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CIRCULAR SUPPLY CHAIN MANAGEMENT IN THE CONSTRUCTION INDUSTRY: A SYSTEMATIC LITERATURE REVIEW OF PRACTICES, DIGITAL ENABLERS, AND FUTURE DIRECTIONS

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ABSTRACT

Global climate change and resource scarcity have highlighted the urgent need for the construction industry (CI) to transition toward a circular economy (CE). However, systematic understanding of Circular Supply Chain Management (CSCM) within the CI remains limited. This study employs a Systematic Literature Review (SLR) to examine the implementation status, research trends, and challenges associated with eight major circular economy practices (CEPs): circular design, circular procurement, waste management, industrial symbiosis, information sharing, material passports, circular business models, and information management. The review reveals a strong emphasis on front-end practices, such as circular design and circular procurement, whereas downstream practices, including waste management and industrial symbiosis, remain comparatively underexplored. It also finds that research on integration of digital technologies remains limited and that existing studies are concentrated largely in developed countries, leaving developing-country contexts insufficiently examined. The findings underscore the need for more empirical case-based research, stronger integration of digital technologies, and context-sensitive strategies to accelerate the transition of the CI toward circularity and support long-term sustainable development.

Keywords: Circular supply chain management, circular economy, construction industry, systematic literature review, sustainable development, circular economy practice.

INTRODUCTION

With the increasing prominence of global climate change, resource depletion, and environmental pollution, sustainable development has become a core issue of concern for the international community. As one of the most resource-intensive industries worldwide, the construction industry (CI) consumes approximately 40% of global raw material resources annually and generates around 30% of solid waste (Liu et al., 2025). Resource wastage and environmental burdens are particularly severe, with the proportion exceeding 60% in some developing countries (Benachio et al., 2020). Traditional construction supply chain models predominantly follow a linear economy approach of "take-make-dispose" (Hsu et al., 2024), neglecting the potential for resource reuse and recycling. This results in significant environmental pressure and resource wastage, making it difficult to achieve a balance among economic, environmental, and social benefits (Liu et al., 2026c; Scheel et al., 2020) . In response to these challenges, the concept of the circular economy (CE) has gradually gained recognition as a key pathway to achieving sustainability in the CI. Among its various applications, circular supply chain management (CSCM) serves as a crucial strategy for implementing CE principles within the CI. CSCM aims to establish a closed-loop resource utilization system at the supply chain level, thereby minimizing environmental burdens and resource wastage across the industry (Charef et al., 2022; González-Sánchez et al., 2020; Shaharudin et al., 2022). Accordingly, CSCM is conceptualized in this paper as the coordinated management of forward and reverse flows of materials, information, and value among construction supply chain actors to slow, narrow, and close resource loops throughout the building life cycle. It extends conventional supply chain management beyond cost, time, and quality objectives by integrating resource retention, reuse, recovery, and regeneration with economic, environmental, and social value creation (Charef et al., 2022; González-Sánchez et al., 2020; Shaharudin et al., 2022).

CSCM practices refer to the organizational, operational, and inter-organizational actions through which circular economy objectives are translated into construction supply chain activities. More broadly, these practices encompass coordinated actions across the construction supply chain that seek to slow, narrow, and close resource loops through the reduction, reuse, recovery, and recirculation of materials and components. They can be implemented at different stages of the building life cycle and typically require collaboration among supply chain actors to retain resource value (Ercan & Çelik, 2022) and support economic, environmental, and social sustainability (Elghaish et al., 2023; Ghafoor et al., 2023; Vanhuyse et al., 2021; Zorpas, 2024).

At the same time, digital technologies such as Building Information Modeling (BIM), the Internet of Things (IoT), big data, and Digital Twins have developed rapidly in the CI in recent years, providing strong technical support for the sector's sustainable transformation (Zhang et al., 2023; Hwang et al., 2022). In this context, digital enablers refer to digital technologies and infrastructures that enhance visibility, traceability, information exchange, coordination, and decision-making across supply chains. These advanced digital tools enable refined management of building materials, equipment, and resource flows, facilitating real-time monitoring and precise analysis throughout the building lifecycle. This significantly enhances resource utilization efficiency and decision-making accuracy in the CI while creating the necessary technical conditions for the effective implementation of CSCM. The relationship between digital enablers and CSCM practices is primarily facilitative: digital enablers provide the informational and technological conditions required to implement and coordinate CSCM practices rather than constituting circular practices in themselves. In particular, the deep integration of IoT and BIM has made digital tools such as Material Passports (MPs) and Information Management (IM) systems essential support mechanisms for CSCM practices in the CI. These technologies provide reliable data and technical support for resource recovery, the remanufacturing of building components, and innovations in CE business models (Lu et al., 2023; KC et al., 2024; Ungureanu et al., 2024).

Although both academia and industry have recognized the potential of CSCM in driving the transformation of the CI, research in this field remains at an early stage, with a predominance of theoretical discussions and relatively few empirical studies. Existing research has primarily focused on the conceptual definition and theoretical model development of CSCM, while in-depth investigations of practical application scenarios, detailed case studies, and integrative analyses of various CSCM practices remain limited. This, to some extent, constrains the practical applicability of existing theoretical findings. Moreover, the CI is characterized by long project cycles, complex supply chains, and diverse stakeholders (Raza et al., 2024), further increasing the challenges associated with implementing CSCM in practice (Nawi et al., 2023). Addressing these implementation barriers through digital technologies and fostering the integration of theoretical frameworks with practical pathways have therefore become urgent priorities in the CI's transition toward a CE.

