at their highest value, in an approach where no further natural resources are required to produce materials, and removed materials are not perceived as waste. This definition is similar to the Ellen MacArthur Foundation (EMF), which tries to promote the CE concept and published several reports to clarify the concept of CE as "restrorative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles" [7]. Additionally, Geissdoerfer et al. [8] discuss CE strategies identified by [9], describing CE as "a regenerative system in which resources input and waste, emission and energy leakage are minimized by slowing, closing and narrowing material and energy loops". These definitions show the alignment of this concept as a system trying to keep the resources at the highest value in a loop and minimize the leakage of waste, emissions, and energy. Several researchers within the field of construction management have followed and engaged in discussions on related topics [1,10,11]. Additionally, studies on reuse or recovery of waste materials, such as plastics and other demolition wastes for new construction projects, are increasingly emerging [12,13].

As CE is an emerging concept within construction, comparable to innovations such as construction 4.0, the industry needs to adopt the CE principles in a feasible way [14]. A system based on CE principles requires the adoption of suitable business models (BMs) that are grounded in using fewer resources for as long as possible while extracting as much value as possible in the process [15]. Osterwalder et al. [16] define a BM as "a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm". Further, Osterwalder and Pigneur [17] developed a framework called Business Model Canvas (BMC) to help visualize, analyze, and develop organizations' BMs, which has been proven to be a powerful tool for analyzing and visualizing the content of BMs [1,17] involving CE principles. The BMC consists of nine key elements: key activities, key partnerships, value propositions, cost structure, revenue streams, key resources, customer relationships, channels, and customer segments [17], making it a useful tool to map the holistic logic of operating businesses. Hence, organizations that want to adopt CE principles into their businesses may benefit from adopting new types of BMs, so-called circular business models (CBM), by altering their value propositions and creating value chains that offer reasonable cost efficiency, production effectiveness, and business performance [18]. Researchers have shown the importance of investigating CBMs for practitioners and researchers to better understand how to propose, create, and deliver value to customers, as well as capture the value generated [2,19,20].

Current management literature has emphasized that CBMs strive to maximize the efficiency of material and energy use [15,16,21–23], which has also gained high interest among researchers in the field of construction management [4,5,24–27]. Given the significant environmental impact of the CI, the application of circular construction principles has become increasingly important [19]. However, it has proven difficult to adopt circular principles in the CI [28], where context-specific peculiarities such as technical complexity (one-off products), market structures (unique supply chains), the mode of business (project-based), and the inclusion of multidisciplinary practitioners have been identified as key issues [29]. Munaro and Tavares [5] highlight the complexity of the construction value chain, which hinders the adoption of CE principles aimed at responsible material consumption and fostering sustainable construction. The lack of awareness among practitioners on how to incorporate circular principles into their current linear BMs and a lack of external support further increase the challenges for construction companies wanting to transform their business logic [19,30,31]. External support in the context of construction relates to policies (e.g., green public procurement) [32] and financial aspects, as well as a lack of market demand from the clients and suppliers [30]. This misalignment stems from conflicts between seeking economic benefits from the private developer's side and the long-term sustainability goal of the public sector [30,33]. These challenges, together with a lack of clear economic cases, have led to a slow adoption of CBMs within the CI, even though their effect on the environment is widely acknowledged [30].

There is an increasing amount of literature emerging on circular principles in construction that has focused on, e.g., the use of policies [34], the application of digital technologies [27,35–37], circular principles [2] such as reuse of concrete components and examples of closed-loop material flows [38,39], reshaping the supply-chain [40], and the challenges and driving forces faced when implementing circularity [5]. Several articles have conducted literature reviews to summarize the current development of the CE in the CI. These reviews include, e.g., a research framework for CE in the built environment [41], studies focusing on technical aspects such as design and material passport [2], and reviews identifying barriers and drivers for implementation of circular principles [5]. Previous reviews evaluate CE from a general perspective, encompassing dimensions such as technical practices, policies, and institutional factors. To facilitate the implementation of CE in the CI, the literature also highlights the importance of addressing not only technical issues but also socio-technical challenges [41]. This is due to barriers encountered in practices, e.g., lack of economic incentives [5,30] and the complexity of collaboration among stakeholders [28], indicating the need to further explore CBMs in the construction industry [2,19,41]. CBMs support construction companies in articulating the business rationale for adopting circular economy principles. They may offer a structured approach to assessing the costs and benefits, managing collaborations with key partners, and then integrating technical, economic, and social considerations into their decision-making processes. Several studies have made efforts to investigate the nature of CBMs in the CI, focusing on key activities [42] or value capture mechanisms [39,43]. Even though these areas are highly relevant for a company's circular business logic, very little attention has been given to the holistic development and use of CBMs, despite the fact that they have been highlighted as playing a vital role in helping construction companies coordinate their relationships with external environments, such as policy and legal frameworks, to adjust their business models accordingly [44].

Some attempts to structure the content of CBMs within the context of construction have, however, been made by, e.g., [4], who conducted a systematic literature review emphasizing the uniqueness of CBMs in the CI and proposed a revised CBM canvas for construction companies based on the seminal work of [16]. Further, Otasowie et al. [26] conducted a bibliometric study, identifying five research clusters emphasizing the need for more focus on CBM archetypes and deeper framework studies to increase understanding of this phenomenon for practitioners and researchers in the construction context. However, these studies do not delve deeply into the content of CBMs for construction companies, such as exploring what encompasses the value proposition involving circular principles. More specifically, previous reviews lack a systematic view of the detailed content of each BM element to support construction companies wanting to transform their business logic toward circularity. Consequently, the objective of this study is to conduct a literature review in an attempt to not only deepen our understanding of the content of CBMs for construction companies, but also to identify potential future research directions in the intersections between the elements. The study uses the concept of the BMC proposed by [16] to conduct the content analysis and also visualize areas for future research directions, which has proven to be a powerful tool for analyzing and visualizing the content of CBMs [1,17].

The article is organized as follows: Section 2 describes the process and analytical methods used for this review; Section 3 presents the content and results from the analysis;

Section 4 discusses the results derived from the content analysis and explores future research directions; and the final section concludes the article.

2. Research Method

The literature review has proven to be an effective method for providing a comprehensive overview of existing knowledge within a field [45], protecting data against bias [5,45], and interpreting literature in a trustworthy and acceptable manner [24,25,34]. This study intends to represent the emerging literature on CBMs within the field of construction management. The chosen method involves a three-step research process (Figure 1), similar to those previously proposed by [25,46].

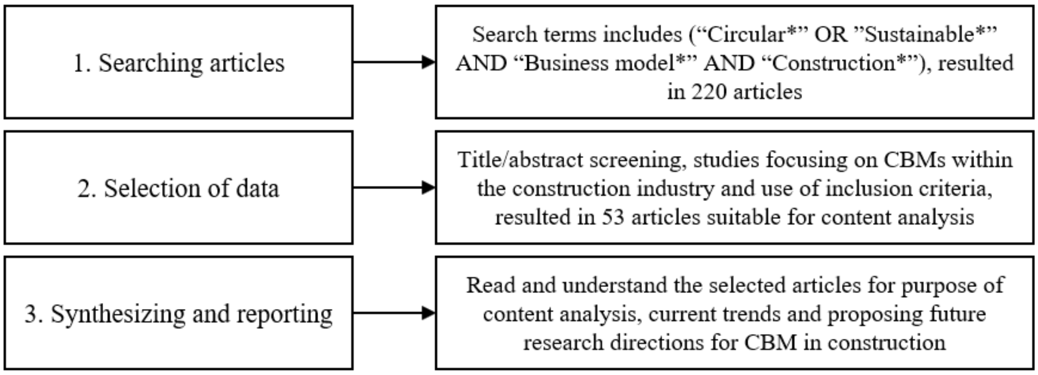

Figure 1. Overview of the research process. Source: The authors (2025).

