Circles of profit
A conceptual framework for economic and financial aspects in circular construction

Khadim, Nouman; van Marrewijk, Alfons

DOI
10.1016/j.spc.2025.03.007

Publication date
2025

Document Version
Final published version

Published in
Sustainable Production and Consumption

Citation (APA)
Khadim, N., & van Marrewijk, A. (2025). Circles of profit: A conceptual framework for economic and financial aspects in circular construction. *Sustainable Production and Consumption*, *55*, 444-457. https://doi.org/10.1016/j.spc.2025.03.007

Sustainable Production and Consumption 55 (2025) 444–457

Contents lists available at ScienceDirect

Sustainable Production and Consumption

journal homepage: www.elsevier.com/locate/spc

Review Article

Circles of profit: A conceptual framework for economic and financial aspects in circular construction☆

Nouman Khadim [a,b,*], Alfons van Marrewijk [a,b,c]

[a] Vrije Universiteit Amsterdam, Faculty of Social Sciences, De Boelelaan 1105, 1081, HV, Amsterdam, the Netherlands
[b] Delft University of Technology, Faculty of Architecture and the Built Environment, Julianalaan 134, 2628, BL, Delft, the Netherlands
[c] BI Norwegian Business School Oslo, Department of Leadership and Organizational Behaviour, Nydalsveien 37, 0484 Oslo, Norway

ARTICLE INFO

Editor: Prof. Idiano D'Adamo

Keywords:
Circular construction
Cost and finance
Circular Economy
Integrated literature review
Circular transition

ABSTRACT

Circular construction is an emerging paradigm aimed at addressing the sustainability concerns related to the construction industry. While technical and environmental aspects of circular construction receive ample attention, their economic dimension remains underexplored and is often limited to costs and micro-level factors, lacking a holistic perspective. In response, this study develops a multi-level conceptual framework to critically evaluate the economic and financial aspects of circular construction, through an Integrated Literature Review (ILR) of 45 academic and grey literature sources, complemented by interview data from actors involved in real-world circular construction projects. Four primary research clusters of economic and financial aspects are identified: (1) economic assessment methods, (2) benefits, barriers, risks, and enablers, (3) market guidelines and reports, and (4) circular business models. The findings reveal that economic and financial aspects are complex, extending beyond traditional cost and finance issues, and multilevel, shaped by supply chain dynamics, market forces and policy frameworks. As there is a high degree of interdependency among economic and financial aspects, any change can trigger cascading effects. Additionally, the study demonstrates how targeted interventions can mitigate multiple barriers and create positive feedback loops. The results contribute to the literature on the economic aspects of circular construction by broadening the traditional cost-focused approach and highlighting interconnected economic dynamics. Furthermore, the results advance the circular construction transition literature by illuminating relationships across multiple levels. Lastly, the study contributes to the literature on circular economy barriers and enablers by critically examining the underlying reasons behind existing barriers. By providing a structured approach to the economic and financial aspects of circular construction, the framework enables stakeholders to systematically identify and address barriers, costs, and uncertainties that often hinder its practical implementation.

List of abbreviations

CBM	Circular Business Model
CE	Circular Economy
EoL	End of Life
EU	European Union
GDP	Gross Domestic Product
ILR	Integrated Literature Review
JCR	Journal Citation Report
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
MCC	Multi Cycle Costing
NPV	Net Present Value
SDG	Sustainable Development Goals
TBL	Tripple Bottom Line
UKGBC	United Kingdom Green Building Council

1. Introduction

Environmental challenges, such as climate change, resource depletion and excessive waste production, stand as paramount issues in

☆ This article is part of a special issue entitled: Circular Economy 2024 published in Sustainable Production and Consumption.

* Corresponding author at: Vrije Universiteit Amsterdam, Faculty of Social Sciences, De Boelelaan 1105, 1081, HV, Amsterdam, the Netherlands.
E-mail addresses: n.khadim@vu.nl (N. Khadim), a.h.van.marrewijk@vu.nl (A. van Marrewijk).

https://doi.org/10.1016/j.spc.2025.03.007
Received 22 November 2024; Received in revised form 4 March 2025; Accepted 7 March 2025
Available online 8 March 2025

today's world (Bahadorestani et al., 2024). The construction sector, accounting for approximately 37 % of the global emissions and responsible for 36 % of solid waste production in the European Union (EU), faces a pressing need for transformative change (UNEP and IEA, 2019). The sector's reliance on a linear 'take-make-dispose' model is the primary driver of these issues (Khadim et al., 2023). Circular construction, grounded in Circular Economy (CE) principles (Wuni and Abankwa, 2023), is emerging as an effective solution to mitigate these concerns by narrowing, slowing, extending and closing material loops with the aim to retain the best possible utility of material and components at all times (Wuni, 2022a; Gillott et al., 2022). Circular construction reduces reliance on virgin materials and mitigates the risk associated with scarcity of valuable resources (Munaro et al., 2021). It replaces the typical End of Life (EoL) concept with regenerative alternatives aimed at reducing waste and minimizing the environmental footprints (Khadim et al., 2025). Pushing towards this direction, various authorities have placed the construction industry at the forefront of their national circularity strategies, e.g., the initiatives from the European Commission (2015) and Government of Netherlands (2016). Additionally, the EU's ambition to attain net-zero emission buildings by 2050 (European Union, 2019) further underscores the construction industry's pivotal role in advancing broader circularity and sustainability targets.

The growing popularity of CE can be attributed to its association with sustainability (Geissdoerfer et al., 2017; Nikolaou and Tsagarakis, 2021) as it is perceived as a 'way' or 'toolbox' to achieve sustainability (Schroeder et al., 2019). Implementation of CE can potentially impact the three pillars of sustainability—environmental, economic, and social—commonly referred to as the Triple Bottom Line (TBL) (Munaro et al., 2021), though a clear connection to the social dimension is yet to be fully established (Luthin et al., 2023). CE is crucial to achieve the 2030 agenda for sustainable development by directly addressing Sustainable Development Goals (SDGs), such as SDG-12 (responsible production and consumption) and SDG-8 (decent work and economic growth) (Schroeder et al., 2019). CE has the potential to lower reliance on virgin materials by 34 % and reduce greenhouse gases by 39 % (Circular Economy, 2023). In economic terms, CE can create new revenue streams, improve profitability and cost savings (Lundgren et al., 2024). It also creates job opportunities through the involvement of emerging actors like EoL waste processors, suppliers of reusable materials, and circularity specialists (Wuni, 2022a).

To fully harness the potential benefits of CE in the construction, extensive research on technical advancements has been undertaken. Innovations such as biobased and recyclable materials (Cascione et al., 2022), sustainable design strategies (Chen et al., 2024), digitalization of the built environment (Dervishaj and Gudmundsson, 2024), and eco-friendly waste treatment techniques are being actively developed. These technical circular solutions (also called technical circularity) have undergone rigorous environmental evaluations, demonstrating significant promise in reducing carbon footprints and minimizing waste generation (Balasbaneh and Sher, 2024). Despite extensive research efforts and numerous policy initiatives, the widespread adoption of circular construction remains limited, primarily restricted to pilot projects and a few individual organizations (AlJaber et al., 2023; Guerra et al., 2021). Implementing circular construction demands fundamental changes across the entire construction process, including how structures are designed, maintained, and deconstructed at the EoL (Khadim et al., 2023). This transition alters traditional concepts of ownership, associated costs, and fundamentally challenges established practices (Balasbaneh and Sher, 2024; Khadim et al., 2024).

CE has emerged as an environmentally centric paradigm, originally developed in response to environmental challenges (Geissdoerfer et al., 2017; Khadim et al., 2025). The predominance of the environmental dimension and 'technical circularity' in CE, overshadowing the economic and social aspects of TBL, has been consistently highlighted in literature (Kanzari et al., 2022; Uhrenholt et al., 2022). Within EU Horizon 2020 projects, engineering and technical aspects received significantly more attention than other dimensions (Kirchherr et al., 2018). This imbalance is also evident in CE assessment studies; Dainelli et al. (2024) found a lack of economic evaluations and a prevailing focus on environmental issues.

Economic aspects are increasingly recognized as critical to the success of the CE (Esposito et al., 2024). In the EU, market and finance-related challenges are the second most pressing concerns for stakeholders (Kirchherr et al., 2018). While economic gains may not be the primary goal of CE, they often serve as catalysts for achieving environmental and social benefits (D'Adamo et al., 2023; Kanzari et al., 2022). In the context of circular construction, high purchasing costs and unclear business cases are identified as significant challenges by stakeholders (Çetin et al., 2021). Financial obstacles are also noted to be more persistent than technical ones, often triggering a chain reaction that affects other areas of circular construction (Wuni, 2022b). Reflecting this,UK Green Building Council (UKGBC, 2019) advocates for viewing CE as a commercial strategy rather than solely a sustainability initiative, emphasizing the need to unlock its economic potential. Furthermore, economic factors also play a pivotal role in the adoption of circular reuse of building components (Rakhshan et al., 2020). However, despite the significant emphasis placed on costs and profit concerns by construction practitioners, many economic challenges remain underexplored in contemporary literature (Charef et al., 2021).

The construction industry is widely recognized for its conservative nature, resistance to change, and fragmented supply chain, which is often characterized by a historical lack of trust among stakeholders and a tendency towards opportunistic behavior (Leising et al., 2018; Eikelenboom and van Marrewijk, 2023). Construction organizations typically operate with a focus on short-term projects, prioritizing their profits and maintaining rigid financial reporting practices (Clegg et al., 2023). At the project level, these factors contribute to financial pressures that limit innovation, posing significant challenges to the adoption of CE. These limitations are further compounded by a reluctance to invest in circular construction, primarily due to the perceived high costs associated with its implementation (Braakman et al., 2021). Supporting this, multiple studies indicate that circular materials are often more expensive than virgin materials (Buyle et al., 2019; Wouterszoon Jansen et al., 2022), and that labor costs may rise due to required alternative construction techniques (Khadim et al., 2024). Similarly, scholars reported that deconstructing a building can cost 300–500 % more time than traditional demolition (Dantata et al., 2005) and required budgets can be 17–25 % higher, due to increased labor, time and disposal expenses (Zaman et al., 2018). Furthermore, the long service life of buildings (ranging from 50 to 100 years) and the complexity related to design and deconstruction make the financial dynamics of circular construction distinct, often rendering prevalent CE models, such as leasing, less applicable (Schut et al., 2016). Given these unique characteristics, it is crucial to study the economic aspects of circular construction with a sector-specific lens, ensuring that strategies are tailored to the inherent challenges of the industry (Palea et al., 2023; Dainelli et al., 2024).

Despite these challenges, several economic benefits are associated with circular construction. For instance, Wuni (2022a) identified 21 potential economic benefits of circular construction but noted that many benefits are 'speculative' and lack substantial evidence, often overlooking the complexity of value creation in construction. Furthermore, several financial barriers such as 'high investment costs' have been repeatedly highlighted in barrier studies over the years (Hart et al., 2019; Çetin et al., 2021; AlJaber et al., 2023; Ababio and Lu, 2023; Mont et al., 2017), yet effective mitigation strategies remain largely absent. Moreover, existing economic assessment methodologies such as Life Cycle Costing (LCC) pose significant limitations when applied to circular construction, leading to inconsistent results (Wouterszoon Jansen et al., 2020; Khadim et al., 2024).

The speculative nature of the claimed benefits can limit the adoption of circular construction. A comprehensive analysis that links the costs and financial challenges to the complexities of the supply chain and industry-specific context is missing (Braakman et al., 2021; Nußholz et al., 2020; Kanzari et al., 2022). There is an urgent need for a more rigorous and multi-level examination of what we term 'Economic Considerations', which encompasses both direct financial indicators and the wider market, regulatory, and business factors shaping the economic viability of circular construction (Nußholz et al., 2019).