Despite the growing recognition of CSCM's potential in driving the sustainable transformation of the CI, a critical research gap persists and can be articulated as a threefold problem. First, existing studies remain fragmented and predominantly theoretical. Conceptual definitions and isolated model constructions dominate literature, while integrative analyses linking multiple circular economy practices (CEPs) into a coherent implementation framework are scarce. Second, the practical pathways through which CSCM can be operationalized in the CI remain underexplored. Given its long project cycles, fragmented supply chains, and diverse stakeholders, the industry faces considerable complexity, yet empirical evidence and case-based validation remain limited. Third, although digital technologies are widely acknowledged as enablers of circularity, the synergistic mechanisms between digital tools and specific CEPs have not been systematically mapped, leaving both researchers and practitioners without a clear, actionable roadmap. Taken together, these issues converge into a single overarching problem: the absence of a systematic synthesis that connects the full spectrum of CEPs, digital enablers, and implementation realities in the CI.

To position the present study, a comparison with existing systematic literature reviews (SLRs) on closely related topics highlights its distinct contribution. Chen et al. (2022b) reviewed 61 publications on CE strategies in construction supply chains but did not address digital enablers. Keles et al. (2025), based on 71 papers, mapped ten key digital technologies in the CI but examined them as individual tools rather than within an integrated CSCM framework. Munaro and Tavares (2021) focused exclusively on material passports, leaving broader practices such as circular procurement, industrial symbiosis, and circular business models unaddressed. Gasparri et al. (2023) identified CE knowledge gaps in construction but remained at the conceptual level without integrating digital enablers. Thirumal et al. (2024) examined barriers to adopting digital technologies for CE in construction, focusing on obstacles rather than implementation practices. Collectively, no existing SLR has simultaneously: (i) covered the full spectrum of the eight key CEPs in the CI; (ii) examined how digital technologies enable these practices; and (iii) synthesized research trends, implementation barriers, and future directions into an integrated account. This unaddressed intersection establishes the distinct contribution of the present review.

To address the gap identified above, this study adopts the SLR method to systematically review and synthesize the development and research trends of eight major CEPs in the CI in recent years: circular design (CD), circular procurement (CP), waste management (WM), industrial symbiosis (ISS), information sharing (IS), material passports (MPs), circular business models (CBMs), and information management (IM). It further examines key knowledge gaps and limitations in both theoretical and practical research. Additionally, the study provides an in-depth analysis of the challenges and bottlenecks associated with implementing CSCM in the CI, including implementation barriers and technological support. Finally, it proposes targeted recommendations and identifies directions for future research.

RESEARCH METHODOLOGY

The methodological design of this review draws on two complementary analytical strands. On the quantitative side, bibliometric analysis is employed to map publication patterns and recent developments across the CEP literature (Liu et al., 2026b). On the qualitative side, content analysis is applied to examine substantive themes and underlying research orientations (Liu et al., 2026a). Combining these two approaches serves a dual purpose. It mitigates the subjectivity inherent in any single-method review while broadening the analytical lens through which research gaps and unresolved questions can be identified.