1. Searching articles—The initial activities of the research process involved determining the use of databases and setting the search strategies. Scopus was chosen as the database for literature search due to its broad coverage and multidisciplinary scope [22,23,27]. Based on the purpose of this study, the search string in Scopus included the basic terms "Circular", "Business Model", and "Construction". Given the various ways of defining circular construction and discussing circular issues in construction [25], such as using the term "sustainable" to describe practices related to CE [1], the keyword "sustainable" was also included in the search string. The asterisk (*) was used to replace letters at the end of certain words; for instance, "circular" could represent "circularity". Therefore, the final search string used in this study was: "Circular*" OR "Sustainable*" AND "Business Model*" AND "Construction*".

2. Selection of data—After searching the Scopus database, 220 initial articles were identified. The next step was to determine whether the results collected should be included or excluded. To ensure the eligibility of the study, the following four inclusion criteria were set for selection:

1. Published in English, and the full text should be available.
2. Published in a peer-reviewed journal.
3. Contains information related to CBMs in the context of construction, not treating construction as a term for the creation of a certain concept.
4. Focus on overall descriptions related to CBMs for construction companies or content associated with specific elements of the BMC.

After applying these four inclusion criteria, 53 articles out of the 220 were selected for full screening and content analysis. The identified articles indicated that the field related to CBMs in the CI is fairly new and emerging. The number of articles has significantly increased since 2019, aligning with observations from [31]. This growth can be attributed to both the urgent trend of policies, such as the European Green Deal introduced in 2019, which reactivated the promotion of CE mentioned by the European Union in 2014, and the pressure from increased construction waste, rising material costs, and depleting natural resources [6,19].

The selected articles were published in different journals. The analysis shows that European countries conducted more than half of all the articles. This is consistent with [47], who emphasized Europe as the leading region in research related to circular construction principles. The database intentionally included studies from both leading (EU) and emerging (Asia) markets to capture regional variations in CBM adoption.

3. Synthesizing and analyzing—All 53 articles were downloaded into the NVivo 14 software for qualitative content analysis and then read with the purpose of synthesizing the content of CBMs for construction companies and proposing potential future research directions. The content analysis was divided into two stages: open-coding and categorization. Open coding involved extracting content related to CBMs for construction companies from the literature. During this analysis, notes and headings were marked in the NVivo software based on their relevance to the study's purpose. The analysis revealed that each article could contribute to several different topics of a CBM. Furthermore, all codes found in the literature were collected and discussed. This discussion showed that the codes aligned well with the nine elements of the BMC proposed by [17], which has found several applications and become widely used within the academic community [1,21,23] because it provides a clear, concise, and visual way to synthesize, categorize, and conceptualize findings regarding CBMs. The purpose of this paper is to analyze the state of the art of business models of the CE in the construction industry, so the framework of BMC was prioritized over other frameworks, e.g., PESTEL (Political, Economic, Social, Legal, Environmental, and Technological), since it can explicitly map how circular value propositions (e.g., material recovery) directly enable revenue streams (e.g., resale markets) which is a critical linkage for construction companies. As an overall blueprint, the BMC helps researchers and industry practitioners better understand the content of CBMs, laying a theoretical foundation for their business activities. Categorization involved classifying and combining different codes under the same element of the BMC to deduce various aspects. Based on the content analysis, the article summarized 34 aspects of the 9 elements of the BMC, see Figure 2. To enhance the reliability of the analysis, the codes and findings were discussed by all authors during continuous meetings.

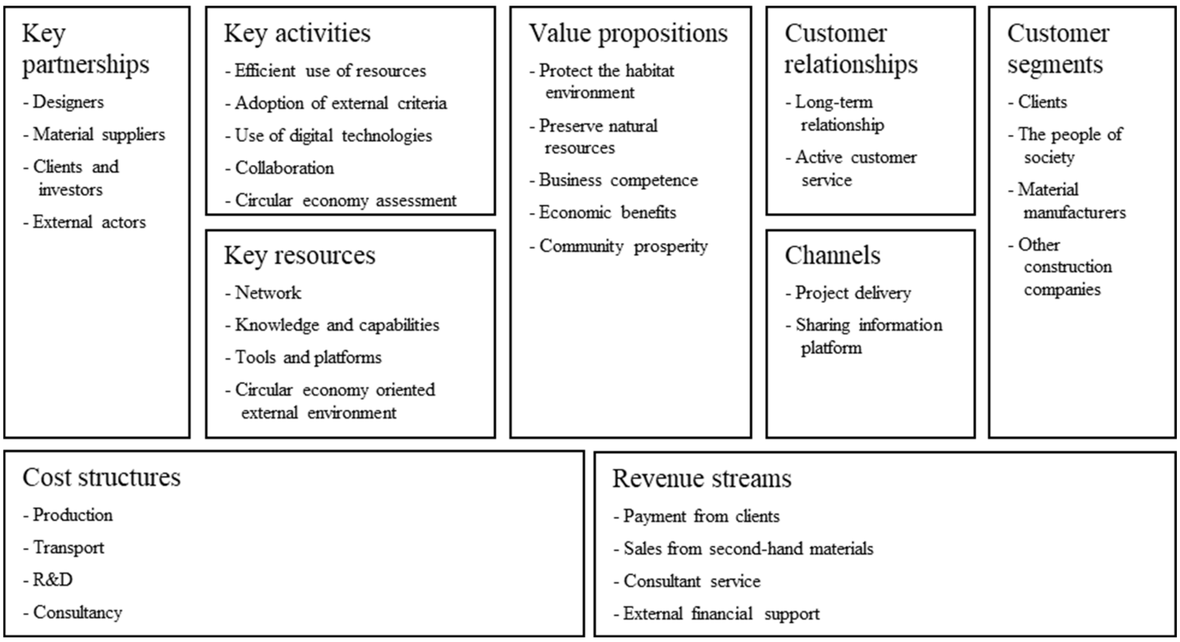

Figure 2. Summary of findings from the literature review. Source: Adapted from [17].

This study relies solely on the Scopus database, which may have resulted in the omission of some relevant literature, which constitutes a limitation of this study. Future literature reviews could address this by incorporating additional databases such as Web of Science and employing snowballing techniques to further develop the results. Furthermore, this study restricted the analysis to papers written in English. Future literature reviews are therefore encouraged to consider including publications in other languages to enrich and diversify the findings.