Previous literature on the economic considerations of circular construction seems fragmented and usually explored along with other aspects. It is mainly focused on the identification of barriers, enablers and benefits (AlJaber et al., 2023; Ababio and Lu, 2023; Wuni, 2022b; Çetin et al., 2021; Charef et al., 2021), Circular Business Models (CBMs) (Lundgren et al., 2024; Ünal et al., 2019), and development and application of economic assessment methods (e.g. LCC, cost-benefit analysis etc.) (Balasbaneh and Sher, 2024; Wouterszoon Jansen et al., 2022). Few studies also explored the relationship between organizational culture and the economic sustainability of circular design (Chen et al., 2024) and the market perspective of circular construction (Schut et al., 2016). However, these domains have typically been studied in isolation, or with partial overlaps, but lack a holistic account of their interplay.

To the best of the authors' knowledge, no existing study in the construction management literature provides a comprehensive and multi-level analysis of the economic considerations in circular construction. This study addresses this gap by synthesizing and critically investigating the economic and financial aspects of circular construction through an Integrated Literature Review (ILR) (Snyder, 2019) and interview data from actors actively engaged in circular construction projects to develop a comprehensive conceptual framework. The ILR offers a broad, multi-level understanding by linking economic and financial dimensions to project, market and supply chain factors, and regulatory factors, while interview data validate findings and provide practical insights. The novelty of this study lies in its integrated approach synthesizing knowledge from multiple streams of construction literature—such as CBMs, barriers, and LCC—to develop a multi-level holistic framework. Unlike previous studies (e.g., Balasbaneh and Sher, 2024; Atapattu et al., 2024; Mahpour, 2023), our study provides a more holistic theoretical foundation and enhanced conceptualization of the economic dimension in circular construction. The study's novelty is further underscored by its sector-specific focus, offering a deep analysis from a circular construction perspective.

This study enhances the economic viability of circular construction by addressing existing barriers, positioning the economic dimension as a key 'enabler' of the circular transition. Construction practitioners can utilize these insights to make informed economic decisions, while policymakers can leverage them to develop regulations that better align economic objectives with circularity goals in the construction sector.

2. Methods

This paper employs an ILR methodology (Snyder, 2019) to develop a conceptual framework (Jaakkola, 2020) for economic considerations of circular construction. Unlike systematic literature review, which typically aims to compile exhaustive literature on a mature topic from a single knowledge domain (Snyder, 2019), an ILR aims to synthesize and critique the literature on emerging topics from diverse sources and domains (Torraco, 2005). This is particularly important for subjects involving significant qualitative research, where the quantitative focus of systematic reviews may fall short (Whittemore and Knafl, 2005). ILR method fosters the development of new conceptual perspectives, conceptual frameworks and a research agenda that identifies important questions for future research (Alcayaga et al., 2019). A conceptual framework, in this context, defines primary variables or constructs, previously unexplored connections between them, and explains how certain processes lead to a particular outcome (Jaakkola, 2020). However, the ILR method is incredibly complex, demanding advanced skills to synthesize data from diverse sources that employ varying methodologies. There is a risk of merely reporting existing literature findings without offering significant contributions to the body of knowledge (Snyder, 2019).

The initial literature search indicated that the research on economic considerations of circular construction is developing and is dispersed across various domains and knowledge streams in construction literature. In this regard, the ILR method enabled the collection and synthesis of articles from these diverse domains and streams, leading to a more nuanced conceptualization of the economic considerations of circular construction. Additionally, the ILR method offers the flexibility to incorporate articles beyond academic journals, including grey literature such as policy communications and reports.

While ILR method does not adhere to strict standards for data collection and analysis, the process must still be transparent and well-documented (Snyder, 2019). The choice of keywords, database, and data analysis methods are crucial parts of a literature review and can significantly impact findings (Khadim et al., 2022). Given the flexibility inherent in the ILR method, there is a potential risk of bias towards specific studies, which may result in overlooking important research (Torraco, 2005). To mitigate this risk and to ensure comprehensive coverage of relevant literature, a broad set of related terms such as 'cost,' 'finan*,' 'economic,' 'value,' and 'business' was used, with 'finan*' capturing all variants of the word (i.e., finance, financial). Additionally, CE-specific terms, including 'circularity,' 'circular economy,' 'circular construction,' and 'circular building,' were incorporated. These terms were searched in the titles, abstracts, and keywords of the articles, as illustrated in Fig. 1. The keyword selection process was iterative, with new terms added as needed to maintain rigor and reduce potential bias.

Three databases were utilized to cover a broad spectrum of literature; Scopus was selected for its status as the largest database of peer-reviewed articles; Web of Science was chosen for its comprehensive coverage of high-impact journals listed in the Journal Citation Report (JCR); and Google Scholar was utilized for its robust search capabilities, particularly in identifying grey literature (Khadim et al., 2022). The initial search in Web of Science and Scopus yielded over 1200 articles, which were then short listed to 789 articles based on preliminary exclusion criteria using the filtering options provided by the databases, as illustrated in Fig. 1. Only journal articles published in English with full-text availability were selected. To focus on recent trends, the search was limited to the past ten years (2014–2024). Given the multidisciplinary nature of CE, the search was not restricted to any specific research discipline. Due to significant overlap among the sources, 245 duplicates were identified and excluded, leaving 544 unique articles for further analysis. In the second stage, the titles and abstracts of the remaining articles were reviewed, resulting in careful selection of 42 documents. The main exclusion criteria were papers that targeted CE while discussing financial and microeconomic aspects, specifically focusing on building, construction, or the built environment. It is important to note that this review is centered on microeconomic factors at the project, organization, or supply chain level, excluding macroeconomic factors such as national economic indicators and GDP growth.

The exclusion of many articles can be attributed to the diverse meanings and contexts in which the search terms were used. For example, the terms 'construction' and 'building' may also refer to the general process of developing or making something (Khadim et al., 2022). Similarly, 'circular economy' inherently includes the term 'economy,' leading to some irrelevant results. Moreover, terms like 'business' and 'value' were often used in diverse and unrelated contexts within the abstracts of many articles. To ensure the rigor of the article search process, various combinations of the terms were explored in Google Scholar. Additionally, a forward and backward search—exploring the citations and references of the selected articles—was also performed through Google Scholar. This process helped discover an additional 19 relevant documents, including 11 government and company reports. This thorough process resulted in the selection of a total of 45 documents for the final analysis.

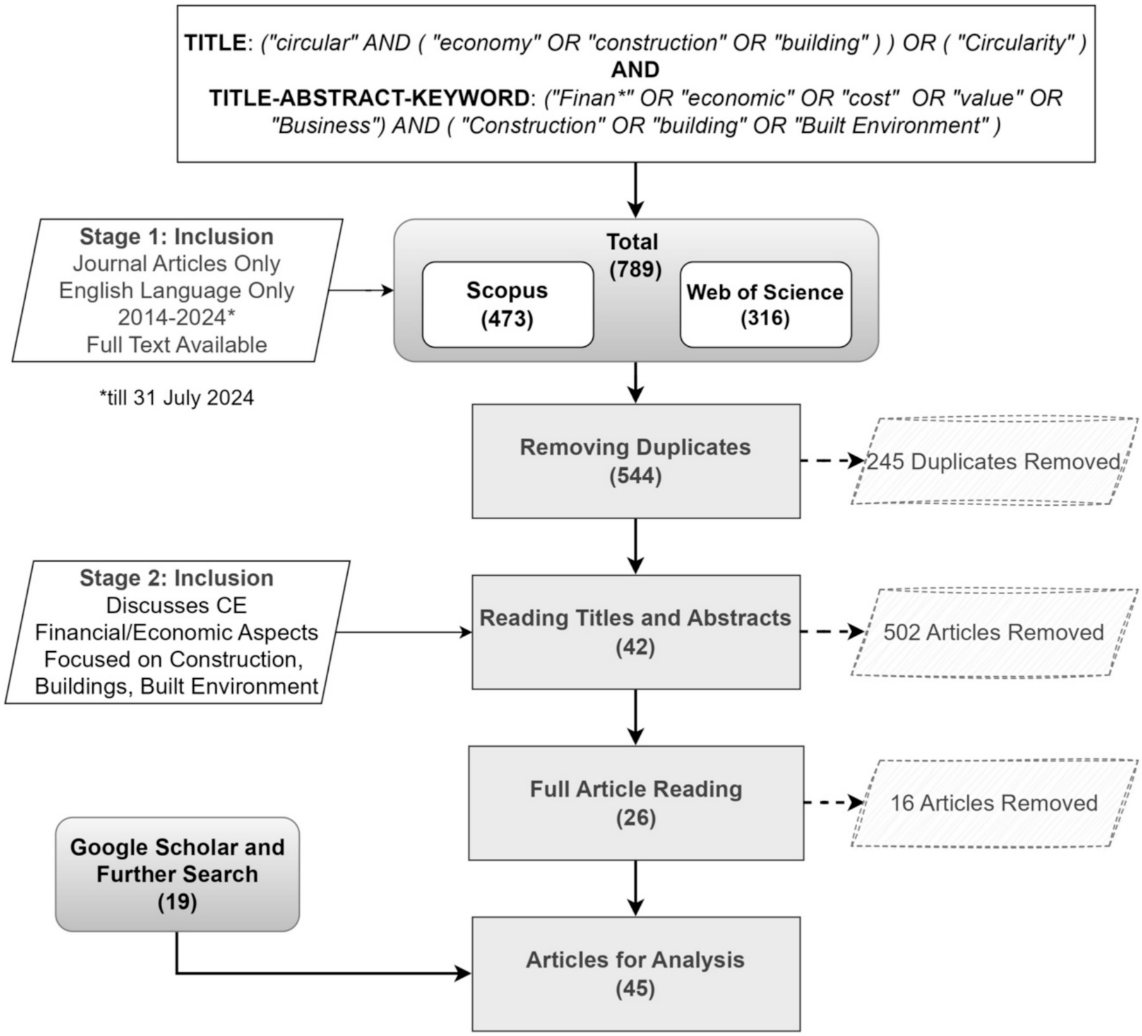

Fig. 1. Document Selection Process for Integrated Literature Review.

Following the ILR, critical bibliometric, descriptive, and conceptual analyses were performed (Wuni, 2022a; Khadim et al., 2022). For that purpose, each document was assigned a unique identifier and sorted in the MS Excel spreadsheets. A thorough reading of documents facilitated the identification of key concepts, primary discussions, empirical data, and major findings relevant to economic considerations of circular construction. Additional characteristics—such as country of origin, methodology type, publication year, central theme, and level of analysis—were also recorded. The data were organized into MS Excel, helping to identify main research themes, bibliometric details, conceptual insights, and key factors for inclusion in the framework (Wuni, 2022a). This analysis provided a synopsis of the selected literature, offering critical discussions on research focus, methodologies, gaps, and distinctive characteristics. Further, the literature critically discusses the variables and interconnections between them that were identified and documented in the spreadsheets. This rigorous process contributed to the development of a conceptual framework for economic considerations in circular construction, which is detailed in the subsequent section.

The framework is validated using a theoretical thematic research method (Braun and Clarke, 2006) through secondary data analysis of pre-collected data from three real-world circular construction projects in the Netherlands: the Circular Viaduct (May–November 2021), Accelerating Together (April 2019–early 2023), and the Hubs Project (September 2020–late 2024). This dataset, collected under the supervision of the second author, aimed to identify facilitating and impeding factors influencing inter-organizational collaboration in circular construction. It includes 103 semi-structured interviews with a diverse range of public and private actors actively involved in these projects. The thematic research method followed four key steps. First, all interview transcripts were carefully reviewed to familiarize ourselves with the involved actors, project specifics, and commonly used terminology. Second, respondents' discussions were analyzed to identify expressions related to financial and economic aspects, leading to the selection of 19 respondents (out of 103) whose insights were most relevant to the analysis. These respondents are referred to as R1 to R19. Third, the responses of these respondents were systematically coded to extract relevant insights. Finally, the coded data was mapped onto the (sub)elements of the framework, validating the literature-based findings and refining the framework's structure. This process enhanced the framework's practical relevance, ensuring its applicability in real-world circular construction projects. Fig. 2 provides an overview of the research methodology employed in this study.