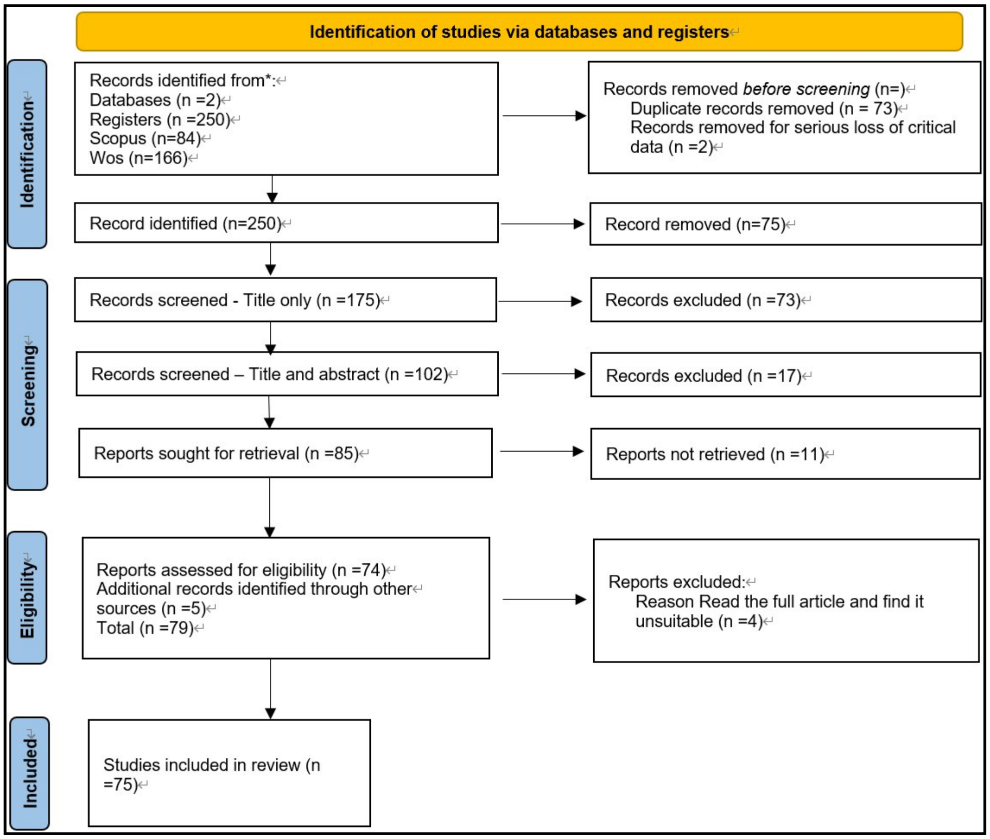
Systematic Literature Review

As a methodological cornerstone of academic inquiry, the SLR has been widely acknowledged for its capacity to ensure both rigor and reproducibility. What distinguishes it from traditional narrative reviews lies not only in its commitment to comprehensive synthesis and critical evaluation of prior scholarship but also in its adherence to a transparent, standardized, and fully traceable protocol governing every stage of the review process, including literature searching, screening, quality appraisal, and synthesis. Such methodological rigor helps mitigate potential biases and enhances the credibility of the conclusions drawn (Hui et al., 2026; Hwee et al., 2026).

Drawing upon these methodological advantages, the present study adopts a structured SLR approach to establish a theoretically grounded and empirically supported framework for examining the trajectory of CEPs within the CI. To this end, clearly defined criteria were established for database selection, search query formulation, inclusion and exclusion criteria, and quality assessment to ensure both the scholarly integrity and thematic relevance of the included literature. To further enhance procedural transparency and facilitate replication, the entire review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Yin et al., 2025a). By systematically documenting each stage of the search, screening, and selection process, this study ensures that its analytical procedures can be transparent, reproducible, and open to independent verification, thereby enhancing the reliability of its findings. Detailed descriptions of the database identification process, search strategy, inclusion and exclusion criteria, and quality assessment procedure are provided in the following subsections, while Figure 1 illustrates the PRISMA-based workflow adopted for data collection.

Figure 1

Workflow Diagram for Data Extraction in This Study



Database Selection

A robust database foundation, coupled with a carefully designed search strategy, is essential for conducting both bibliometric analysis and qualitative discussion. Several databases are available for sourcing scholarly articles, including Scopus, Web of Science, and Google Scholar. Among these, Scopus and Web of Science together index approximately 95% of peer-reviewed academic publications (Liu et al., 2026b). Accordingly, these two databases were selected as the primary sources for this review to maximize literature coverage and ensure indexing quality. To further ensure topical relevance and methodological rigor, a temporal filter was applied during the retrieval process, restricting the search to peer-reviewed articles published between 2014 and 2024.

Search String

The search strings employed in this review were constructed around two anchor concepts: CEPs and the CI. For each concept, a comprehensive set of synonyms and abbreviations was incorporated to broaden the scope of the search and minimize the risk of overlooking relevant studies. The two concept groups were linked using the Boolean operator "AND", while synonymous terms within each group were connected with "OR". The resulting search strings were then executed separately in Scopus and Web of Science. Table 1 presents the complete search strings used in this systematic review.

Table 1

Search Strings Used for the Literature Search

Source	Search String
Scopus and Web of Science	(“Circular Economy Practice*” OR “Circular Practice*” OR “Circular supply chain management Practice*” OR “Circular supply chain Practice*” OR “CE practice*” OR “CSCM practice*” OR “CSC practice*” OR "circular econom*" OR "Closed-loop system*" OR "Reverse logistic*" or “supply chain practice*”) **AND** (“building*” OR “construction” OR “building* industry” OR “construction industry” OR “construction sector” OR “building* sector”)

Eligibility Standards for Literature Selection

To maintain methodological soundness and trustworthiness throughout this review, a clearly defined framework of eligibility and exclusion criteria was established before the screening process commenced. At a fundamental level, only peer-reviewed literature was considered, providing an initial safeguard for academic quality. The detailed criteria adopted in this study are outlined below. First, eligible publications had to be written in English. Second, eligible document types were limited to original research articles and review articles. Third, the publication year was restricted to the period from 2014 to 2024. Fourth, each selected study had to address the research questions or objectives of this review in a substantive manner, rather than merely making tangential or superficial references to the subject. Fifth, the full text of each study had to be accessible and sufficiently clear, with its methodological procedures and reported findings presented in adequate detail. Sixth, the retained body of literature was restricted to empirical studies and systematic reviews, while purely theoretical or conceptual papers lacking a clearly defined methodological foundation were excluded. Through the consistent application of these criteria, the final corpus of literature included in this review was expected to demonstrate both scholarly rigor and thematic relevance.

Quality Assessment

To safeguard the methodological integrity of this review, the quality assessment (QA) phase was conducted in two sequential stages. During the first stage, records identified through the database search were screened based on their titles and abstracts to determine whether they fell within the thematic scope of the present study, thereby generating an initial set of candidate studies for further evaluation. In the second stage, the full texts of these candidate studies were assessed using a structured appraisal procedure adapted from protocols employed in comparable SLRs (Liu et al., 2026a; Ohueri, 2026). Rather than relying on standard off-the-shelf quality assessment tools, the QA framework adopted in this study was tailored to its research objectives, enabling the evaluation criteria to capture both the methodological rigor of each study and its relevance to the central research questions. Four assessment dimensions were established. The first evaluated the extent to which a study addressed the implementation of CEPs in the CI and aligned with the scope of this review. The second examined the depth and conceptual clarity of its treatment of CEPs within the CI. The third assessed the methodological rigor and procedural transparency of the research design. The fourth evaluated the extent to which the findings contributed to both practical application and theoretical advancement. A three-point rating scale was applied to each dimension, where 0 indicated that the criterion was not met, 1 indicated partial fulfillment, and 2 indicated complete fulfillment. The aggregated score served as the basis for determining whether a study qualified for inclusion in the review.