3. Results of Analysis

The emerging literature on CBMs has identified the need for a holistic perspective on BM aspects, as this would support the development and implementation of circular principles in the project-based CI [2,19]. The BMC is a crucial tool for analyzing BMs in detail, based on the nine elements of value propositions, customer segments, channels, customer relationships, revenue streams, key partnerships, key activities, key resources, and cost structure [17]. Among the reviewed articles, the most frequently mentioned element was key activities (30 articles), followed by key resources (19 articles), value propositions (17 articles), and cost structures (12 articles). This pattern suggests that previous studies on the adoption of CBMs in the CI have primarily focused on the activities and conditions to enable the circularity goals of companies. At the same time, increasing attention to economic feasibility reflected by cost structures indicates a shift toward a more systematic approach to adopting CBMs in the CI. In the following sections, we describe the BM aspects relevant for construction companies to shift to circular construction principles based on the analysis from the literature review, see Figure 2 for an overview of the results.

3.1. Value Proposition

The value proposition demonstrates a company's competitive advantage by providing a bundle of products and services for target customers [17]. This element is one of the most studied within the field of construction management [6,39,48]. The content analysis identifies five related aspects: protecting the habitat environment, preserving natural resources, business competence, economic benefits, and community prosperity. These are briefly described below; for more details and references, see Table A1.

Protecting the habitat environment relates to environmental value, including reducing waste generation, minimizing environmental impact (carbon emissions), and enhancing the environmental resilience of cities and infrastructure. This aligns with the primary goal of transitioning the CI to a CE, reducing the industry's heavy reliance on natural resources, and mitigating associated environmental issues, such as high volumes of construction waste and greenhouse gas emissions [35,49].

Preserving natural resources involves increasing material and energy efficiency through practices like recycling, reuse, and designing to minimize waste. This conserves natural resources, prevents overexploitation, and reduces on-site waste generation [39,48]. This approach minimizes environmental degradation risks associated with excessive construction waste and reduces greenhouse gas emissions by decreasing resource extraction and component manufacturing, thereby contributing to carbon neutrality and slowing down climate change.

Business competence relates to sustainable values. In terms of increasing competitiveness, CBMs provide companies with a market advantage by improving resilience, such as mitigating risks associated with raw material shortages or price fluctuations, while building valuable knowledge and experience in managing innovative projects [6]. This makes construction companies more trustworthy and capable of fulfilling client demands [39,50]. Circular construction practices enable companies to offer high-quality, affordable components [39]. By reusing or reprocessing materials, companies can improve their public image [48,51]. Additionally, reprocessed components from recycled materials can have unique aesthetic qualities, appealing to niche clients and markets [48].

Economic benefits are another aspect of the value proposition. CBMs may offer direct economic benefits to clients, including lower operational energy costs due to improved energy efficiency, enhanced investment performance resulting from a stronger public image, and potential reductions in material costs that enhance product affordability and market competitiveness [6,39,51–53]. For instance, some case studies have shown that the reuse of precast concrete elements could realize a decrease in material costs [39] under certain circumstances.

Community prosperity is the final aspect of the value proposition. Implementing CBMs in the CI remains an innovative area that has recently started gaining attention [19]. Compared to traditional construction models, CBMs require new activities and knowledge [29]. For instance, reusing building components necessitates considering disassembly during the design phase [39], and recycling or reusing materials requires efficient on-site management and recovery practices [36]. These new requirements can create job opportunities and develop new markets (e.g., for second-hand material trading, consulting services, and maintenance services), thereby fostering economic growth and contributing to community prosperity.

3.2. Customer Segments

Customer segments primarily refer to the segmentation of customers in the market [17], meaning the practices through which construction companies can add value. Overall, the main customer segments for construction companies implementing CBMs include *clients*, *people of society*, *material manufacturers*, and *other construction companies* that wish to implement circular business models. See Table A2 for further information and references.

Clients are the traditional customer segment in the construction context. The CI, characterized by its project-specific procurement processes and significant capital thresholds, typically limits customer types to either public or private investors. The long-term environmental benefits of CBMs do not typically attract private investment due to prevailing economic interests, especially in real estate, signaling a need for legal and policy reforms to bridge this gap [33,54]. Currently, it appears that successfully attracting customers often depends solely on their own interest in sustainability [49].

People of society is another aspect of the customer segment, related more to circular or sustainable construction. Despite the challenges related to implicit economic incentives mentioned above, there are economic incentives for adopting CBMs. Efficient energy use not only reduces operational costs for end-users but also enhances property values, benefiting clients [53]. Additionally, the unique aesthetic qualities of recycled materials can appeal to specific clients and users, further adding value to projects [48,53]. Due to the long lifecycle of construction products, the customers of construction companies can sometimes extend from clients to users, which is part of the people of society [55].

Material manufacturers are one aspect of customer segments. Construction companies implementing CBMs can extend their market influence beyond traditional roles. By repurposing construction waste as raw materials for other suppliers (e.g., concrete components), construction companies help close the material loop within a larger ecosystem, potentially creating new revenue streams [39,48].

Other construction companies are the last potential customer segment. Construction companies implementing CBMs can leverage their expertise in circular construction to offer consultancy services to other companies aiming to adopt similar models [39].

3.3. Channels

Distribution channels in the CI, as derived from the BMC framework [17], involve methods through which construction companies engage with and deliver value to their customers. Unlike industries with standardized distribution channels, such as automotive, where products reach customers through retail outlets, construction companies must adapt circular principles to the project-based nature of their industry [56]. Traditional channels in construction, therefore, include *project-delivery* methods, whereas *sharing information platforms* for secondary material information sharing or information exchange might be seen as innovative [42,57]. See Table A3 for further information and references.

Project-delivery that utilizes, for example, recycled materials or the reuse of building components in their value propositions can offer distinct environmental and economic benefits to clients [39,58]. These projects may extend beyond meeting client demands and align with sustainable development goals, providing a competitive advantage in the market. The efficiency of these traditional distribution channels in delivering value may, however, be questioned from a circularity perspective, as they respond to the unique requirements of each project and are restricted to the method of project delivery. The CI, compared to others, is heavily path-dependent, as practitioners often rely on proven work methods and traditional project-delivery practices [29]. Studies suggest that building ownership and the choice of project delivery method (e.g., Energy Performance Contract) can significantly impact the performance and perception of projects, particularly those aiming for energy efficiency [57].

Sharing information platforms are an innovative channel for connecting with customers. Recent studies have begun to explore these platforms. For instance, Janjirawatna et al. [48] suggest that construction companies (as a material supplier) could leverage owned websites, sales personnel, and industry exhibitions to establish connections with potential customers. Moreover, for exchanging information related to secondary materials or construction wastes, information platforms could also be related to the digital marketplace [35,38].

3.4. Customer Relationship

Customer relationship is related to acquiring and retaining customers and boosting sales [14]. According to the content analysis, it may, in the context of construction, refer to long-term customer relationships and active customer service. See Table A4 for further information and references.

Long-term customer relationship includes an opportunity for trust-building between the client or other customers and the construction company [42]. This kind of relationship could help build not only a stable project organization but also relationships that last between projects, easing the realization of circularity values and sustainability certifications (e.g., LEED, BREEAM) in project deliveries. Working with certifications to demonstrate high-quality delivery may also help create long-term relationships between actors and attract sustainability-oriented customers [38,39,55]. Economic benefits from CBMs in the CI have not yet been significant for clients [19,30]. However, the literature review has identified ways to positively influence the maintenance of customer relationships from a business perspective. Circular principles such as waste management and the use of materials composed of recycled materials could boost the reputation or improve the public image of the project, benefiting both clients and construction companies in maintaining their relationships [39].