3. Results

This section presents the results of the study, beginning with the findings of the literature analysis, which examines publication trends, research clusters, and their contribution to the development of a conceptual framework. The framework is then introduced, with each

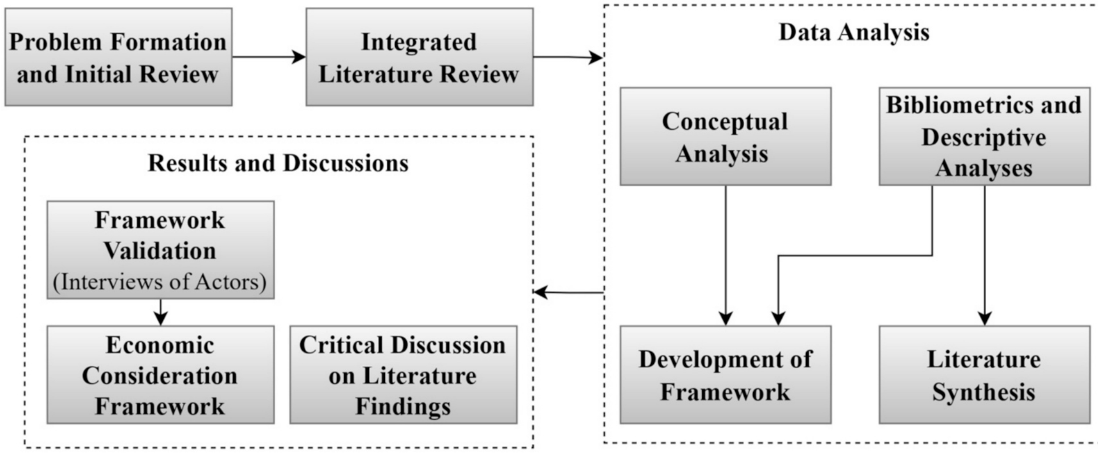

Fig. 2. Research methodology flowchart.

element explained in detail using insights from both the literature and interview data to provide a comprehensive understanding. Finally, the interrelations between framework elements are discussed, with examples provided, and targeted interventions are presented to address the identified challenges.

3.1. Literature analysis and framework development

The critical bibliometric analysis highlighted distinct characteristics of the studied documents. Most of the research originates from Europe (71 %), followed by contributions from Asia (22 %). Notably, the Netherlands appeared as the leading country, contributing 31 % of the work reviewed. This trend underscores the EU's strong emphasis on

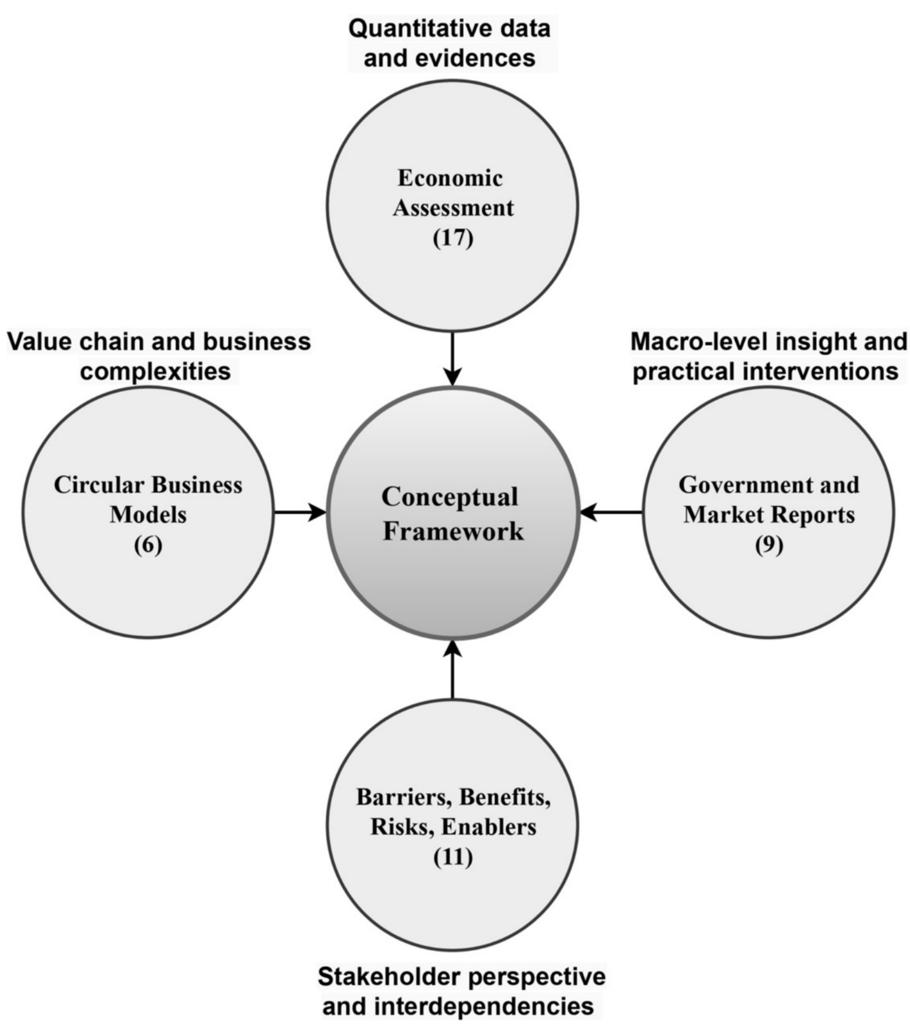

Fig. 3. Research clusters and their unique contributions to framework development.

circular construction (European Commission, 2015). Additionally, there has been a growing interest in this topic over recent years, with a peak of 11 documents published in 2022. Furthermore, it is found that the examined studies are distributed across various levels of analysis. The majority (16) focus on the industry level, followed by material and component levels (12), building or project level (8) and company or organizational level (5). This multi-level distribution of documents facilitated a deeper understanding of the economic considerations across different levels. Additionally, the content analysis identified the four primary research cluster of the documents: economic assessment methods; benefits, barriers, risks and enablers; guidelines and reports; and CBMs, as shown in Fig. 3. Each cluster offers a unique perspective, contributing to the conceptualization of key elements, their interrelationships, and potential bottlenecks, all of which are crucial for developing the framework.

The most prevalent research cluster centers on development and application of economic assessment methods, with 17 documents in the reviewed literature dedicated to this area. LCC emerged as the most frequently used method (Buyle et al., 2019; Wouterszoon Jansen et al., 2020), followed by Total Value of Ownership, cost-benefit analysis (Azcarate-Aguerre et al., 2022), and machine learning models (Rakhshan et al., 2021). Most studies employed quantitative methodology to evaluate the economic feasibility of circular construction. Particularly, LCC predominantly (6 out of 8 times) combined with environmental Life Cycle Assessment (LCA) to link the monetary values with the environmental benefits.

The importance of quantified assessment is also indicated by diverse interviewees. Respondent R5 emphasized the need for concrete financial data to support procurement decisions and performance monitoring in circular construction: *"We need to have concrete figures, like: 'In 2020, we purchased a certain percentage of materials circularly.' … But we don't have those numbers… If you want to get more people involved, having these figures is essential."* Other interviewees, for example respondent R6, highlighted that while quantitative assessments are valuable for tracking progress, stakeholders are primarily concerned with the practical steps needed to achieve these figures.

The economic assessment cluster provided quantitative insights into the financial benefits and costs of circular construction, emphasizing trade-offs between environmental and monetary values. Similarly, LCC and LCA offered a long-term lifecycle perspective on financial assumptions. However, methodological limitations of these assessment methods, particularly in the CE context, restrict comparability and limit the broader applicability of research findings.

Research on financial barriers, benefits, and drivers constitute the second most discussed topic among the selected documents. Studies within this cluster, predominantly conducted through systematic literature reviews and stakeholder interviews, provides insights into how financial constraints influence the adoption of circular construction (Charef et al., 2021). This cluster further highlights the interconnected nature of economic factors, demonstrating how financial barriers can set off cascading effects that amplify existing challenges in circular construction (Wuni and Abankwa, 2023). Given that many of these financial factors are shaped by regional policies and market conditions (Alberto López Ruiz et al., 2022; Schut et al., 2016), special consideration has been given to integrating these findings into our framework.

Governmental and organizational reports form the third research cluster. Developed by governmental ministries (Schut et al., 2016) and organizations like UK Green Building Council (UKGBC, 2019), these documents provide a macro-level perspective on financial challenges specific to circular construction and offer guidelines to address them, often supported by real-life examples and case studies (Oppen and Bosch, 2020). The studies in this cluster also shed light on governmental, policy, tendering, procurement and market perspectives, contributing to a more comprehensive and rigorous framework by incorporating non-academic viewpoints (Conde et al., 2022).

The fourth cluster focuses on CBMs, exploring how 'value' is proposed, created and delivered in circular construction, often through case study methodology (Nußholz et al., 2020; Ünal et al., 2019). This body of research highlights not only the crucial role of CBMs in enabling circular construction but also the challenges associated with their implementation. Specifically, it emphasizes the interconnectedness of CBMs with supply chain dynamics, market conditions, and policy frameworks, demonstrating how these factors collectively influence their feasibility and success (Nußholz et al., 2019; Munaro et al., 2021). By offering insights into business and value chain complexities, this cluster directly informs the framework developed in this study.

The synthesis of these diverse yet interrelated perspectives, captures the multilevel nature of economic considerations in circular construction, providing a strong foundation for the framework. Fig. 3 visually represents the four research clusters and their key contributions to framework development.

3.2. Conceptual framework

Circular construction transforms business practices, market dynamics, financial performance, contracts, and procurement methods, creating new revenue opportunities while also posing significant financial risks and uncertainties (Schut et al., 2016). These transformations fundamentally affect the costs, profits and the overall affordability of circular construction (Nußholz et al., 2020). While many of these economic factors have been discussed individually or with slight overlap, often under different terminologies such as 'financial,' 'economic,' 'market,' or 'business,' combined with terms 'performance', 'risks,' 'value,' 'barriers.' However, these issues are inherently complex, interrelated, and span multiple levels, from individual projects to broader policy considerations (Uhrenholt et al., 2022; D'Adamo et al., 2023). To address these intricacies holistically, the term 'Economic Considerations' has been introduced within this framework to encompass all relevant factors influencing the financial performance and economic viability of circular construction. Economic considerations include, but are not limited to, direct financial indicators such as costs, investments, revenues, and profits, as well as broader elements related to business, market and regulatory aspects including market mechanism, supply chain dynamics, business models, and policy challenges.

Fig. 4 illustrates the conceptual framework developed in this study which is structured around three primary elements: cost and finance (micro level), market and supply chain (*meso* level), and regulatory and policy (macro level) (Nikolaou and Tsagarakis, 2021). Each of these core elements is further divided into three sub-elements. An exhaustive list of economic factors associated to these elements, was identified from the selected literature. For instance, Charef et al. (2021) lists 34 such factors. However, to maintain comprehensiveness and parsimony, the framework organizes these factors into a more concise set of sub-elements (Kirchherr et al., 2018). This approach aligns with the framework's aim of offering a conceptual explanation, rather than merely listing all possible factors. Consequently, related factors that were listed as separate by other scholars have been grouped together. For example, 'huge investment cost for circular building project' (Wuni and Abankwa, 2023) and 'high upfront cost' (Hart et al., 2019) have been grouped and discussed under 'cost and investment' sub-element. We observed that there are multiple potential interactions both between the elements and within each element of the framework. A critical discussion of each element and these interactions is provided in the subsequent sections.