The weighting score was calculated using Equation 1:

$$\text{Rating Score} = \sum \text{Qacriteria} \tag{1}$$

Based on the cumulative scores, the included studies were classified into three quality tiers:
High: Score ≥ 6
Medium: Score = 4–5
Low: Score ≤ 3

For the analytical stage, only studies with a quality assessment of 6 or above were retained, resulting in a final dataset of 75 articles. To minimize potential subjective bias, two independent reviewers conducted the quality assessment in parallel. Any discrepancies in their evaluations were resolved through discussion until consensus was reached.

RESULTS

Bibliometric Analysis

Figure 2 illustrates the annual distribution of the selected publications. From 2014 to 2017, no relevant articles were identified, indicating that CSCM had not yet emerged as a major research focus in the CI. The field began to gain traction in 2018, with a modest output of three to six articles per year through 2020, reflecting an early exploratory stage of research. A sharp increase occurred between 2021 and 2023, culminating in a peak of 21 publications in 2023, likely driven by the global emphasis on the Sustainable Development Goals (SDGs) and carbon neutrality targets. The slight decline to 20 publications in 2024 suggests that the field is maturing while maintaining strong scholarly interest, although this figure may also have been influenced by the data collection cut-off date.

Figure 2

Years of Publication of Selected Literature

Figure 3 presents the geographical distribution of authors contributing to the reviewed literature, revealing that CSCM and CE research within the CI is driven by contributions from both developing and developed economies. China ranks first in terms of authorship, followed closely by the United Kingdom (UK), Italy, and Australia. Notably, although China leads individually, developed economies such as the UK, Italy, Australia, and several European countries collectively account for a substantial share of authorship, reflecting their established research capacity and long-standing commitment to sustainability. At the same time, developing economies, led by China and supported by growing contributions from India, Brazil, and several African countries, play an increasingly prominent role, reflecting their pressing need to address resource constraints, rapid urbanization, and construction-related environmental challenges through circular practices. Overall, the distribution indicates that the transition toward circular construction supply chains is a globally shared agenda, advanced jointly by developed economies with mature research traditions and developing economies facing pressing sustainability challenges.

Figure 3

Geographical Distribution of Authors by Country or Region

Figure 4 presents the keyword co-occurrence network, in which "circular economy" and "sustainability" emerge as the dominant themes, closely associated with keywords such as "BIM," "life cycle," and "energy efficiency." These connections reveal the major research hotspots and thematic intersections within the field, indicating that these concepts occupy a central position in CE-related research in the CI.

Figure 4

Keyword Co-occurrence Network

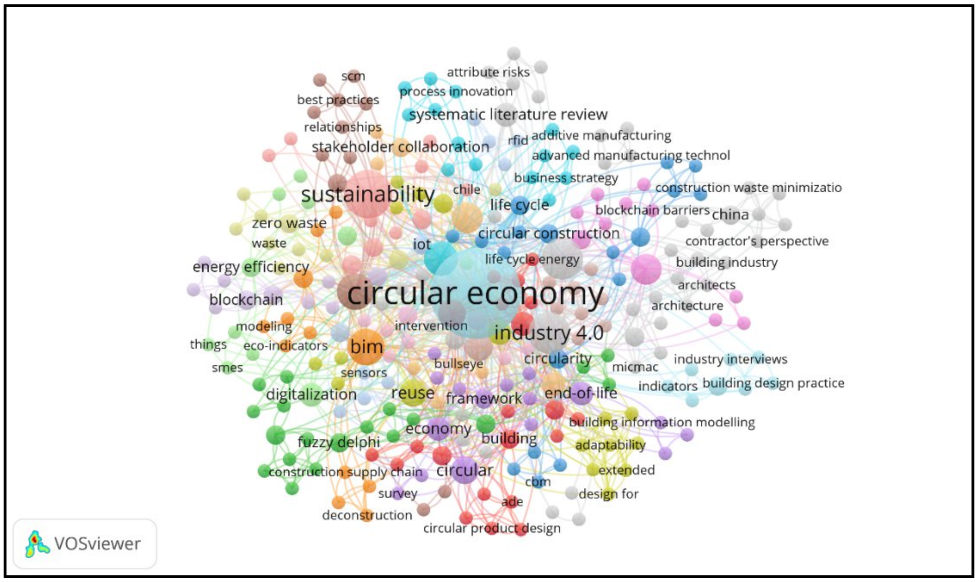


Figure 5 presents the keyword word cloud, in which terms such as "management," "circular economy," and "sustainability" appear most prominently, reflecting their dominant role in current research, particularly in relation to CEPs, implementation challenges, and supply chain management (SCM) in the CI.