Active customer service is another way to maintain and strengthen customer relationships. In this regard, the CI may share similarities with the manufacturing industry, where construction companies also act as suppliers of materials such as stone dust and construction waste, actively engaging with customers to maintain relationships [48,59].

3.5. Revenue Streams

Revenue streams represent income from customer segments [17]. The most common revenue stream for construction companies is payment from clients. However, by implementing circular value propositions, construction companies may establish more sources of revenue, such as sales from second-hand materials, revenue from consultant services like waste management and circular design services, and external financial support. See Table A5 for further information and references.

Payment from clients is the traditional revenue stream. This is a common revenue model in construction projects, where clients pay suppliers, such as construction companies, a certain amount of money to cover their construction costs and profits. In this context, customer satisfaction may be related to profitability and performance of the project, and construction companies can enhance the value captured by reducing resource consumption costs and minimizing waste [55,60].

Sales from second-hand materials is an important new revenue stream. The implementation of CBMs requires the development of a second-hand material market to simplify the use of recycled materials. Some materials from the construction site could be sold as sources to recycle or recover, adding a source of revenue for the construction company [48,61].

Consultant services is another aspect. Construction companies build knowledge and experience that could be used to develop a source of revenue. For instance, an experienced construction company could provide consultancy services for waste management, which is often sophisticated for a start-up or SME and causes additional cost and time [29]. Consultant services based on circularity principles, which help certain companies save time and cost, may, therefore, act as a revenue stream for experienced construction companies [48].

External financial support is another possible revenue stream in CBMs. This aspect primarily pertains to incentives such as bonuses or subsidies received from government bodies or institutions due to the innovative value of CBMs, such as environmental protection and energy conservation, which support the development and facilitate the transformation of projects [49,53,57,58].

3.6. Key Activities

Key activities differ based on the business type, but always include the most important activities that the company should operate to make the business work [17]. Findings from the literature review reveal that this element is well studied, and the content analysis identified five important activities related to CBMs: efficient use of resources, adoption of external criteria, use of digital technologies, collaboration, and circular economy assessment. See Table A6 for further information and references.

Efficient use of resources to mitigate the climate impact of construction activities includes principles of renewable energy, material recovery, waste recycling, and component remanufacturing. These principles contribute to a more efficient use of resources by minimizing waste, conserving natural resources, and reducing the use of raw materials [11,51]. Partnerships with other industries through industrial symbiosis have shown the potential to further enhance resource efficiency [58]. However, these principles often come with higher project delivery costs, which may be challenging, especially for SMEs (small- to medium-sized enterprises) [36,48].

Adoption of external criteria such as green building certifications (e.g., LEED, BREEAM) offers a structured path for companies to align with sustainable practices and achieve circularity [10,51]. The transition to circular practices requires robust external support from guidelines, policies, and partnerships, which can facilitate the broader adoption of CBMs. This involves negotiating better partnership agreements and advocating for supportive policies that offer long-term financial incentives for circular practices [19,54].

Use of digital technologies has been shown to be important in shifting the CI from a linear economy to a circular economy, enhancing resource efficiency and supporting CBMs [19,35]. BIM technology facilitates storing and tracking material information and supports the decision to reuse and recycle by addressing the fragmented construction supply chain [35,42,51]. Digital technologies may also facilitate stakeholder collaboration and bridge the gap in the second-hand material market by managing information flows and supporting communication [19,35]. They also have the potential to estimate the circularity potential early in the design phase [35]. Other digital technologies, such as AI for waste classification, Big Data for analytics, and blockchain for transparency, have also shown potential to enhance the construction sector's ability to implement circular principles [35,36].

Collaboration is crucial for construction companies implementing CBMs. The complexity of technology, traceability of material information, availability of special materials, and control of qualities all require collaboration with specific partners to meet these demands. Developing a specific collaboration network to ensure the availability of materials and smooth information exchange is essential. Additionally, collaboration and efficient communication between stakeholders both within and outside the project organization have shown to be important to reach targeted project performance [20,48,49,62].

Circular economy assessment is also identified as an aspect of key activities since it is essential to evaluate past decisions and guide future ones [63,64]. Evaluation tools for CBMs focus on assessing the performance of CE practices in projects. This ensures that projects operating under CBMs have a clear understanding of the gap between current situations and target performances [62].

3.7. Key Resources

Key resources refer to the capital (human and financial) that the company needs to operate its business [17]. The literature review reveals four different aspects related to resources for CBMs in construction companies: network, knowledge and capabilities, tools and platforms, and a circular economy-oriented external environment. See Table A7 for further information and references.

Network involves every stakeholder being open to CE practices and sharing knowledge about recycling, dismantling, and recovery [19,65]. Designers need to possess knowledge of designing materials and components for recyclability to facilitate the disassembly and reuse of building materials [66,67]. Overall, CBMs in the CI rely on a robust cross-sectoral collaboration network, including designers, suppliers, clients, and policymakers, who collectively drive the implementation and development of the CE.

Knowledge and capabilities also act as a key resource since the attitude towards the CE within the CI forms the foundation for the successful implementation of CBMs. Internally, especially in SMEs, a shifting attitude is crucial for developing a supportive corporate culture for the CE [29,68]. Additionally, educational and organizational learning processes are key avenues for shaping this culture, which could be concluded as lessons and knowledge for companies [68,69]. Digital and innovation capabilities also play an important role in the transition of construction companies from a linear economy to a circular economy model [70].

Tools and platforms that facilitate the implementation of CBMs include certification systems for secondary materials, physical and virtual assets, digital platforms for information exchange, etc. [36,48,68]. These not only promote the recycling of materials but also support CE practices in the CI.

Circular economy-oriented external environment, like policy support and market conditions, are external key factors that influence the implementation of CBMs [29,54,68]. Policies can incentivize companies to adopt CBMs by providing financial support, setting national standards, and more, while the demand for circularly manufactured products in the market also promotes the implementation of these principles [19,49].

3.8. Key Partnerships

Key partnerships refer to the network and actors needed to make the BM functional [17]. This element is well-studied. For example, Wuni and Shen [20] investigated the critical success factors for the implementation of circular construction principles and found that several factors relate to collaboration, such as early commitment of the client and knowledge and information sharing among the project organization. Due to the fragmented supply chain in the CI, collaboration among practitioners is imperative to accumulate knowledge and experience about circular principles in projects [42]. The key partnerships that construction companies need to develop according to the literature review are with designers, material suppliers, clients and investors, and external actors. See Table A8 for further information and references.

Designers play a pivotal role in the design phase, facilitating the reuse and recycling of materials. Innovations such as design for disassembly are critical in ensuring that materials are easily reusable or recyclable post-demolition [42,61,67]. To make the reuse or recycling easier for practitioners, design principles such as design for reuse and design for disassembly should be applied. These principles require collaboration between designers, construction companies, and suppliers of material or component inputs [20].