3.2.1. Cost and finance

Cost and finance refer to any micro-level changes in cash flows, costs, revenue streams, as well as associated financial risks, uncertainties, and financing models resulting from the implementation of circularity in construction. As a tangible and measurable aspect of economic performance, it is the most frequently discussed factor in the literature (Wuni, 2022b; Ababio and Lu, 2023) and remains a key concern for interviewees, particularly for clients and contractors who link value of

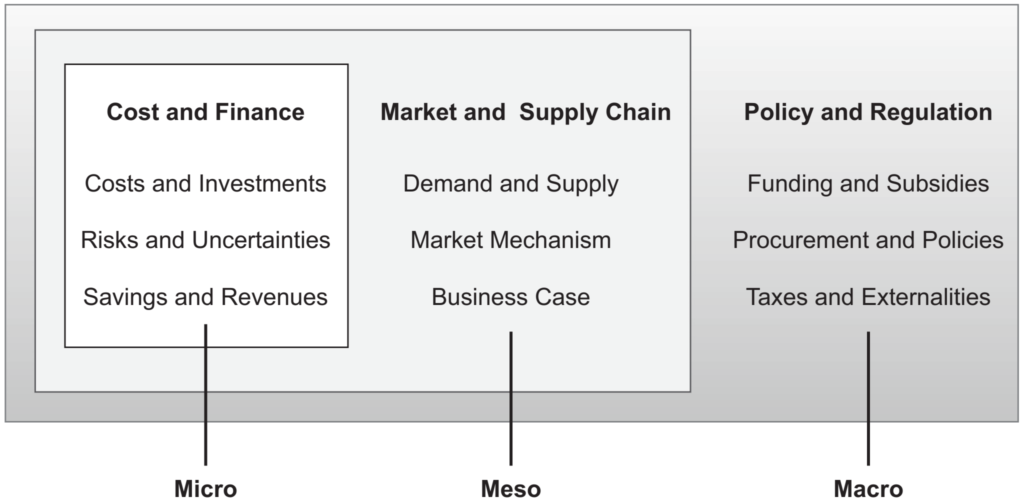

Fig. 4. Conceptual Framework.

circular construction to profits (Chen et al., 2024). While CE solutions should ideally be cost-effective due to use of secondary material, modular design, and generation of revenues from EoL activities (Wuni, 2022a), empirical evidence shows that circular construction can be costly, especially due to high initial expenses (Wouterszoon Jansen et al., 2022; Braakman et al., 2021), and poses considerable financial risks and uncertainties (Mont et al., 2017). Several factors, both direct and indirect influence financial dynamics of circular construction.

A key factor contributing to the high initial costs of circular construction is the relative affordability of virgin materials compared to their secondary or circular counterparts (Hart et al., 2019). This disparity largely stems from issues in pricing structures (Conde et al., 2022). Current pricing mechanisms fail to fully account for externalities, which gives virgin materials an undue cost advantage. Virgin materials often embody higher embedded energy and carbon due to resource-intensive processes. In contrast, the environmental impacts of secondary materials are lower due to distribution across multiple life cycles (Cascione et al., 2022). Despite these differences, both types of materials are subject to the same levies and certification requirements, and in some cases, circular materials may incur higher costs to comply with regulatory standards. This disparity has been termed 'unbalanced playing field' (Conde et al., 2022).

Similarly, the economic value of the demolition waste is insufficient to cover cost of high-quality demolition and reuse (Schut et al., 2016). The complexity of sourcing secondary materials from structures not originally designed for disassembly leads to resource-intensive complicated EoL processes, such as technical audits, disassembly planning, and careful deconstruction (Mont et al., 2017). Post-deconstruction, materials must be cleaned, sorted (onsite or offsite), even reusable materials require manual treatment (Rakhshan et al., 2020). Recovered materials may also fail to meet quality, health, and safety standards due to contamination, reducing their reuse potential.

Additionally, high logistical and storage costs arise from the bulky nature of construction materials, with transportation and storage being sensitive to the proximity of facilities (Mont et al., 2017). For example, respondent R14 noted the difficulty in sourcing secondary materials: *"It could be enforced, but then I'd need a bigger budget. That way, I could tell my contractor: Order that material from Turkey, transport it in a van, and lay it all out properly with blankets in between. Then maybe it would work."* These challenges not only add to cost of secondary materials but also create uncertainties in estimating the exact quantity and residual value of materials, complicating the business case for circular deconstruction (Charef et al., 2021). For material recovery to be economically viable, revenues from recovered materials must exceed demolition costs (Nußholz et al., 2020), as shown in Fig. 5.

The recovery challenge is further aggravated by the prevailing financing model in construction, which typically excludes demolition and recycling costs. Banks provide mortgages covering the structure and land, while EoL demolition costs are often borne by the society or new developers (Schut et al., 2016). This financial flaw makes linear solutions such as development on greenfield, more cost-effective than circular renovation or recovery, as municipalities earn profits from selling land rather than incurring the high costs of demolition of existing structures (Schut et al., 2016).

On the input side, secondary materials require innovative design, research and development, and permit acquisition that further drive-up initial costs (Leising et al., 2018; Gillott et al., 2022). Empirical evidence consistently shows that circular alternatives are initially more expensive (Balasbaneh and Sher, 2024; Lundgren et al., 2024), with costs up to 69 % higher than the least expensive traditional solutions during the early

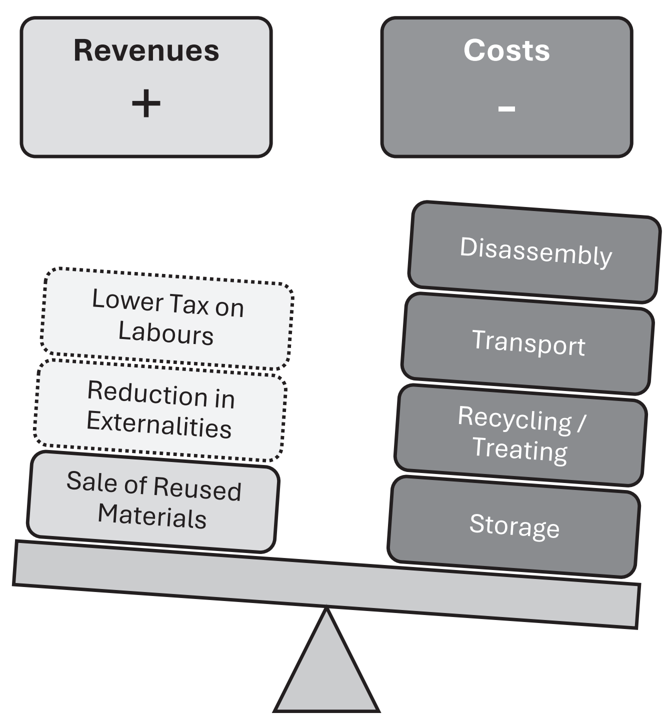

Fig. 5. Comparison of EoL demolition cost and revenues.

phases (Buyle et al., 2019). Although the total LCC of circular construction may eventually be lower than those of linear, this cost advantage can take up to 30 years to materialize (Wouterszoon Jansen et al., 2022). The short-term, project-based focus coupled with a historical lack of trust between industry actors (Eikelenboom and van Marrewijk, 2023; Clegg et al., 2023), underscores the urgency of reducing these high initial costs to accelerate the adoption of circular construction.

The lower LCC of circular construction is associated with low repair and maintenance, and EoL costs (Braakman et al., 2021). However, a lack of experience with long-term use of novel approaches, such as biobased materials (Schmitz, 2024), alongside uncertainties in the repair, maintenance, and EoL recovery potential, further heightens investment risk (Gillott et al., 2022). Wouterszoon Jansen et al. (2020) noted that circular alternatives result in high LCC if they fail to meet life expectancy targets. This increased risk also leads to higher insurance premiums (Schmitz, 2024).

Moreover, the extended lifespan of buildings, often 50 years or more, spreads cash flows over a long period, creating liquidity risks for construction firms (Mont et al., 2017; Ababio and Lu, 2023). This makes it difficult for companies to manage high initial costs, as returns may take decades to materialize, offering minimal contribution to early-stage valuations (Conde et al., 2022). Cash flow evaluations are typically conducted using Net Present Value (NPV) analysis, where future returns are discounted based on interest rates and external economic factors, introducing an additional layer of uncertainty and financial risks (Lundgren et al., 2024). Respondent R9, for example, noted that while circularity is beneficial, its financial value is only realized at the end of the chain, therefore, it is hard to maintain circular ambitions: *The financial benefit only comes after 30 years, when you have a higher residual value, I don't look at it from the perspective of how much money I can make from demolition."* Similarly, respondents R10, R12, and R17 emphasized that the lack of short-term financial benefits compels contractors to prioritize cost reduction to meet contractual obligations. However, respondents acknowledged the high initial investment but viewed it as a long-term commitment to achieving sustainability goals; *"Everything extra we invest must be recovered, No, you invest because you want to achieve a certain sustainability ambition."* (respondent R1).

Cost and finance (micro level) are particularly vulnerable to influences from other elements, such as business models and market dynamics (*meso* level) (Wouterszoon Jansen et al., 2022) and regulatory frameworks (macro level) (D'Adamo et al., 2023; Wuni and Abankwa, 2023). As shown in Fig. 4, these micro-level factors are nested within the meso and macro levels. Market dynamics—such as the demand and supply of circular materials, the availability of recycling facilities, and viable business models—significantly impact the costs and revenues of circular construction (Charef et al., 2021). Likewise, macro-level factors, including regulations on secondary materials, pricing and tax structures, and contractual frameworks, directly influence the financial structure and viability of circular construction projects (Conde et al., 2022; Wuni and Abankwa, 2023). Similarly, cost and finance also influence other elements. For instance, reducing the cost of circular construction can stimulate higher customer demand, which in turn attracts increased investment in circular construction projects (Kirchherr et al., 2018).

3.2.2. Market and supply chain

Market and supply chain refers to factors related to collaboration in the supply chain and acquiring materials and products in the market which affects the economic and financial performance of circular construction (Schut et al., 2016; Uhrenholt et al., 2022). The supply and demand for circular materials differ significantly from those of traditional materials. Conventional materials like steel and concrete are mass-produced, benefiting from stable markets, established standards, and relatively consistent pricing, with a wide range of suppliers (Conde et al., 2022). Their supply chains are demand-driven, making them less vulnerable to external disruptions.

In contrast, the supply of circular materials depends on existing structures, making it highly sensitive to factors such as geographic location, residual value, recycling infrastructure, and temporal availability (Meglin et al., 2022; Ünal et al., 2019). Additionally, the limited number of suppliers handling reused materials, coupled with weak market demand, further complicates the supply chain (Hart et al., 2019; Braakman et al., 2021; Lahane and Kant, 2021). Interview data underscores the crucial role of market demand in determining the viability of circular material. Respondent R16 emphasized that if no buyers are willing to bids for secondary material it signals a lack of market interest on circularity for that material; *"the market determines the value of these materials because if no money can be made from them, then they have no right to exist. Growth for profit is what I heard recently."*

The low demand for circular materials is largely driven by client perceptions and affordability concerns. Clients often view reused materials as inferior in quality and generally more expensive (Uhrenholt et al., 2022). Unlike energy-efficient buildings, clients do not anticipate significant financial benefits from circular buildings, making them unwilling to pay more (Schmitz, 2024). This lack of demand aggravates the challenges in creating a stable, scalable market for circular materials.

The lack of infrastructure results in downcycling and failure in developing mechanisms for the reverse flow of collected materials in the supply chain (Sajid et al., 2024). In the EU, downcycling of concrete into low-value recycled aggregates remains the most common EoL strategy, offering minimal economic benefits (Meglin et al., 2022). Similarly, the scarcity of dedicated recycling facilities for circular insulation materials results in inadequate waste treatment, thus diminishing their economic potential (Wiprächtiger et al., 2020). The absence of a functional market to sell extracted secondary materials often compelling companies to choose traditional demolition methods, forfeiting potential revenue from material recovery (Ababio and Lu, 2023).