Figure 5

Keyword Word Cloud

Content Analysis

Theoretical Foundations

This study is grounded in three complementary theories that jointly underpin the analysis of CSCM in the CI. Supply Chain Management (SCM) theory (Mentzer et al., 2001) provides the structural foundation by emphasizing coordination, integration, and information flow among supply chain actors as essential conditions for circular practices. The Triple Bottom Line (TBL) framework (Elkington, 1998) defines the performance dimension by requiring circular practices to be evaluated across economic, environmental, and social outcomes. Circular economy (CE) theory (Geissdoerfer et al., 2017; Kirchherr et al., 2017), grounded in the R-principles of slowing, narrowing, and closing resource loops, provides the operational logic for identifying and interpreting circular practices. Together, these perspectives constitute an integrated analytical framework that guides the subsequent coding, categorization, and interpretation of CEPs in the CI.

Categories of CSCM Practices

Building on the theoretical foundations presented in Section 3.2.1, the literature was coded using NVivo software, with SCM theory, the TBL framework, and CE theory jointly serving as the analytical lens. Mentions of CEPs relevant to the CI were recorded together with the corresponding bibliographic information. After each paper was reviewed, duplicate entries were merged and the total number of mentions for each practice was calculated. Descriptive coding with explicit labels was then applied to organize the identified practices into coherent categories. Through this theory-informed process, eight distinct CEPs were identified.

Systematic Analyses of CEPs in the CI from the Literature

CEPs comprise a series of systematic and strategic actions implemented throughout the production and consumption cycle to minimize resource loss and maximize value retention through the 10Rs framework (Refuse, Reduce, Rethink, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, Recover) (Zorpas, 2024). These practices are rooted in CE principles, which emphasize closing, slowing, and narrowing resource loops while integrating sustainable design, responsible procurement, and efficient WM (Vanhuyse et al., 2021; Elghaish et al., 2023; Ghafoor et al., 2023). In the present study, CEPs encompass Circular Design (CD), Circular Procurement (CP), Waste Management (WM), Industrial Symbiosis (ISS), Information Sharing (IS), Material Passports (MPs), Circular Business Models (CBMs), and Information Management (IM) within the CI, ensuring that materials and components remain in use for as long as possible, thereby reducing environmental impacts and contributing to economic, environmental, and social sustainability.

Circular Design

CD refers to a design philosophy that integrates life cycle thinking with CE principles during the design phase to enhance resource efficiency and minimize waste generation. The central idea of this approach is to circulate resources throughout the entire life cycle of a product or building so that material value is preserved to the greatest possible extent while environmental burdens are minimized. Within the context of this study, CD occupies a foundational role in promoting the sustainable use of resources from the outset of construction projects and constitutes one of the essential building blocks underpinning the implementation of CSCM (Chen et al., 2022a). Viewed through the lens of the CE paradigm, CD is inherently a multifaceted undertaking that requires a shift in design thinking from the prevailing product-oriented logic toward a more holistic, systems-based perspective (Dewagoda et al., 2022). Its objective is to deliver fully functional products or services using optimally selected materials, thereby ensuring superior performance while minimizing adverse impacts throughout the entire life cycle (Dokter et al., 2021). Moreover, decisions made during the design stage can exert a considerable influence on both the environmental footprint and the social impacts of construction activities (Abdullah et al., 2019). Service design is also closely intertwined with product design processes (Milton & Rodgers, 2023). Consequently, design guidelines for both products and services play an indispensable role in guiding contractors toward the adoption of CE principles (Blomsma et al., 2019; Giorgi et al., 2022).

Circular Procurement

CP can be understood as a procurement approach that promotes an environmentally responsible supply chain by prioritizing the sourcing of recycled materials, reclaimed components, and related products. This procurement approach emphasizes the green and circular characteristics of the supply chain as a whole, with the aim of improving resource. Within the present study, CP is recognized as one of the key enablers that significantly influences the implementation of CSCM in the CI (Xu et al., 2022). When CE principles are integrated into the procurement process, the conventional considerations of price, quality, time, and cost effectiveness are fundamentally redefined (Grimbert & Zabala-Iturriagagoitia, 2024). Often used interchangeably with sourcing, purchasing, or supply, the procurement function involves acquiring goods and services on behalf of organizations in both the private and public sectors (Sanders, 2020). Within the CE framework, raw materials are expected to possess either technical reparability or biological renewability to minimize environmental impacts (Genovese et al., 2017). Accordingly, CP emphasizes collaboration with environmentally responsible suppliers and the procurement of materials with low ecological impacts.

Waste Management

WM in the CI refers to the reduction of environmental pollution and the improvement of resource efficiency through systematic activities such as reduction, segregation, recycling, and disposal throughout the life cycle of a construction project. At its core, WM promotes the sustainable development of the CI through source control, resource recovery, and safe disposal. With the advancement of the CE, the reuse of construction waste has become an increasingly important focus within the CI. Using the post-war Benghazi region of Libya as a case study, Saeid et al. (2025) explored the feasibility of processing construction waste into recycled concrete aggregate. Their findings showed that recycled aggregate concrete performs comparably to conventional concrete in terms of structural stability and environmental performance, thereby reducing environmental pollution, lowering the demand for new raw materials, and supporting the CI's transition toward sustainability. In addition, Zhang et al. (2025) proposed the use municipal solid waste incineration bottom ash (MSWIBA) to produce modified geopolymer materials for construction applications. Their study demonstrated that these modified MSWIBA-based materials achieve strength and durability comparable to those of conventional construction materials while effectively reducing construction waste. Alongside the rapid advancement of digital technologies, the application of artificial intelligence (AI) in construction WM has emerged as a growing research hotspot. Kyriakarakos (2025) examined the role of AI in building energy management and waste control, reporting that intelligent building control systems can optimize resource use through real-time monitoring and data analysis, thereby reducing construction waste generation by up to 30%. By integrating technological innovation with intelligent management, construction waste recycling can improve resource efficiency, reduce environmental pollution, and ultimately support the sustainable transformation of the CI.