Material suppliers are another key partner, including recyclers, manufacturers, and component producers who are integral to the three primary activities of reuse, recycling, and recovery [15]. Effective collaboration with these suppliers is central for efficient waste management and resource recovery. In this regard, the material supplier plays an important role in ensuring that materials used in projects are at least partly waste-based materials (e.g., aggregates or biomass) [48,58].

Clients and investors significantly influence circular practices through procurement. Public procurement has shown the potential to serve as a catalyst for embracing CBMs [71]. For example, clients can promote circular principles by changing their demand to include more products made from recycled materials [29]. Early engagement with clients is crucial for the success of CBMs, yet there exists a tension between the pursuit of short-term economic gains and the long-term value offered by circular principles [20,33].

External actors include policymakers, governments, and research institutes. Policies can drive the adoption of CBMs by providing economic incentives for using secondary materials and simplifying certification processes [19,38,54]. Additionally, governments and research institutes may have responsibilities for proposing policies and incentives or helping identify the quality of reused components [54,57]. Furthermore, Scialpi and Perrotti [58] found that the challenge of finding suitable suppliers to realize circular principles could be decreased by collaborating with research institutions to assure the viability of materials, which causes higher costs.

3.9. Cost Structures

Cost structures refer to the money needed to operate the business model [17]. The cost for implementing CBMs for construction companies includes production, transport, R&D, and consultancy. See Table A9 for further information and references.

Production indicates the cost for business activities to construct and deliver the products, which includes labor costs, machine and equipment costs, material costs, and landfill fees. Moreover, for the successful implementation of CBMs, integral collaboration among different actors across the supply chain is considered significant [61]. Therefore, the cost of connecting each actor, i.e., the cost of establishing an information-sharing platform [42], could also be a significant cost for the contractor.

Transport is considered a significant part of the cost structure for construction companies. Selecting material suppliers is, therefore, a business decision that needs to be considered when implementing CBMs [52,58,60]. Suitable selection of material suppliers may not only decrease the cost by optimizing transportation distance but also decrease transport emissions.

R&D Research & Development of new materials and components could occupy a part of the cost structure in CBMs for construction companies. To resolve the concerns of architectural designers, research institutes play an important role in this process [58].

Consultancy costs may increase due to the novelty of circular principles in the design and construction phases [55,72]. However, as construction companies accumulate experience in projects, such costs may decrease.

4. Discussion

The findings reveal that the individual elements of the BMC are well covered in construction management on circularity [19,39,48]. However, according to [16], the intersections or relationships between each element need further investigation since all elements must be aligned for a BM to function well. Although some studies have highlighted the intersections among different elements in the business model, particularly by discussing the barriers and drivers of implementing circular economy strategies in the construction industry [19], it remains important to explicitly explore these intersections from a business model perspective. Doing so enables the company to better understand the relationships among various elements, which can facilitate both the design and implementation of circular business models. Based on the content analysis of the different elements, this chapter discusses four potential future research directions found in the intersections between different elements, including *coordinating the value propositions of key partnerships, more comprehensive assessment of cost structure for key activities, impact of new customer segments on revenue streams,* and *developing key activities to improve channels* (see Figure 3).

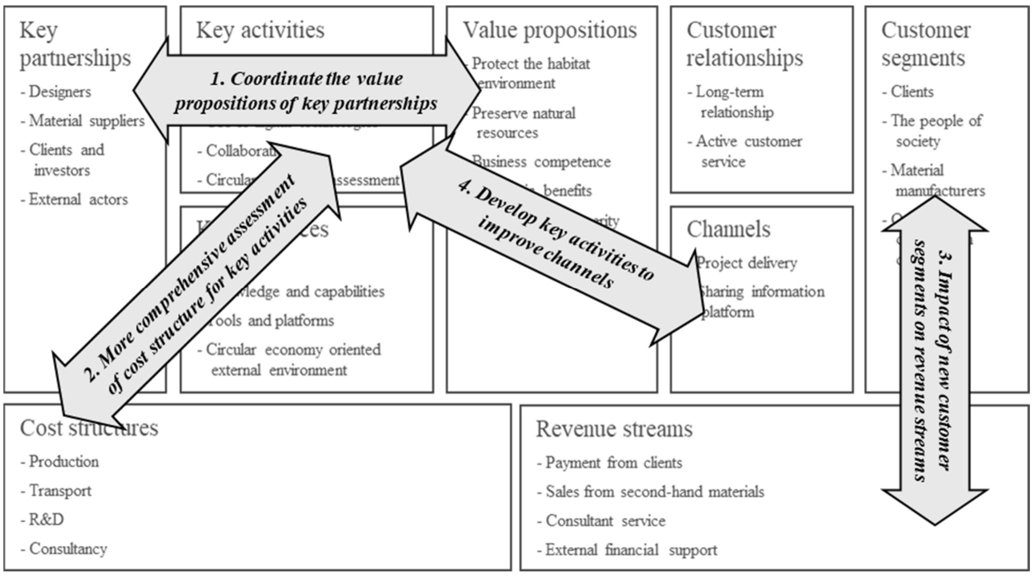

Figure 3. Future research directions in the intersections between elements. Source: Adapted and developed from [17].

Additionally, the project-based context of the CI often leads to non-continuity in supply chain collaboration and a lack of transparency in information, thereby incurring extra costs. The procurement methods are also limited, predominantly with owners procuring project services, which significantly impacts the owner's awareness and satisfaction with the project. Consequently, the success of a project can aid a construction company in securing future projects. Therefore, it is plausible to hypothesize an interplay between the implementation of CBMs at the project level and the company's transition to CBMs, warranting further exploration.

4.1. Coordinate the Value Propositions of Key Partnerships

Close collaboration based on circular principles within the supply chain is crucial for implementing CBMs for construction companies [40]. The implementation of CBMs necessitates tight cooperation among designers, architects, material suppliers, and others. However, actors within the construction supply chain vary in their understanding of both circular construction principles and the concept of BMs. Some actors may pursue short-term commercial benefits [33], others may depend on traditional construction methods [29], and some designers lack awareness of circular construction principles [30]. This diversity can lead to cooperation difficulties, including communication challenges and increased costs due to extended timelines of construction processes. Additionally, the client plays a vital role in facilitating the cooperation among actors through their procurement, e.g., green public procurement [32].

Therefore, exploring how to better facilitate collaboration among actors when implementing circular construction principles is a valuable research direction. It could help companies reduce communication costs and more effectively fulfill their value propositions. The value proposition, as an indicator through which companies communicate their business objectives to their target customers, may serve as a good entry point for studying how to better collaborate with key partners and develop strategic partnerships. For example, understanding what value propositions different roles in the supply chain should have can help facilitate the smooth implementation of circular construction principles in cooperation between construction companies and their partners, achieving their value propositions and delivering projects to customers.

The interaction between value propositions and key partners might also impact operational costs within the cost structure. Thus, incorporating consideration of lifecycle costs when studying the interactions between value propositions and key partnerships could better demonstrate and evaluate their collaborative effects. Given the project-based nature of the CI, it is challenging for individuals to collaborate across projects, adding complexity to the implementation of CBMs for construction companies. It is important for key partners to have a common goal or coordinated value propositions. The impact of aligning the value propositions of different actors in the project supply chain on the performance of construction companies and the role of maintaining specific strategic partnerships with coordinated value propositions in implementing circular construction principles are both worth exploring.