Market competition driven by financial concerns makes actors hesitant to invest in circular construction (Braakman et al., 2021). As the sector is still developing, there is a prevailing belief that the first movers who invest in learning will likely incur losses, while those who follow will reap the rewards. As a result, companies often wait for others to take the lead (Kirchherr et al., 2018). This competitive dynamic also discourages firms from communicating lessons learned from circular projects (Eikelenboom and van Marrewijk, 2023). Though, supply chain collaboration and knowledge sharing positively affect the cost and value of circular products (Uhrenholt et al., 2022). Interview data further emphasize the importance of collaboration and knowledge sharing. For example, respondent R4 noted that while linear construction benefits from established processes and existing projects, circular construction requires experimental data and supporting evidence to manage its complexities.

CBMs hold significant potential in enhancing the financial competitiveness of circular construction (Nußholz et al., 2019). A business model outline how a company delivers value to customers by attracts revenue, and converts that revenue into profit (Munaro et al., 2021). Interview data signifies the critical role of a well-defined business case. Respondent R7 acknowledged the lack of clarity surrounding circular ambitions due to the early stage of transition, while respondent R13 highlighted that this uncertainty results in circularity receiving less attention compared to other sustainability concepts: *"Energy savings get about 90% of the attention. That's because it is, of course, the easiest to implement and the fastest to link to concrete goals and measurable results"* (respondent R13). Circular strategies do not inherently lead to carbon or cost savings; a robust business model is essential to unlock these benefits (Nußholz et al., 2019). In circular construction, contractors' responsibilities often extend to the EoL demolition of structures, which may require construction firms to either expand their portfolios to include demolition services or outsource the EoL phase. This extension of responsibility significantly impacts the financial structure and overall business case. Similarly, already discussed issues regarding difficulty in estimation, financial uncertainties and risks create concerns about clear business case as profitability is lined to collected volume and external economic factors (discount rates). For example, respondent R2 pointed out the financial strain on contractors in circular construction, stressing the need for equal value distribution: *"Contractors have actually been underpaid for what they do for as long as anyone can remember... these companies must be able to earn a fair and sustainable income."* Another complexity associated with CBMs in the construction is its heavy reliance on other sectors, as construction materials and components are sourced from a wide range of industries (Bon and Hutchinson, 2000). As a result, the circularity and associated economic value of construction are also dependent on the circularity of these external sectors. Therefore, achieving clear business case for circular construction also requires macro-level changes.

Supply chain and market dynamics can significantly influence and regulate the costs and finances associated with circular construction (Wuni and Abankwa, 2023). At the same time, regulations and policies shape the behavior of these markets and supply chains (Uhrenholt et al., 2022). Therefore, market and supply chain are nested in regulatory barriers, as shown in Fig. 4. For example, obstructive laws and regulations can create unsupportive supply chain environments, which, in turn, drive up the costs of circular materials.

3.2.3. Regulatory and policy

The regulatory and policy element encompasses those macro-level factors such as policies, procurement regulations, taxation, and subsidies that significantly influence the costs and financial risks associated with circular construction (Lahane and Kant, 2021; Dziedzic et al., 2025). Many barriers, such as unsupportive supply chains, pricing issues, and compliance costs, stem from existing policies and regulations (Uhrenholt et al., 2022). Policymakers and national and local authorities play a crucial role in this context (Kirchherr et al., 2018), as they can help make circular construction economically viable by regulating markets and supply chains at the *meso* level, and projects at the micro level through targeted interventions (Wuni and Abankwa, 2023).

Lack of funding and subsidies has been reported as a major barrier to the transition towards circular construction (Çetin et al., 2021; Hart et al., 2019). Funding and subsidies are fundamental to this transition, as it is often the first crucial step in many countries to build the necessary capacity, infrastructure, and knowledge to implement CE solutions at scale (Circular Economy, 2024; Dziedzic et al., 2025). Funding is required to execute ambitious circular projects with experimental materials, research and development and knowledge sharing platforms. In the current developing stage, funding and subsidies can help curb the high initial cost as well as to engage universities, researchers, practitioners and society at large to encourage them to take part in circularity transition in construction (Ababio and Lu, 2023; Uhrenholt et al., 2022).

In addition to funding limitations, traditional procurement processes present substantial financial challenges for both contractors and suppliers (Wuni and Abankwa, 2023; Lahane and Kant, 2021). Typically, these processes prioritize securing the highest quality at the lowest possible costs (Sajid et al., 2024). This cost-driven approach often leads to the development of rigid technical tenders with predetermined project specifications. Such constraints limit practitioners from utilizing their expertise to innovate, as their primary focus is on fulfilling project objectives within the confines of budget constraints (Oppen and Bosch, 2020). Consequently, this leads to moving away from each other, while a collaborative mode of working is needed for achieving circular construction goals with flexible circular contracts that frequently incurs higher costs but delivers improved environmental and social values (Sajid et al., 2024). The importance of translating circular construction ambitions into clear procurement criteria is often highlighted as a critical step to effectively prepare markets and supply chains for this transition (Schut et al., 2016). This can include strategies such as integrated project delivery and incorporating circularity as a key criterion in the evaluation of tenders (Oppen and Bosch, 2020).

Multiple respondents stressed the financial and regulatory constraints imposed by procurement and regulatory practices. Respondent R14 pointed out that circular ambitions often lead to higher costs, making it challenging to secure bids: *"In the tendering phase, my budget and contract sum would become so high that they would choose a smaller contractor… and I end up with my green vision and green budget, but without the project."* Similarly, respondents R10, R12, and R17 emphasized that construction actors deprioritize circularity goals as they are not regulated criteria like cost and time. As R10 stated, *"Why prioritize this (circular) aspect when I don't get any immediate return from it? I would only do it if regulations required it."* Furthermore, R15 highlighted the complexity of procurement laws in achieving circular objectives, noting that enforcement mechanisms are weak once contracts are awarded. R15 stated *"You cannot later revoke the contract just because the contractor did not meet an effort obligation to achieve a higher circularity rate for each demolition project."* Adding to this, R19 referenced the case of Amsterdam, where sustainability requirements are mandatory in public tenders, yet full compliance remains unachieved due to the absence of regulatory measures. These insights reinforce the framework by demonstrating how procurement policies and regulatory gaps influence the economic viability of circular construction.

Furthermore, obstructive regulations and policies significantly increase the costs associated with circular construction projects (Sajid et al., 2024; Dziedzic et al., 2025). Secondary materials are required to meet the same standards as virgin materials. The absence of CE certification (Wuni, 2022b) and difficulties in obtaining permission (Azcarate-Aguerre et al., 2022) are critical policy barriers, often leading to delays, additional effort, and increased costs. Furthermore, waste treatment regulations influence project costs. For instance, Alberto López Ruiz et al. (2022) noted that regional differences in landfilling fees reduced the cost of concrete disposal by 15 %, which may incentivize landfilling over circular alternatives. Similarly, policies related to ownership pose legal barriers, as buildings often change ownership throughout their lifecycle, creating legal complexities around liability and intellectual property (Conde et al., 2022). These ownership changes also create challenges for the implementation of circular revenue models such as pay-per-use, leasing, and sharing (Oppen and Bosch, 2020).

Governments and policymakers play a crucial role in taxation of circular construction (Schut et al., 2016), and are perceived as significant financial obstacles in the transition (Hart et al., 2019). Current tax frameworks often fail to account for externalities, which inadvertently provide a cost advantage to the use of virgin materials (Sajid et al., 2024). By internalizing environmental and social costs, taxation systems can translate these values into monetary incentives, helping to balance the costs and revenues associated with secondary materials, as illustrated in Fig. 5.

Regulatory and policy represent the most independent elements within our framework (Wuni and Abankwa, 2023; Uhrenholt et al., 2022). Regulation and policies play significant role in shaping supply chains (meso level) and can significantly impact the costs (micro level) of circular construction. Factors such as procurement regulations and taxation schemes, though beyond the scope of an individual projects or organizations, exert significant influence over their economic dynamics. Therefore, cost and finance, and market and supply chain are embedded within the regulatory and policy, as illustrated in Fig. 4. Although actions are required at both the supply chain and project levels, policies and regulations function as overarching mechanisms that help to remove barriers and ensure the transition remains on course. Further, it is acknowledged that policies and regulations can be influenced by factors such as political or cultural. However, the focus of this study is on the microeconomics of circular construction, these factors are outside the scope of this paper.

3.2.4. Interrelations and potential interventions

The elements within our framework are interdependent, with multiple potential interactions between the various (sub)elements, collectively forming a complex system or chain reaction. Changes in one (sub) element can trigger cascading effects across others. In addition to induvial (sub)elements, understanding of their interrelations and potential interventions are crucial (Wuni and Abankwa, 2023). This understanding helps in visualizing the complex multi-level interactions and demonstrates how targeted interventions can improve the financial performance of circular construction.

There are several possible examples to illustrate these interactions; one such example is presented here. As shown in Fig. 6, supportive policies can reduce taxation on CE activities, subsequently lowering secondary material cost (Wuni and Abankwa, 2023). Additionally, supportive policies also stimulate the development of infrastructure and knowledge related to CE that can reduce uncertainties and improve the feasibility of recycling and reuse, further driving down material cost (Çetin et al., 2021; Schut et al., 2016). Correspondingly, a reduction in material cost can generate higher demand for CE, which subsequently elevates the interest of contractors and suppliers in offering circular solutions (Kirchherr et al., 2018). In addition, reduced material costs can increase revenues thus improving the profitability and leading to further market interest. This resulting surge in market interest will also contribute to infrastructure development and knowledge building, creating a reinforcing feedback loop.

Beyond these discussed interactions, numerous other potential linkages and variables can be incorporated into Fig. 6, making it further complex. The multi-faced and multi-level interaction of economic considerations emphasizes the significance of adapting a system approach. A systems approach provides a holistic understanding of complex systems by highlighting interdependencies and interconnections between various elements. It help understanding the dynamics and how these interactions may lead to certain outcomes that aids in development of interventions to optimize CE practices (Iacovidou et al., 2021). Our framework highlights similar dynamic, where addressing one barrier can trigger the elimination of others (Kirchherr et al., 2018), ultimately enhancing the affordability and economics of circular solutions (Uhrenholt et al., 2022).

Several interventions to improve the economic performance of circular construction have been identified from the literature and interview

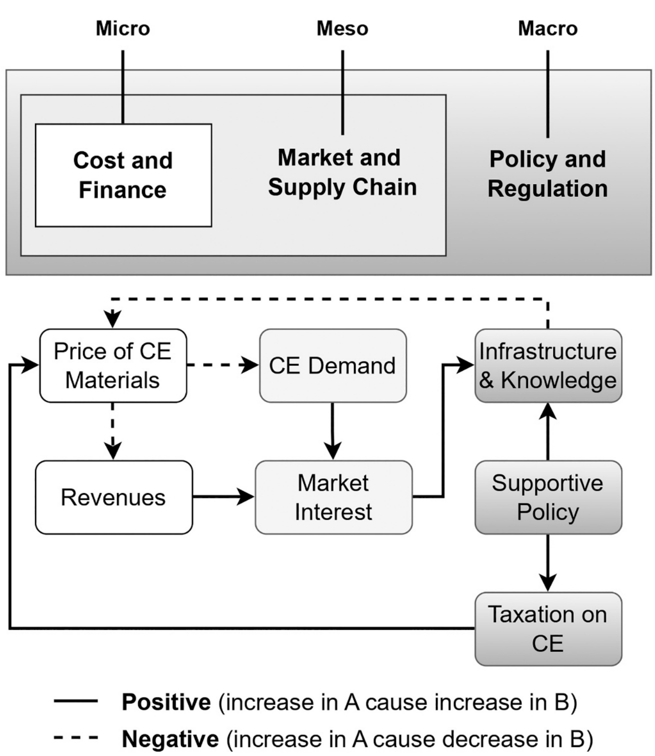

Fig. 6. Example of interactions between (sub)elements within the framework.

data. These interventions are presented here as they offer ways to address key economic challenges outlined in our framework and deepen the understanding of economic considerations.