Industrial Symbiosis

ISS is an important component of industrial ecology, emphasizing resource sharing, waste exchange, and by-product reuse among different firms and industries to improve overall resource efficiency and reduce environmental impacts (Chertow, 2000). In the CI, ISS refers to the establishment of resource-sharing and waste-reuse networks between the construction sector and related industries to reduce resource consumption and environmental burdens. For example, construction waste can be supplied as raw material to other industries, while industrial by-products can be used to manufacture sustainable building materials, thereby creating a mutually beneficial symbiotic industrial system (Genc, 2024). Tanguler-Bayramtan et al. (2024) explored the practical application of ISS in the CI by using Monte Carlo simulation to assess the environmental impacts of calcium sufflaminate cement (CSA). Their findings indicated that cross-industry collaboration with sectors such as metallurgy enables the CI to effectively reuse construction waste and industrial by-products (e.g., metallurgical slag) thereby significantly reducing environmental impacts. In addition, Kollias and Leroy (2024) examined an innovative European Union (EU) project that promotes symbiotic collaboration between the aluminum industry and the CI. Their study investigated how bauxite tailings could be converted into construction materials, thereby reducing solid waste generated by the aluminum industry. These findings suggests that cross-industry technological collaboration and resource recovery can reduce CI's dependence on natural resources while lowering carbon emissions. Furthermore, Aguiar et al. (2025) analyzed the potential of reusing casting waste in the CI and proposed an optimal WM approach based on industrial ecology. Their study demonstrated that casting waste can be effectively utilized to produce high-strength concrete, road sub-base materials, and thermal insulation materials. The authors further recommend that governments and industry collaborate to establish cross-industry resource-sharing platforms to promote the adoption of ISS in the CI. Overall, ISS provides an important pathway for improving resources efficiency, reducing waste, and advancing the sustainable development of the CI.

Information Sharing

Information sharing (IS) in the CI refers to the real-time exchange of data among project participants, including designers, engineers, contractors, and owners, to enhance project management efficiency, reduce errors, and support informed decision-making. Through digital technologies such as BIM, cloud computing, and smart contracts, IS significantly enhances collaboration and data visualization capabilities (Li et al., 2025). Specifically, Tong and Ye (2025) emphasize the critical role of BIM in information sharing, demonstrating that semantic graph-based BIM models improve data visualization, traceability and communication among project stakeholders while reducing construction errors and enhancing material utilization. Furthermore, Ali and Brouwer (2025) explored the integration of AI technology and IS in the context of smart city infrastructure. Their study demonstrated that AI-enabled information-sharing platforms can monitor construction progress in real time, optimize material allocation, and predict potential safety risks. From a supply chain perspective, Martinez-Neri (2025) identified IS as a key factor in improving construction supply chain performance. The study reported that an effective information-sharing system can reduce material waste by approximately 20%, lower logistics costs, and improve overall operational efficiency. In addition, Abugu (2025b) examined the role of IS in coordinating construction costs, environmental impacts, and stakeholder collaboration. The findings indicate that effective IS facilitates the adoption of green building materials and supports the development of more environmentally sustainable construction solutions.

Material Passports

Material passports (MPs) are digital datasets containing detailed information on construction materials to improve their traceability, recyclability, and sustainability. They record information such as material composition, origin, usage history, environmental impacts, and recycling potential (Honic et al., 2021). The concept of MPs originated from Europe's CE strategy and gained widespread recognition through the "Madaster" platform in the Netherlands (Munaro & Tavares, 2021). Their primary objective is to establish a "material bank" that enables construction materials to be reused at the end of a building's life cycle rather than being discarded (Çetin et al., 2023). MPs are commonly implemented through BIM, which tracks material life cycle data and facilitates efficient material recovery following building deconstruction (Atta et al., 2021). In smart building management systems, MPs are frequently integrated into BIM platforms to enable real-time material information management (IM) (Göswein et al., 2022). In addition, integrating radio frequency identification (RFID) technology with MPs has been shown to improve recycling efficiency, particularly for concrete. Studies indicate that MPs can increase the market value of recycled materials by approximately 20%, optimize material procurement and management, and reduce the consumption of raw materials (Vahidi et al., 2024). Recent research has also explored the use of QR codes and blockchain technology to enhance data traceability and transparency. For example, each construction material can be assigned a QR code that enables users to access its complete life cycle information by simply scanning the code (Byers & De Wolf, 2023). Furthermore, Lu et al. (2023) reported that MPs can reduce construction waste by 30–50%, primarily by extending material life spans and improving recyclability. As one of the world's largest generators of waste, the CI can substantially enhance material reuse through the adoption of MPs, thereby mitigating its environmental impact.