4.2. More Comprehensive Assessment of Cost Structure for Key Activities

Key activities within CBMs for construction companies continue to focus on improving the efficiency of material or energy use. However, the economic benefits of different circular principles may vary. For example, Cho et al. [11] provided a preliminary calculation of the economic benefits that can be derived from applying circular principles to construction waste materials. Overall, the implementation of circular construction principles offers significant economic benefits to society, rather than delivering short-term benefits for a specific actor.

Company-level challenges arise due to unfamiliarity with the process of handling construction waste, lack of infrastructure for waste management, and additional labor costs for waste processing or dismantling, which can lead to increased costs compared to traditional linear business principles [29,48]. Adams et al. [30] also highlighted the dilemma of lacking clear economically viable cases. Nevertheless, recent construction cases that have adopted circular construction principles have shown economic feasibility [39]. The key to cost reduction using circular principles is that the decrease in material costs, due to recycling, must outweigh the additional operational costs for testing and storing material away from the construction site. A systematic framework is needed to assist companies in making decisions to reduce construction costs using circular construction principles. Such a framework would be meaningful and likely attract private sector investment interest in circular principles within the CI.

Project-level versus company-level implementation of CBMs requires exploring the relationship between the costs associated with key activities. For instance, implementing CBMs might reduce material costs because of the internal recycling of materials across projects within the company. However, inter-organizational communication and transportation (between projects) could impact overall costs for the company. This interplay between project-level and company-level merits further attention for construction companies wanting to implement circular principles such as the reuse of materials.

4.3. Impact of New Customer Segments on Revenue Streams

In previous research, the customer segment element for construction companies has primarily been seen as relating to investors or clients [4]. However, results from the conducted review reveal that the customer segment encompasses not only clients but also positions construction companies as suppliers of recycled materials to manufacturers. The market for CBMs in construction is emerging, especially for established construction companies. However, small and medium enterprises face constraints due to a lack of knowledge and experience [40] and may encounter financial difficulties [29] that prevent them from investing in the development of necessary capabilities for circular construction principles. This situation creates a market for consulting services on circular construction principles for construction companies that are pioneers in implementing CBMs. This might be seen as a new customer segment, and its potential revenue streams should also be considered in developing CBMs, whether focused on recycling or reuse, to more comprehensively assess their value capture capabilities.

It remains worthwhile to explore the differences between project-level and company-level implementation. For instance, establishing strategic partnerships at the company level with new types of customers, such as manufacturers using recycled materials, may significantly aid in enhancing revenue across various projects. This warrants interest in how strategic partnerships can provide insights into how CBMs can be more effectively leveraged for economic gain for construction companies.

4.4. Develop Key Activities to Improve Channels

Delivering projects is the traditional method for construction companies to provide value to clients [39]. However, for CBMs, capturing and tracking material information and regional information-sharing platforms can significantly aid in integrating supply chains and scaling circular construction principles. Chen et al. [40] also highlighted the role of digitization in promoting circular principles on an urban scale, including finding suitable materials and key partners. While some studies have mentioned the role of information-sharing platforms [48], research on how construction companies can expand opportunities to connect with target customers and deliver valuable outcomes through digital technologies is limited.

From the perspective of construction companies, information serves as a critical resource for the successful implementation of CBMs. It plays a key role in activities such as identifying suitable material suppliers, tracking material flows, assessing the environmental and economic impacts of using recycled or reused materials, and conducting life cycle cost analysis. Integrating digital technologies such as material passports and Building Information Modeling (BIM) into business decision-making processes can enhance predictability and reduce associated risks. This integration appears to be a promising approach for facilitating the adoption of CBMs in the construction sector. Future research directions could focus on methods and cases where digital technologies are used to connect construction companies with clients and deliver valuable outcomes. Such research might encourage construction companies to take greater interest in adopting digital technologies and implementing CBMs, helping to scale construction projects based on circularity within certain regions. Establishing a digital platform can positively influence the development of channels for construction companies and their customer expansion. However, whether this platform should be established at the project level or the company level remains a question. It could be positioned either at the project level, as projects are concrete entities where value creation occurs, or at the company level to offer a broader perspective for selecting and connecting with customers across various projects. How projects and companies effectively coordinate in establishing channels and connecting with the market warrants further investigation to optimize interactions and enhance business outcomes.

5. Conclusions

This article conducts a literature review to explore the content related to CBMs for construction companies. The study employed the BMC framework as the foundational framework for visualizing the results of the content analysis. Through this analysis, elements relating to 34 aspects distributed across the nine elements of the BMC were identified. The research suggests that current literature on CBMs for construction companies focuses more on how to create projects and products with certain value propositions (e.g., preserving natural resources) than on how to interact and connect with the market to increase revenue and profit. An increased focus is needed on the economic benefits generated by projects implementing CBMs. For example, the implementation of reuse might potentially yield greater economic returns than recycling materials or waste management. The article also proposes interesting future research directions in the intersections between elements, which are significant for both the academic community and the industry in several ways.

By unpacking the abstract concept of CBMs for construction companies, this study enables researchers to more easily understand the content of these models and examine research gaps among different elements. Compared to previous studies on circular principles in the CI [2,40], this research focuses more on a holistic perspective, which includes a business perspective, summarizing the creation and costs of circular value, value propositions, and the connections between related activities and the market side. It identifies the key activities and client engagement opportunities within CBMs for construction companies, highlighting the potential for diversifying revenue streams. It provides a theoretical foundation for researchers conducting case studies on CBMs for construction companies. Additionally, compared to other review studies related to CBMs for construction companies [4], this study follows the BMC proposed by Osterwalder [17], specifically summarizing the content of CBMs for construction companies and discussing the interactions between different elements.

Under the aspects of customer segments and channels, the study proposes that construction companies could also focus on selling building components to material manufacturers and using information-sharing platforms to generate additional revenue. Additionally, the transformation from linear to circular BMs in construction is greatly assisted by the application of digital technologies. For example, digital technologies may ease decision-making during design, track material information at the end of life, and reduce the costs of construction waste sorting. Thus, the study helps researchers more intricately understand the structure of CBMs for construction companies.

For industry practitioners, this research aids in understanding the concept of CBMs and finding opportunities to integrate circular principles into and optimize their current BMs. Companies can also use the classifications of value propositions provided by the study to clarify their BMs and establish clear criteria for seeking customers and suitable partners. The framework based on the BMC serves as a cornerstone in their process of BM innovation. The contents of the CBM framework for construction companies can be adjusted and innovated based on the obstacles and drivers encountered during implementation, as well as internal and external conditions. Additionally, structural changes within the construction company also play a central role in the adoption of CBMs. The elements within the BMC can act as a guide to stimulate internal transformation, such as organizational learning.