Many scholars advocate the implementation of financial incentives aimed not only to reduce costs but also to motivate stakeholders across the construction sector (Wuni, 2022b; Dziedzic et al., 2025). For instance, offering higher remuneration to designers could encourage the adoption of circular design, which typically require more time and effort (Gillott et al., 2022). Designers should prioritize modular designs using a minimal variety of materials, which can streamline procurement processes and reduce labor requirements. Additionally, subsidies or discounts could be extended to laborers engaged in circular demolition activities, further reducing the financial burden on contractor/EoL actors (Wuni and Abankwa, 2023). Incentives can also target builders who use materials with high residual and circular value by offering higher building valuations and facilitating easier access to mortgages for clients investing in circular buildings (Schut et al., 2016). Moreover, linking environmental and social improvements with monetary benefits could further incentivize sustainable practices. For example, the introduction of a carbon tax could penalize materials with high embedded carbon while encouraging the use of low-carbon alternatives (Çetin et al., 2021). In line with this, respondent R11 proposed linking environmental damage to construction budgets using frameworks such as CO_2 budgets. Furthermore, high upfront costs associated with circular construction often lead companies to seek loans to reduce financial risk and cover initial investments (Conde et al., 2022). In this regard, offering lower interest rates on loans tied to circular projects could provide further financial support and promote the broader adoption CE.

In addition to financial incentives, contingency funds can be allocated to mitigate the financing issue associated with the demolition (Gillott et al., 2022). These funds would remain with the financing institutions and be made available at the EoL to ensure a high-quality demolition. However, while this approach provides financial security for the demolition phase, it also raises the project's upfront costs. Therefore, additional considerations are needed to balance these increased initial expenses. For that purpose, collaborative workshops can be conducted to cost out uncertainties and promote shared risk and benefit management among stakeholders (Gillott et al., 2022; Lahane and Kant, 2021). Collaboration is identified as a key-strategy for mitigating financial risks and enhancing the financial performance of CE projects (Uhrenholt et al., 2022). This approach ensures equitable distribution of value, risks, and financial burdens among supply chain partners (Uhrenholt et al., 2022). For example, Lundgren et al. (2024) found that early tenant collaboration removed regulatory barriers in tenancy contracts, improving profitability by resolving complex issues early.

To address the financial issues arising from procurement, functionality-based tenders are proposed for circular construction projects, focusing on functional requirements rather than technical specifications (Oppen and Bosch, 2020). For example, a tender might call for 'a working space for a company' rather than specifying exact dimensions or material requirements. Support this approach, respondent R7 emphasized that in the early stages of transition, where practices are still evolving, fixed targets can unintentionally restrict innovation and exclude alternative solutions.

It is also recommended to incorporate circularity as a key evaluation criterion in the tendering process. To ensure circularity goals are met, tenders can include financial incentives and legal guarantees, such as follow-up contracts. For example, respondents R16 and R19 advocating for circularity as a tender criterion. As R16 stated, *"Anyone who submits a bid with stronger circular commitments should receive a higher quality score."* However, some interviewees also raised concerns regarding execution, noting that circularity remains an unregulated criterion, making its achievement and monitoring more challenging for the clients.

To address policy related issues, well-defined standards for secondary materials can help eliminate regulatory and permitting challenges, leading to potential cost savings. Additionally, the development of digital platforms for materials and components is essential for enhancing transparency and providing reliable data for various analyses (Sajid et al., 2024). Schut et al. (2016) recommend that governments should develop MCC frameworks, as current LCC methods are insufficient for application in circular construction.

In addition to these interventions, economies of scale can significantly improve the financial viability of circular construction. For instance, Nußholz et al. (2020) argue that the modest financial performance is largely due to the high fixed costs associated with early production lines. As economies of scale are achieved, these costs will decline, simultaneously driving demand and improving market mechanisms, ultimately reducing overall costs, as illustrated in Fig. 6. Research further highlights that a 0.1 increase in circularity adoption reduces the risk of default by 8.63 %, strengthening financial attractiveness of companies to financial institutions (Bocconi University et al., 2021). Supporting this view, respondent R3 compared circularity to the energy transition, emphasizing that increased adoption will drive down costs, making it more affordable and beneficial in the long run.

4. Discussion

The study presents new insights on economic considerations of circular construction with help of a comprehensive multi-level conceptual framework developed through an ILR and interview data. We found that the economics of circular construction is a complex and multi-level phenomenon. It is not only influenced by micro-level factors related to cost and finance but also significantly shaped by market and supply chain dynamics, as well as by regulatory and policy frameworks. Our conceptual framework highlights the high degree of interdependence among these economic factors, where a change in one factor can trigger (un)favorable shifts in others. The study further reveals how targeted interventions can help to mitigate multiple barriers and create positive feedback loops that enhances the economic viability of circular construction. These findings contribute to three academic debates on circular construction, which will be discussed below.

4.1. Advancing the economic perspective on circular construction

Firstly, our study contributes to the growing body of literature on the economic and financial aspects of circular construction (Chen et al., 2024; Rakhshan et al., 2021; Kambanou and Sakao, 2020) and CE more broadly (Dainelli et al., 2024; Palea et al., 2023; Kanzari et al., 2022) by adopting a holistic view that captures the interconnected economic dynamics. We extended beyond the usual singular focus on technical, environmental or cost aspects (Balasbaneh and Sher, 2024) by highlighting the economics of circular construction as complex, multi-level and unique from other industries. In line with findings of Uhrenholt et al. (2022), we showed how factors beyond cost and monetary values, such as collaboration, supply chain and regulatory aspects, can significantly influence the economic viability of circular construction.

This holistic view has not been explicitly addressed in previous literature and broadens the scope of existing literature on economic aspects of circular construction. This literature has predominantly focused on LCC (Balasbaneh and Sher, 2024; Wouterszoon Jansen et al., 2022) or business models (Lundgren et al., 2024; Gyimah et al., 2024), often overlooking contextual factors like risks, uncertainties and construction supply chain dynamics etc. By developing a framework tailored specifically for circular construction, our study extended the scope of existing frameworks in broader CE literature that studied financial aspects of take-back system (Uhrenholt et al., 2022) and CBMs (Kanzari et al., 2022), CE business financing (Saarinen and Aarikka-Stenroos, 2023), and financial sustainability of circular innovation in small firms (Dainelli et al., 2024).

Encompassing multi-level considerations, our framework contributes to enhancing the clarity of a business case for circular construction, which is identified as a major barrier (Sajid et al., 2024), by offering a concise set of economic (sub)elements, a critical discussion on their occurrence, and insights into potential interactions between these (sub) elements. These findings can serve as a valuable guiding framework for economic assessment methods such as LCC, as it can help estimators for accurate planning of scenarios by offering comprehensive insights into costs that may arise beyond the immediate scope of a given project.

Our study suggests that while economic considerations and targeted interventions can improve the financial performance of circular construction, it still may remain more expensive than linear construction. A key challenge in circular construction is the uneven distribution of value among stakeholders (Bao et al., 2019). Interview data highlight that clients and contractors often bear the increased financial burden of circular solutions, while receiving limited financial returns. Meanwhile, societal and environmental benefits, such as reduced waste and lower emissions, are widely distributed across multiple stakeholders. This imbalance in value distribution presents a significant barrier to the broader adoption of circular practices, discouraging investment and long-term engagement.

Our study also challenges the existing overoptimistic narrative about economic benefits of circular construction, as highlighted by (Wuni, 2022a), and align with the findings of previous empirical studies (Buyle et al., 2019; Wouterszoon Jansen et al., 2022). Therefore, this shift requires construction industry to adopt a broader perspective, emphasizing long term social and environmental benefits. We suggest that the economic pillar should serve as a ‘catalyst’ or ‘grease’ for circular transition, encouraging stakeholders to embrace circularity. However, economic gains should not be seen as the main objective; rather, it should be integrated with broader sustainability goals (Ciambellini et al., 2025; Khadim et al., 2025).

4.2. Illuminating the relationships and multi-level interactions

Secondly, the study advances the literature on transition to circular construction (Kooter et al., 2021; Charef et al., 2022; Gyimah et al., 2024) by illuminating the often-overlooked relationships and interdependencies across micro, *meso* and macro levels. In line with existing research (Clegg et al., 2023; Eikelenboom and van Marrewijk, 2024; Nikolaou and Tsagarakis, 2021), our framework suggests that construction organizations should evolve their focus on circular construction projects. The short-term focus of project-based endeavors on the traditional iron triangle should be extended to a long-term, continuous process focus by fostering stakeholder collaborations, making long-term investments and engaging in knowledge sharing (Sajid et al., 2024). We illustrate how collaboration between key stakeholders, such as inclusion of tenants at an early stage of project made it easier to reach consensus on the terms of the tenancy contract (Lundgren et al., 2024). Thus, construction organizations should look beyond immediate profits and economic returns, prioritizing long-term intangible gains such as competitive advantages. This insight lends support to earlier conceptual research suggesting that construction industry should take a holistic approach about value created and extend their responsibilities through improved collaboration between supply chain partners (Leising et al., 2018).

Our framework connect these micro- and meso-level elements, which are partially in control of the individual organization (Uhrenholt et al., 2022), to key policy issues related to the economics of construction. The framework highlights the necessity of macro-level interventions from policymakers, such as supportive regulatory frameworks for permits, public procurement, and CBM implementation, demonstrating how these policies can shape and regulate actions at lower levels to facilitate circular construction adoption. In this way, we shift away from an exclusive focus on top-down policy interventions, allowing for improvements across multiple levels (Bahadorestani et al., 2024), thus fostering a more integrated and effective circular transition.

4.3. Extending the knowledge on barriers, benefits and enablers

Thirdly, our research findings contribute to the existing body of knowledge of barriers, enablers and benefits of CE (Ababio and Lu, 2023; Gillott et al., 2022). While previous studies have primarily focused on identifying these factors, often yielding repetitive and identical findings, we delve deeper to uncover the underlying reasons behind these established factors. For example, we provided detailed analysis of the barrier 'high initial costs' (Khadim et al., 2024), by critically discussing the causes such as pricing of material, impact of infrastructures, material standards and taxation factors. This critical analysis can help policymakers and stakeholders in planning the interventions.

Our study places a specific focus on economic and financial issues, which are typically examined alongside other barriers in circular construction literature, usually associated with costs, funding and subsidies (Çetin et al., 2021). Through our framework, we broadened this understanding by linking economic and financial barriers to other categories such as policy, regulatory, and technology challenges (Wuni, 2022b). For instance, key economic barriers identified in this study include low investment levels in circular construction and a lack of knowledge sharing among stakeholders. As discussed, reluctance to invest and a lack of knowledge sharing often stem from uncertainty about long-term benefits and market competition (Sajid et al., 2024). Interview respondents emphasized the importance of developing knowledge through targeted investments and funding experimental circular projects. Overcoming these barriers is critical to establishing a more favorable investment environment and promoting active stakeholder engagement, ultimately supporting the transition to circular construction.

Moreover, we identified and critically discussed several interventions for circular construction, commonly referred to drivers and enablers, derived both from academic (Gillott et al., 2022) and grey literature (Schut et al., 2016). These interventions offer valuable insights for contractors and practitioners, helping them assess costs and business viability while facilitating the mitigation of barriers and the maximization of benefits.

4.4. Limitations

While the study provides valuable contributions, there are several limitations to acknowledge. First, the study mainly relies on the ILR method. While ILR method enables a broad synthesis of knowledge and is an excellent approach for developing conceptual models (Jaakkola, 2020), its reliance on the existing body of knowledge limits its ability to incorporate emerging trends and practical barriers that have not yet been discussed in academic literature (Snyder, 2019). This can lead to potential gaps in the framework. To mitigate this, insights from interviews with actors actively engaged in circular construction were incorporated, reducing the risk of overlooking new perspectives and providing validation for the literature findings. Second, the framework remains conceptual, and while it offers a structured approach to understanding economic considerations, it may require further practical implication to fully establish its relevance across different contexts.