Circular Business Models

Circular Business Models (CBMs) are innovative business strategies that integrate product-service systems, resource sharing, and circular resource utilization into the core of organizational operations to achieve closed-loop resource management and maximize economic value. In the CI, CBMs are regarded as a key mechanism for driving the transition to a CE and serve as a central link connecting and supporting other CEPs. Grounded in CE theory, CBMs emphasize business model innovation to enhance resource efficiency while balancing economic, social, and environmental benefits (Pieroni et al., 2019). By redesigning how value is created, delivered, and captured, organizations can establish sustainable competitive advantages. Several key drivers underpin the adoption of CBMs in the CI, including effective information dissemination, project and product certification, and professional training and education. These factors strengthen stakeholder collaboration, promote technological innovation, and support the development of robust product certification frameworks (Itanola et al., 2024). Additionally, Véliz et al. (2025) highlight the importance of systems thinking and modeling approaches for understanding the complex interactions among drivers and barriers influencing CBM implementation. This holistic perspective is essential for accelerating the sustainable transformation of the CI.

Information Management

Information Management (IM) in the CI refers to the systematic processes, technologies, and standards used to collect, store, share, and analyze construction-related information to improve project efficiency and quality (Farmanesh et al., 2025). IM spans the entire project life cycle, encompassing the design, procurement, construction, operation, and maintenance phases. BIM serves as a key enabler of IM by allowing architects, engineers, and contractors to collaborate within a shared three-dimensional (3D) digital environment, thereby optimizing design and construction processes. The integration of BIM with IM systems enhances project visualization, reduces design and construction errors, and improves on-site safety (Otranto et al., 2025). One notable innovation in IM is the BIM Semantic Graph, which analyzes building model information to improve information flow and interpretability (Tong & Ye, 2025). Furthermore, the integration of AI has advanced IM by enabling capabilities such as project schedule prediction, supply chain optimization, and construction risk mitigation (Saavedra et al., 2025). Effective IM also supports real-time monitoring of project budgets, construction progress, and resource utilization, thereby reducing the risk of cost overruns and enhancing financial transparency (Okpaka, 2025). Research further indicates that inadequate IM is a major contributor to cost overruns. By adopting integrated IM systems, construction projects can reduce information redundancy and errors, improve project predictability, and automate data analysis, enabling project managers to make timely decisions, adjust schedules in real time, and minimize project delays (Saavedra et al., 2025, Yin et al., 2026b).

DISCUSSION AND IMPLICATIONS

In recent years, research on the CE in the CI has grown significantly, reflecting the increasing global emphasis on sustainable development. Benachio et al. (2020) pointed out that although theoretical discussions of CE principles in the CI are extensive, their practical application remains limited, highlighting a persistent gap between theory and practice. In contrast to the manufacturing industry, where empirical studies have demonstrated the feasibility of CE through practices such as optimizing resource circulation in production processes (Constantinos Challoumis, 2024), the CI has experienced slower implementation due to its project-based nature, extended project life cycles, and fragmented supply chains (Bhattacharya & Chatterjee, 2021; Li et al., 2024). This contrast reflects not only industry-specific challenges but also limitations in the existing literature, which has predominantly focused on theoretical framework development while offering relatively limited exploration of practical implementation (Soltani et al., 2025; Kussl & Wald, 2025). In addition, successful practices adopted in the manufacturing industry, such as closed-loop supply chain design, could be adapted to the CI (Hafiz et al., 2024). Further research is needed to evaluate their applicability and identify the modifications required for effective implementation (Dewagoda et al., 2024; Abbasi et al., 2023).

Among the key CEPs supporting CSCM in the CI, CD, CBMs, and CP are widely regarded as the primary drivers of the transition toward a CE. Charef et al. (2021) emphasized that CD can significantly reduce resource waste by optimizing material selection and building design, a view that is widely supported in the literature. In contrast, Branca et al. (2021) observed that WM and ISS have achieved measurable progress in the European CI through policy incentives and innovative practices. For example, the UK has implemented tax incentives to encourage waste reuse (Panzone et al., 2021). However, these downstream practices remain relatively underdeveloped globally, particularly in developing countries (Luthra et al., 2022; Halog & Anieke, 2021). This regional disparity may stem from the CI's long-standing reliance on the traditional linear "extract-build-dispose" model, which provides limited systemic support for material recovery and regeneration. Therefore, future research should not only strengthen upstream role of CD, for instance by embedding design-for-disassembly and modular design principles into the design phase, but also draw lessons from ISS practices in the manufacturing sector to develop construction-specific resource recovery strategies (Bressanelli et al., 2022; Castellet-Viciano et al., 2022; Colpo et al., 2022). Potential research directions include developing advanced classification and recycling technologies for demolition waste and investigating the feasibility of cross-industry collaboration, such as sharing waste treatment facilities with the manufacturing sector, to establish a more comprehensive circular resource system.