For policymakers in construction management, this study is also meaningful. It helps policymakers identify ongoing issues in real-world applications, such as interactions between key activities and cost structures. This research outlines the structure of CBMs from the perspective of construction companies. However, the findings may inform policymakers on how to support and incentivize the adoption of CBMs within the industry by fostering a more enabling network or ecosystem. For instance, establishing funding schemes to support innovation in pilot projects could help reduce financial risks for companies. Additionally, promoting circular practices among actors across the construction value chain may lower the transaction costs associated with sourcing suitable suppliers. As a key form of external support, well-designed policies may play a crucial role in facilitating the transition of construction companies toward circular business models.

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Appendix A

Table A1. Value propositions of construction companies' circular business models. Source: The authors (2025).

Aspects	Concrete Descriptions	References
Protect the habitat environment	Reducing the waste generation	[6,39,48,50,59,73]
	Minimizing the environmental impact (carbon emissions)	[36,39–51,59]
	Environmental resilience of cities and infrastructure	[31,51,52]

Table A1. *Cont.*

Aspects	Concrete Descriptions	References
Preserve natural resources	Maximizing efficient use of natural resources Promoting the efficient use of energy	[11,39,44,48,59] [50,74]
Business competence	Reduction of volatility and risks from the market and supply chain High material or project quality with affordable prices Strengthening knowledge and competitiveness of enterprises Boosting the companies' public images Aesthetic value for clients who value sustainability or uniqueness	[6,11,15,44,75] [39,48,68] [11,39,50] [11,48,51,59,75] [39,48]
Economic benefits	Increased investment performance	[51,52,75]
	Effective costs on materials and practices	[6,36,39,48]
Community prosperity	Good work conditions and enhanced safety More job opportunities and economic growth	[48] [31,39]

Table A2. Customer segments Source: The authors (2025).

Aspects	Details	References
Clients	Owners and users Target customers are organizations that are open to reuse and interested in more environmentally friendly solutions (e.g., public housing organizations to meet such certification standards) [49] Public housing associations Social housing company (public clients) Organizations that are open to reuse and interested in environmentally impact solutions The customers who value the environmentally low impact Public governmental clients and private corporate customers The underlying reasoning appears to be that large developers can readily recognize the value of off-site construction	[72] [49] [49] [57] [49] [49] [55] [59]
Material manufacturers	The material and waste generated on the building site could be valuable for suppliers of materials (concrete, fly ash, etc.)	[39,48]
Other construction companies	Stone mining company that has problems with waste management To provide consulting services to other contractors	[48] [39]
People of society	Office tenants (the customer who hopes to use the building for office purposes) Considering the long lifetime of constructed products, customers beyond the initial clients to individuals The higher sustainability awareness of people who use and inhabit a building Economic benefits generated by the adoption of the circular business model for the whole society	[53] [55] [59] [11]

Table A3. Channels Source: The authors (2025).

Aspects	Details	References
Project delivery	PPP partnership in the energy efficiency projects PPP (Public and private partnership) and PFI (Private finance initiatives) are the only examples of business models that, at least in principle, aim at providing compensation for provided value EPC (Energy Performance Contract) Design build is used, which makes it less meaningful to introduce certain types of environmental preferences in the procurement stage Buy back and take back contract form	[57] [75] [75] [55] [33]
Sharing information platform	The digital marketplace Sharing platforms and digital marketplaces to manage information exchange	[38] [35]

Table A4. Customer relationship Source: The authors (2025).

Aspects	Details	References
Long-term customer relationship	To involve end users in the early design phase to co-create value from a project's early stages Actors with specific competencies may win more bids than conventional competitors Contractors should strive to meet clients' requirements to improve buildings' performance from the life cycle perspective	[59] [39] [55]

Table A4. *Cont.*

Aspects	Details	References
Long-term customer relationship	The expertise of the construction company to meet its customers' needs and the target customer would define the way that the company has to deal with its customers	[55]
	A holistic approach was adopted to maximize the opportunity for cost control. A firm-fixed-price, design/build framework enabled and motivated competing teams to incorporate energy efficiency as a minimum requirement, while assuring owners that the proposals would be economically feasible	[53]
	Try to meet the clients' sustainability-related requirements for the project	[38]
	PPP could stimulate the collaboration toward more energy-efficient services	[74]
Active customer service	24-h customer service	[48]
	Accept and respond to customer feedback	[48]

Table A5. Revenue streams Source: The authors (2025).

Aspects	Details	References
Payment from the clients	Value can be captured by decreasing resource and cost waste through lean approaches	[60]
	Among different project performances, client satisfaction and profitability are directly related	[55]
Sales from second-hand materials	The sales from secondary products	[49]
	Revenue from the sale of stone dust concrete	[48]
	Sales of used bricks	[49]
	The builders repurposed materials from their own demolition sites for subsequent sites or sold them	[38]
Consultant service	Revenue from stone waste management service fees	[48]
	Safe and efficient deconstruction BCR (Building Components Reuse) pilot references will be valuable in generating new revenues from future consultation projects	[39]
	Patents and trademarks for the stone dust business	[48]
External financial support	Incentive awards fee by the DOE (Department of Energy, US)	[53]
	Finance support and energy subsidies for the project	[53]
	Public funding to support technology development	[49]
	Monetary incentives	[57]
	External funding for development	[58]

Table A6. Key activities Source: The authors (2025).

Aspects	Details	References
Efficient use of resources	Transform the waste into new construction material	[49]
	Reduced waste and improved waste management, lower resource and energy consumption, and decreased transportation needs	[59]
	Waste management	[35]
	Waste trading CI	[76]
	Stone waste management service	[48]
	Implement recycled aggregated concrete instead of new aggregate concrete	[52]
	To recycle rubble to obtain aggregates	[60]
	Waste recycling (specifically open loop)	[6]
	Looping materials back into the construction of new projects	[38]
	Use the waste in civil construction for soil preparation and landfills	[60]
	Design for less use of concrete	[60]
	Design for reuse and recycling	[67]
	Reuse bricks or concrete	[49]
	Material reuse during construction projects, such as using metallic props to avoid the use of wood and techniques	[60]
	Reuse forms and metal struts for concrete reinforcement	[60]
	Reusable materials for construction	[72]
	Design strategy for both variable and standardized products	[59]
	Design building materials with durability and long-term environmental performance	[59]
	Energy efficiency practices	[57]
	Design for energy efficient and renewable energy	[53]
	Self-builders tend to invest in energy efficiency measures due to the long-term investment	[77]
	Practices for improved energy efficiency	[59]
	Design for the life extension	[51]
	The use of renewable energy	[51]