5. Conclusions

Circular construction has emerged as a key approach to addressing sustainability challenges in the construction industry. While significant research has focused on its technical and environmental dimensions, the economic and financial aspects remain underexplored, often limited to cost considerations and micro-level factors, despite being a major concern for construction practitioners. Addressing this gap, this paper synthesizes and critically investigates economic and financial aspects of circular construction by developing a novel conceptual framework through an ILR of 45 documents and interview data from actors actively involved in real-world circular construction projects. Our analysis of selected documents identified four major research clusters within the selected literature: (1) economic assessment methods, (2) benefits, barriers, risks and enablers, (3) circular guidelines and reports, and 4) business models, with economic assessment emerging as the most prevalent area.

Our framework underscores the complexity of circular construction economics as a multilevel phenomenon influenced by cost, finance, supply chain dynamics, and regulatory factors. Drawing on interview data from actors involved in circular construction projects, the study provides practical insights into market uncertainties, procurement challenges, and knowledge gaps that hinder adoption. Furthermore, it offers a comprehensive view of the interconnected economic elements and targeted interventions specific to the construction industry. To the best of the authors' knowledge, our paper is the first conceptual study in construction management literature that explicitly focuses on the microeconomics of circular construction.

By integrating literature and actors' perspectives, this study provides actionable insights for key stakeholders. Policymakers should establish supportive regulatory frameworks for permits, public procurement, and CBM implementation while introducing economic incentives, such as tax reductions, to ease financial barriers. Investments in infrastructure by governmental authorities can further enhance the economic viability of material recycling and reuse. Construction firms can leverage the framework to visualize costs and financial benefits, integrating long-term economic planning and collaborative business models to address economic barriers. Financial institutions are recommended to develop financial mechanisms for circular construction, such as green loans.

Future research can focus on developing quantitative indicators and assessment methods, such as MCC, using the framework as a guiding tool. Other studies could explore political and cultural factors, which may significantly influence the economics of circular construction. Furthermore, as circular construction continues to evolve, future research can refine and expand the framework to adapt to emerging developments and challenges.

This work supports SDG 12 by addressing key economic and financial aspects of circular construction. By discussing market and supply chain challenges, it contributes to target 12.5 by promoting material reuse and reducing waste generation. Clarifying the business case and exploring interventions to improve affordability supports target 12.6, encouraging the integration of sustainability into organizational practices. Lastly, discussing procurement barriers and interventions aligns with target 12.7, promoting sustainable public procurement practices. Together, these efforts advance responsible production and consumption within the construction sector.

CRediT authorship contribution statement

Nouman Khadim: Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Alfons van Marrewijk:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Conceptualization.

Funding

The authors declare that research was conducted within the Circular Collaboration (CirCol) consortium funded by the Dutch Research Council, under the grant number NWA.1432.20.001.

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.

References

Ababio, B.K., Lu, W., 2023. Barriers and enablers of circular economy in construction: a multi-system perspective towards the development of a practical framework. Constr. Manag. Econ. 41 (1), 3–21. https://doi.org/10.1080/01446193.2022.2135750.

Alberto López Ruiz, L., Roca Ramon, X., Melissa Lara Mercedes, C., Gasso Domingo, S., 2022. Multicriteria analysis of the environmental and economic performance of circularity strategies for concrete waste recycling in Spain. Waste Manag. 144, 387–400. https://doi.org/10.1016/j.wasman.2022.04.008.

Alcayaga, A., Wiener, M., Hansen, E.G., 2019. Towards a framework of smart-circular systems: an integrative literature review. J. Clean. Prod. 221, 622–634. https://doi.org/10.1016/j.jclepro.2019.02.085.

AlJaber, A., Martinez-Vazquez, P., Baniotopoulos, C., 2023. Barriers and enablers to the adoption of circular Economy concept in the building sector: a systematic literature review. Buildings 13 (11), 2778. https://doi.org/10.3390/buildings13112778.

Atapattu, A.M.D.S., Hadiwattage, C., Perera, B.A.K.S., Rajaratnam, D., 2024. Employing criteria scoring matrix in appraising the economic return of transcending to a circular built environment. Smart Sustain. Built Environ. 13 (2), 267–290. https://doi.org/10.1108/SASBE-04-2023-0077.

Azcarate-Aguerre, J.F., Conci, M., Zils, M., Hopkinson, P., Klein, T., 2022. Building energy retrofit-as-a-service: a Total value of ownership assessment methodology to support whole life-cycle building circularity and decarbonisation. Constr. Manag. Econ. 40 (9), 676–689. https://doi.org/10.1080/01446193.2022.2094434.

Bahadorestani, A., Motahari Farimani, N., Karlsen, J.T., 2024. Projects as game changers for navigating sustainability transitions in societies: multi-level effects from micro-level decisions. Sustain. Cities Soc. 115, 105758. https://doi.org/10.1016/j.scs.2024.105758.

Balasbaneh, A.T., Sher, W., 2024. Economic and environmental life cycle assessment of alternative mass timber walls to evaluate circular economy in building: MCDM method. Environ. Dev. Sustain. 26 (1), 239–268. https://doi.org/10.1007/s10668-022-02707-7.

Bao, Z., Lu, W., Chi, B., Yuan, H., Hao, J., 2019. Procurement innovation for a circular economy of construction and demolition waste: lessons learnt from Suzhou. China. Waste Manage. 99, 12–21. https://doi.org/10.1016/j.wasman.2019.08.031.

Bocconi University, Ellen Macarthur Foundation, Intesa Sanpaolo, 2021. The circular economy as a de-risking strategy and driver of superior risk-adjusted returns. https://www.ellenmacarthurfoundation.org/publications.

Bon, R., Hutchinson, K., 2000. Sustainable construction: some economic challenges. Build. Res. Inf. 28 (5–6), 310–314. https://doi.org/10.1080/096132100418465.

Braakman, L., Bhochhibhoya, S., de Graaf, R., 2021. Exploring the relationship between the level of circularity and the life cycle costs of a one-family house. Resour. Conserv. Recycl. 164, 105149. https://doi.org/10.1016/j.resconrec.2020.105149.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Buyle, M., Galle, W., Debacker, W., Audenaert, A., 2019. Sustainability assessment of circular building alternatives: consequential LCA and LCC for internal wall assemblies as a case study in a Belgian context. J. Clean. Prod. 218, 141–156. https://doi.org/10.1016/j.jclepro.2019.01.306.

Cascione, V., Roberts, M., Allen, S., Dams, B., Maskell, D., Shea, A., Walker, P., Emmitt, S., 2022. Integration of life cycle assessments (LCA) in circular bio-based wall panel design. J. Clean. Prod. 344, 130938. https://doi.org/10.1016/j.jclepro.2022.130938.

Çetin, S., Gruis, V., Straub, A., 2021. Towards circular social housing: an exploration of practices, barriers, and enablers. Sustainability 13 (4). https://doi.org/10.3390/su13042100.

Charef, R., Ganjian, E., Emmitt, S., 2021. Socio-economic and environmental barriers for a holistic asset lifecycle approach to achieve circular economy: a pattern-matching method. Technol. Forecast. Soc. Change 170, 120798. https://doi.org/10.1016/j.techfore.2021.120798.

Charef, R., Lu, W., Hall, D., 2022. The transition to the circular economy of the construction industry: insights into sustainable approaches to improve the understanding. J. Clean. Prod. 364, 132421. https://doi.org/10.1016/j.jclepro.2022.132421.

Chen, Y., Yin, X., Lyu, C., 2024. Circular design strategies and economic sustainability of construction projects in China: the mediating role of organizational culture. Sci. Rep. 14 (1), 7890. https://doi.org/10.1038/s41598-024-56452-0.

Ciambellini, G., D'Adamo, I., Gastaldi, M., Smol, M., 2025. Sustainability and competitiveness: economic analysis of a photovoltaic plant with storage in an Italian textile company. Innov. Green Dev. 4 (2), 100209. https://doi.org/10.1016/j.igd.2025.100209.

Circular Economy, 2023. The Circularity Gap Report 2023. https://www.circularity-gap.world/2023.

Circular Economy, 2024. The Circularity Gap Report 2024. https://www.circularity-gap.world/2024.

Clegg, S., Loosemore, M., Walker, D., van Marrewijk, A., Sankaran, S., 2023. Construction cultures: sources, signs, and solutions of toxicity. Construction Project Organising 3-16. https://doi.org/10.1002/9781119813798.ch1.

Conde, Á., Sutherland, A.B., Fraser, M., Roemers, G., Sosa, L., Rohmer, M., 2022. THE CIRCULARITY GAP REPORT: built environment, the Netherlands. Available at. https://www.circularity-gap.world/sectors.

D'Adamo, I., Ribichini, M., Tsagarakis, K.P., 2023. Biomethane as an energy resource for achieving sustainable production: economic assessments and policy implications. Sustain. Prod. Consum. 35, 13–27. https://doi.org/10.1016/j.spc.2022.10.014.

Dainelli, F., Daddi, T., Marrucci, L., 2024. Financial sustainability of circular innovations in SMEs. A case study from the fashion industry in Italy. J. Clean. Prod. 451, 142042. https://doi.org/10.1016/j.jclepro.2024.142042.

Dantata, N., Touran, A., Wang, J., 2005. An analysis of cost and duration for deconstruction and demolition of residential buildings in Massachusetts. Resour. Conserv. Recycl. 44 (1), 1–15. https://doi.org/10.1016/j.resconrec.2004.09.001.

Dervishaj, A., Gudmundsson, K., 2024. From LCA to circular design: a comparative study of digital tools for the built environment. Resour. Conserv. Recycl. 200, 107291. https://doi.org/10.1016/j.resconrec.2023.107291.

Dziedzic, R., Pondicherry, P., Dziedzic, M., 2025. Review of national policy instruments motivating circular construction. Resour. Conserv. Recycl. 215, 108053. https://doi.org/10.1016/j.resconrec.2024.108053.

Eikelenboom, M., van Marrewijk, A., 2023. Creating points of opportunity in sustainability transitions: reflective interventions in inter-organizational collaboration. Enviro. Innov. Soc. Transit. 48, 100748. https://doi.org/10.1016/j.eist.2023.100748.

Eikelenboom, M., van Marrewijk, A., 2024. Tied islands: the role of organizational members in knowledge transfer across strategic projects. Int. J. Proj. Manag. 42 (3), 102590. https://doi.org/10.1016/j.ijproman.2024.102590.

Esposito, B., Sica, D., Supino, S., Malandrino, O., 2024. Measuring the impact of circular economy performance on financial performance: the moderating role of stakeholder engagement. Bus. Strateg. Environ. 33 (6). https://doi.org/10.1002/bse.3744.

European Commission, 2015. Closing the loop-An EU action plan for the Circular Economy. Available at https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF.

European Union, 2019. Going climate-neutral by 2050; a strategic long-term vision for a prosperous, modern, competitive and climate-neutral EU economy. Publications Office. https://doi.org/10.2834/508867.

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017. The circular Economy – a new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048.

Gillott, C., Davison, B., Densley Tingley, D., 2022. Drivers, barriers and enablers: construction sector views on vertical extensions. Build. Res. Inf. 50 (8), 909–923. https://doi.org/10.1080/09613218.2022.2087173.

Government of Netherlands, 2016. A Circular Economy in the Netherlands in 2050. Available at https://circulareconomy.europa.eu/platform/en/strategies/circular-economy-netherlands-2050.

Guerra, B.C., Shahi, S., Mollaei, A., Skaf, N., Weber, O., Leite, F., Haas, C., 2021. Circular economy applications in the construction industry: a global scan of trends and opportunities. J. Clean. Prod. 324, 129125. https://doi.org/10.1016/j.jclepro.2021.129125.