Table A6. *Cont.*

Aspects	Details	References
Efficient use of resources	The recovery of materials from waste	[51]
	In a consumer-focused approach, the design of the product as a service in the sector (PSS sharing model) (PSS: Product service system)	[51]
	Use-oriented PSS (services delivered via product functions)	[59]
	PSS model in façade	[56]
	The customers can rent a product for a set period of time and then choose to buy it outright or return it to the company for refurbishment	[67]
	Delivering the functionality instead of ownership (offers rotary parking to replace ownership)	[60]
	Long-lasting practices such as solar energy, rational use of water through rainwater harvesting, smart waste disposal, and external coatings	[60]
	Selective demolition, design out waste, and make savings	[6]
	Selective demolition uses alternative procedures for mapping, separating and sorting materials for reuse, recycling, and recovery	[38]
	Deconstruction of a building to redirect secondary resources into the building lifecycle	[66]
Adoption of external criteria	Adopt LEED and BREEAM principles as guidance to reduce carbon footprint	[72]
	The development and implementation of the sustainable building certification (CES) in Chile	[51]
	According to the UN's International Resource Panel, building certification systems are a strong tool to influence design and construction	[6]
	Adopt green project delivery principles to drive LEED, BREEAM, and smart buildings using BIM (Building Information Model)and IoT (Internet of Things).	[72]
	Projects certified by the green building rating system are more circular than others; LEED-certified buildings tend to receive high circularity scores	[63]
Use of digital technologies	Integrate IoT (Internet of Things) and BIM into the green business model to enhance green design and construction	[72]
	The implementation of a passport of materials for construction and asset management	[51]
	Digitalization, which supports the flow of information and traceability of waste	[54]
	Ensure product data integration for CE business models through computer modeling and blockchain for decision-making processes, choices of materials, business model coordination, and product redesign	[62]
	The classification of construction waste material using AI (Artifical Intelligence) technology	[36]
	Additive and robotic manufacturing	[35]
	Design optimization with AI technologies (could find the perfect solution for predefined performance criteria)	[35]
	Combined with other techniques such as big data and IoT; façade service application is an example	[35]
	AI to be used for end-use phase activities	[35]
	Big data analytics is used for training machine learning algorithms for the design	[35]
	Blockchain technology to share necessary information and leverage the collaboration of the supply chain	[35]
	Digital twins and the use of material passport	[35]
	RFID (Radio-frequency identification), radio frequency identification, can stimulate the reuse of construction components	[78]
	New circular business opportunities emerge with technological and scientific advancements	[31]
	AI technology to classify the construction waste materials	[36]
Collaboration	Develop a partner network to develop the standards to assure the material quality	[49]
	Develop a supplier network to ensure sufficient access to reused bricks	[49]
	Planning and permitting construction and demolition activities	[54]
	Research and development and marketing	[48]
	Communicate with internal and external stakeholders for a shared vision across the supply chain	[62]
	Integrate environmental and social criteria into the supplier selection process	[73]
	Green supply chain management	[58]
	A multi-stakeholder engagement would facilitate developing a CE roadmap, for example, through public/private partnership projects	[6]
	Communication between the procurers and suppliers in the value chain	[58]
	Communicate with internal and external stakeholders for a shared vision across the supply chain	[62]
	The communication within design and the timely feedback during the construction stage	[53]
	A design that consists of several stakeholders to integrate possible solutions	[53]
	Ensuring the necessary flow of information between stakeholders is crucial throughout the building lifecycle	[67]
	Collaborative working and information sharing among project teams	[20]
	To improve the reuse strategy, on a local scale, there is a need to foster stakeholder networking to locally manage the flow of materials	[19]
	Vertical integration of different sectors to buffer price volatilities	[44]

Table A6. *Cont.*

Aspects	Details	References
Circular economy assessment	Extending the time for the CE principles evaluation process for reconsideration of decisions made for CE projects	[62]
	Holistic and comprehensive evaluation of building materials and their sustainable alternatives	[52]
	The CE evaluation process would allow for reconsideration of decisions made for CE-implemented projects	[62]
	The evaluation of the economic feasibility of a sustainable business model for CDW (Construction & Demolition Waste)recycling	[79]

Table A7. Key resources Source: The authors (2025).

Aspects	Details	References
Supply chain and network	To create and deliver value, establishing a supplier network is a key innovation in the business model, ensuring adequate access to reclaimed bricks	[49]
	To facilitate the development of a circular value chain, a local network was established for private companies in the construction and demolition sectors	[38]
	Circular supply chain in start-up companies	[80]
	Networking is valuable for organizations and initiatives	[51]
	Identifying new circular business models in a win/win situation could create stable supply chain relationships	[19]
	Sustainable water supply projects with value co-creation and service ecosystems	[81]
Knowledge and capabilities	Human resource	[48]
	The market perception	[29]
	IT orchestration and CE innovation capability	[70]
	Professionalism and delivery of sustainability	[75]
	A change of business infrastructure and culture	[75]
	A systems-thinking approach, centered on a closed-loop system and enhanced stakeholder integration driven by environmental awareness within the value chain, is essential	[38]
	The lack of a sustainability-oriented vision can affect the transformation of strategies to competitive advantages	[65]
	Innovation knowledge collection, which could quantify the sustainability impacts of each project and let interested stakeholders learn from and engage with the technology providers	[82]
	Awareness of CE among leaders	[62]
Tools and platform	Physical assets	[48]
	Construction case developed a new waste collection and sorting system to estimate the volume of plastic, metal, and cardboard wastes	[29]
	Tools for assessment and evaluation	[64]
	The product platform is a strength for a company to create a material passport in a digital, standardized, and predictable manner	[42]
	Circular assessment tools	[63]
	A certification scheme that can guarantee their quality to potential buyers	[38]
	Use of environmental and economic life cycle assessment tools	[19]
	Easy access to a reliable waste trade platform	[76]
	Circular construction hubs	[83]
	Required physical assets	[48]
	An integrated design tool for technical, industrial, and business model generator	[61]
Circular economy-oriented external environment	Demands from consumers are necessary	[6]
	Clients and budget for projects are success factors	[6]
	New technologies provide possibilities and an environment for the development of sustainable resource management and new business models	[78]
	Incentives to design for disassembly and reuse at the end	[30]

Table A8. Key partnerships Source: The authors (2025).

Aspects	Details	References
Designers	Designers and engineers with a circularity orientation	[51]
Material suppliers	Logistic companies	[48]
	Partnership in biowaste supply	[58]
	Key partners for ensuring ample secondary materials for using in the project	[49]
Clients and investors	Municipalities (especially for public procurement)	[54]
	BASF actively participates in industry innovation to invest in innovative start-ups	[31]
	Local cooperation to close the loop and reduce the transportation costs	[38]
	Social housing corporations	[84]

Table A8. *Cont.*

Aspects	Details	References
External actors	Establish active partners (federal agencies, small and large businesses, academia, and non-governmental organizations (NGOs)	[53]
	Collaboration between academia, the public sector, and the private sector	[51,58]
	End users are crucial for material passports at the apartment level and during the use phase	[42]

Table A9. Cost structure Source: The authors (2025).

Aspects	Details	References
Production	Cost of green material for construction	[72]
	Increased profits for the economy through the purchase of these materials savings	[60]
	Cost for secondary materials, manufacturing process, and labor	[49]
	Investment costs	[85]
	Higher recycled materials	[6]
	Higher price for labor and new processes	[58]
	Cost for secondary materials, manufacturing, and labor	[49]
	Cost for facilities	[49]
	Hire a waste recycling contractor	[29]
	High costs for the waste management on-site	[76]
	Cost for deconstruction	[66]
	AI is used to decrease the cost of waste management	[36]
Transport	Increased profits from the savings related to the transport and proper destination	[60]
	Geographic proximity	[58]
	Considering the transport distance	[52]
R&D	Cost for the certification of secondary material and research and development costs	[58]
	Costs for technology development	[49]
Consultancy	Cost for innovative technologies	[72]
	More work is required in the design of green buildings	[55]

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