Gyimah, S., Owusu-Manu, D.-G., Edwards, D.J., Buertey, J.I.T., Danso, A.K., 2024. Exploring the contributions of circular business models towards the transition of green economy in the Ghanaian construction industry. Smart sustain. Built Environ. https://doi.org/10.1108/SASBE-09-2023-0265 ahead-of-print(ahead-of-print).

Hart, J., Adams, K., Giesekam, J., Tingley, D.D., Pomponi, F., 2019. Barriers and drivers in a circular economy: the case of the built environment. Procedia CIRP 80, 619–624. https://doi.org/10.1016/j.procir.2018.12.015.

Iacovidou, E., Hahladakis, J.N., Purnell, P., 2021. A systems thinking approach to understanding the challenges of achieving the circular economy. Environ. Sci. Pollut. Res. 28 (19), 24785–24806. https://doi.org/10.1007/s11356-020-11725-9.

Jaakkola, E., 2020. Designing conceptual articles: four approaches. AMS Rev. 10 (1), 18–26. https://doi.org/10.1007/s13162-020-00161-0.

Kambanou, M.L., Sakao, T., 2020. Using life cycle costing (LCC) to select circular measures: a discussion and practical approach. Resour. Conserv. Recycl. 155, 104650. https://doi.org/10.1016/j.resconrec.2019.104650.

Kanzari, A., Rasmussen, J., Nehler, H., Ingelsson, F., 2022. How financial performance is addressed in light of the transition to circular business models - a systematic literature review. J. Clean. Prod. 376, 134134. https://doi.org/10.1016/j.jclepro.2022.134134.

Khadim, N., Agliata, R., Han, Q., Mollo, L., 2025. From circularity to sustainability: advancing the whole building circularity indicator with life cycle assessment (WBCI-LCA). Build. Environ. 269, 112413. https://doi.org/10.1016/j.buildenv.2024.112413.

Khadim, N., Agliata, R., Marino, A., Thaheem, M.J., Mollo, L., 2022. Critical review of nano and micro-level building circularity indicators and frameworks. J. Clean. Prod. 131859. https://doi.org/10.1016/j.jclepro.2022.131859.

Khadim, N., Agliata, R., Mollo, L., 2024. Circling towards profit: A circular life cycle approach to evaluate the economic and environmental feasibility of buildings. In: Proceedings of the 11th International Conference of Ar. Tec.(Scientific Society of Architectural Engineering): Colloqui. AT. E 2024-Volume 3, p. 454. https://doi.org/10.1007/978-3-031-71867-0_31.

Khadim, N., Agliata, R., Thaheem, M.J., Mollo, L., 2023. Whole building circularity indicator: a circular economy assessment framework for promoting circularity and sustainability in buildings and construction. Build. Environ. 241, 110498. https://doi.org/10.1016/j.buildenv.2023.110498.

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., Hekkert, M., 2018. Barriers to the circular Economy: evidence from the European Union (EU). Ecol. Econ. 150, 264–272. https://doi.org/10.1016/j.ecolecon.2018.04.028.

Kooter, E., Uden, M.V., Marrewijk, A.V., Wamelink, H., Bueren, E.V., Heurkens, E., 2021. Sustainability transition through dynamics of circular construction projects. Sustainability 13 (21). https://doi.org/10.3390/su132112101.

Lahane, S., Kant, R., 2021. Evaluation and ranking of solutions to mitigate circular supply chain risks. Sustain. Prod. Consum. 27, 753–773. https://doi.org/10.1016/j.spc.2021.01.034.

Leising, E., Quist, J., Bocken, N., 2018. Circular Economy in the building sector: three cases and a collaboration tool. J. Clean. Prod. 176, 976–989. https://doi.org/10.1016/j.jclepro.2017.12.010.

Lundgren, R., Kyrö, R., Olander, S., 2024. The lifecycle impact and value capture of circular business models in the built environment. Constr. Manag. Econ. 42 (6), 527–544. https://doi.org/10.1080/01446193.2023.2279743.
Luthin, A., Traverso, M., Crawford, R.H., 2023. Assessing the social life cycle impacts of circular economy. J. Clean. Prod. 386, 135725. https://doi.org/10.1016/j.jclepro.2022.135725.
Mahpour, A., 2023. Building maintenance cost estimation and circular Economy: the role of machine-learning. Sustain. Mater. Technol. 37, e00679. https://doi.org/10.1016/j.susmat.2023.e00679.
Meglin, R., Kytzia, P.S., Habert, P.G., 2022. Regional environmental-economic assessment of building materials to promote circular economy: comparison of three Swiss cantons. Resour. Conserv. Recycl. 181, 106247. https://doi.org/10.1016/j.resconrec.2022.106247.
Mont, O., Plepys, A., Whalen, K., Nußholz, J.L.K., 2017. Business model innovation for a circular economy drivers and barriers for the Swedish industry Available at https://lup.lub.lu.se/search/ws/files/33914256/MISTRA_REES_Drivers_and_Barriers_Lund.pdf#page=4.28.
Munaro, M.R., Freitas, M.d.C.D., Tavares, S.F., Bragança, L., 2021. Circular business models: current state and framework to achieve sustainable buildings. J. Const. Eng. Manage. 147 (12). https://doi.org/10.1061/(ASCE)CO.1943-7862.000218, 04021164.
Nikolaou, I.E., Tsagarakis, K.P., 2021. An introduction to circular economy and sustainability: some existing lessons and future directions. Sustain. Prod. Consum. 28, 600–609. https://doi.org/10.1016/j.spc.2021.06.017.
Nußholz, J.L.K., Nygaard Rasmussen, F., Milios, L., 2019. Circular building materials: carbon saving potential and the role of business model innovation and public policy. Resour. Conserv. Recycl. 141, 308–316. https://doi.org/10.1016/j.resconrec.2018.10.036.
Nußholz, J.L.K., Rasmussen, F.N., Whalen, K., Plepys, A., 2020. Material reuse in buildings: implications of a circular business model for sustainable value creation. J. Clean. Prod. 245, 118546. https://doi.org/10.1016/j.jclepro.2019.118546.
Oppen, C.v., Bosch, S., 2020. Circular Procurement in 8 Steps: Guideline for Residential and Non-Residential Construction. Available at https://circulairebouweconomie.nl/wp-content/uploads/2022/01/Guideline-Circular-Procurement-Residential-and-Non-Residential-Construction-2021.pdf.
Palea, V., Santhià, C., Miazza, A., 2023. Are circular economy strategies economically successful? Evidence from a longitudinal panel. J. Environ. Manag. 337, 117726. https://doi.org/10.1016/j.jenvman.2023.117726.
Rakhshan, K., Morel, J.-C., Alaka, H., Charef, R., 2020. Components reuse in the building sector – a systematic review. Waste Manag. Res. 38 (4), 347–370. https://doi.org/10.1177/0734242X20910463.
Rakhshan, K., Morel, J.-C., Daneshkhah, A., 2021. A probabilistic predictive model for assessing the economic reusability of load-bearing building components: developing a circular Economy framework. Sustain. Prod. Consum. 27, 630–642. https://doi.org/10.1016/j.spc.2021.01.031.
Saarinen, A., Aarikka-Stenroos, L., 2023. Financing-related drivers and barriers for circular Economy business: developing a conceptual model from a field study. Circ. Econ. Sustain. 3 (3), 1187–1211. https://doi.org/10.1007/s43615-022-00222-5.
Sajid, Z.W., Aftab, U., Ullah, F., 2024. Barriers to adopting circular procurement in the construction industry: the way forward. Sustain. Futures 8, 100244. https://doi.org/10.1016/j.sftr.2024.100244.
Schmitz, R.Q., 2024. Towards Sustainable Investments: Integrating Embodied Carbon Reduction in Investment Decision-Making by Using a Discounted Cash Flow Model. Delft University of Technology, The Netherlands, Architecture and the Built Environment. https://resolver.tudelft.nl/uuid:7d4f1bbb-9293-4736-9c3e-a7dbeb6d2649.
Schroeder, P., Anggraeni, K., Weber, U., 2019. The relevance of circular Economy practices to the sustainable development goals. J. Ind. Ecol. 23 (1), 77–95. https://doi.org/10.1111/jiec.12732.
Schut, E., Crielaard, M., Mesman, M., 2016. Circular economy in the Dutch construction sector: a perspective for the market and government. https://open.rijkswaterstaat.nl/open-overheid/onderzoeksrapporten/@42490/circular-economy-the-dutch-construction/.
Snyder, H., 2019. Literature review as a research methodology: an overview and guidelines. J. Bus. Res. 104, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039.
Torraco, R.J., 2005. Writing integrative literature reviews: guidelines and examples. Hum. Resour. Dev. Rev. 4 (3), 356–367. https://doi.org/10.1177/1534484305278283.
Uhrenholt, J.N., Kristensen, J.H., Rincón, M.C., Jensen, S.F., Waehrens, B.V., 2022. Circular economy: factors affecting the financial performance of product take-back systems. J. Clean. Prod. 335, 130319. https://doi.org/10.1016/j.jclepro.2021.130319.
UKGBC, 2019. Circular Economy Guidance for Construction Clients : How to Practically Apply Circular Economy. https://www.ukgbc.org/wp-content/uploads/2019/04/Circular-Economy-Report.pdf.
Ünal, E., Urbinati, A., Chiaroni, D., Manzini, R., 2019. Value creation in circular business models: the case of a US small medium enterprise in the building sector. Resour. Conserv. Recycl. 146, 291–307. https://doi.org/10.1016/j.resconrec.2018.12.034.
UNEP, IEA, 2019. Global Status Report for Buildings and Construction. Available at https://wedocs.unep.org/bitstream/handle/20.500.11822/30950/2019GSR.pdf?sequence=1&isAllowed=y.
Whittemore, R., Knafl, K., 2005. The integrative review: updated methodology. J. Adv. Nurs. 52 (5), 546–553. https://doi.org/10.1111/j.1365-2648.2005.03621.x.
Wiprächtiger, M., Haupt, M., Heeren, N., Waser, E., Hellweg, S., 2020. A framework for sustainable and circular system design: development and application on thermal insulation materials. Resour. Conserv. Recycl. 154, 104631. https://doi.org/10.1016/j.resconrec.2019.104631.
Wouterszoon Jansen, B., van Stijn, A., Eberhardt, L.C.M., van Bortel, G., Gruis, V., 2022. The technical or biological loop? Economic and environmental performance of circular building components. Sustain. Prod. Consum. 34, 476–489. https://doi.org/10.1016/j.spc.2022.10.008.
Wouterszoon Jansen, B., van Stijn, A., Gruis, V., van Bortel, G., 2020. A circular economy life cycle costing model (CE-LCC) for building components. Resour. Conserv. Recycl. 161, 104857. https://doi.org/10.1016/j.resconrec.2020.104857.
Wuni, I.Y., 2022a. Burden of proof beyond the triple bottom line: mapping the benefits of circular construction. Sustain. Prod. Consum. 34, 528–540. https://doi.org/10.1016/j.spc.2022.10.006.
Wuni, I.Y., 2022b. Mapping the barriers to circular economy adoption in the construction industry: a systematic review, Pareto analysis, and mitigation strategy map. Build. Environ. 223, 109453. https://doi.org/10.1016/j.buildenv.2022.109453.
Wuni, I.Y., Abankwa, D.A., 2023. Understanding the Key Risks in Circular Construction Projects: From Systematic Review to Conceptual Framework. Innov, Construct. https://doi.org/10.1108/CI-04-2023-0068.
Zaman, A.U., Arnott, J., McLntyre, K., Hannon, J., 2018. Resource harvesting through a systematic deconstruction of the residential house: a case study of the 'whole house reuse' project in Christchurch. New Zealand. Sustainability 10 (10), 3430. https://doi.org/10.3390/su10103430.