The role of digital technologies in CSCM has become increasingly prominent, with BIM, life cycle management, and energy efficiency tools emerging as major research hotspots. Through case studies, Han et al. (2021) demonstrated that BIM significantly enhances the transparency of resource management and reduces construction waste. For example, in a commercial building project in the UK, the implementation of BIM resulted in an approximately 15% reduction in material waste (Iacovidou et al., 2021; Abugu, 2025a). However, Senna et al. (2022) further revealed that, despite the considerable potential of digital technologies, their adoption is hindered by barriers such as high initial costs, technical complexity, and a shortage of skilled professionals. These challenges are particularly pronounced among small and medium-sized enterprises (SMEs), which often lack the financial and technological resources required to undertake complex digital transformation initiatives (Rupeika-Apoga & Petrovska, 2022; Bamidele Micheal Omowole et al., 2024). Moreover, existing research on the application of digital technologies remains relatively limited, often relying on conceptual discussions or small-scale pilot studies with insufficient empirical evidence. Future research should undertake large-scale empirical studies to evaluate the specific contributions of BIM and IoT to resource circulation, such as quantifying their effects on material tracking and waste reduction (Althoey et al., 2024; Chen et al., 2023). In addition, further investigations are needed to address practical implementation challenges, including the lack of unified technical standards and difficulties in data integration (Jeddoub et al., 2024). Exploring affordable digital solutions, such as cloud-based lightweight BIM platforms, may also help lower the barriers to digital adoption among SMEs.

Significant disparities exist between developed countries (e.g., the UK, Sweden) and developing countries (e.g., China and Brazil) in the implementation of CSCM, reflecting differences in technological adoption, policy environments, and stages of economic development. Li et al. (2023) observed that developed countries primarily rely on policy incentives and technological innovation to advance CSCM. For example, Sweden has implemented stringent construction waste classification regulations, significantly improving resource recovery rates (Sundlin, 2021). In contrast, developing countries tend to rely more heavily on government-led pilot projects, such as China's promotion of green building demonstration zones in selected cities (Qiao et al., 2022). Compared with developed countries, many developing countries remain at an early stage of technological adoption due to inadequate infrastructure, limited industry collaboration, and financial constraints (Pandey et al., 2022; Shahadat et al., 2023). For example, the slow progress of CP in Ghana's CI has been partly attributed to the absence of a mature material recycling market (Ababio et al., 2023). These regional differences suggest that CSCM strategies should be tailored to local contexts. In developed countries, policy frameworks and technology integration could be further strengthened, for example, by providing tax incentives to encourage the adoption of BIM (Jiang et al., 2021). In developing countries, greater emphasis should be placed on promoting affordable and easy-to-implement solutions, such as localized CD guidelines (Ababio et al., 2023). Moreover, developing countries can draw on the policy experiences of developed nations to progressively strengthen their technological capabilities and market maturity (Luo et al., 2023). Future research should undertake cross-national comparative studies to identify best-practices for implementing CSCM across different economic contexts.

Existing research has largely examined individual CEPs, such as CD or WM, while paying relatively little attention to the synergies among them. This fragmented approach limits a comprehensive understanding of CSCM effectiveness. Cerqueira-Streit et al. (2021) criticized CE research for its lack of a systems perspective, arguing that existing theoretical frameworks remain fragmented and provide limited actionable guidance. In contrast, other scholars have advocated technology-integrated platforms based on BIM and IoT, emphasizing the synergistic potential of technology-driven approaches. For example, BIM can integrate CD with material life cycle information, while IoT enables real-time monitoring of procurement activities and WM (Elghaish et al., 2023; AlJaber et al., 2023). These technology-driven strategies offer promising pathways for integrating CEPs; however, their practical feasibility requires further empirical validation. Challenges such as data interoperability between BIM and IoT, together with the high development costs of digital platforms, may constrain their widespread adoption. Compared with the conceptual critique advanced by Kirchherr et al. (2017), these technology-enabled approaches appear more operationally oriented, although robust empirical evidence supporting their effectiveness remains limited. Therefore, future research should investigate integrated implementation pathways for CEPs, for example, by evaluating the synergies between CD and WM through pilot projects, or by combining policy instruments, such as green certification schemes, with digital technologies to establish a comprehensive CSCM framework. In addition, system dynamics modeling could be employed to simulate the impacts of different combinations of CEPs on resource efficiency and economic performance, thereby providing more rigorous decision support for policymakers and industry practitioners (Khan & Abonyi, 2022).

To address practical obstacles in CSCM implementation, optimization strategies incorporating blockchain, BIM, and IoT have attracted increasing attention. Waqar et al. (2024) suggested that blockchain, through its distributed ledger technology, can significantly enhance supply chain transparency. For example, in a pilot project conducted in Australia, blockchain was successfully applied to material traceability, improving the accountability and traceability of individual batches of construction materials. Similarly, Hussain et al.

(2024) found that IoT-enabled real-time monitoring of WM has shown promising results in small-scale construction projects, such as using sensors to track the generation and movement of construction waste. However, these technological approaches also face significant challenges. Blockchain implementation requires substantial computational resources and broad industry consensus (Xu et al., 2023), whereas IoT adoption is constrained by implementation costs, data privacy concerns, and equipment maintenance requirements (Wang et al., 2021). These findings indicate that although digital technologies offer considerable potential, their economic viability and technical feasibility require further empirical validation. Future research should undertake large-scale pilot studies to evaluate the effectiveness of these technologies across different types of construction projects. For example, blockchain applications could be compared between high-rise building developments and infrastructure projects to assess their relative performance and implementation challenges. Such studies could also identify barriers to adoption and propose practical solutions, including the establishment of data security standards and the development of industry-wide training programs. Addressing these practical challenges will be essential for enabling digital technologies to support the widespread implementation of CSCM.

A comparison with previous studies highlights the key trends and remaining gaps in CSCM research within the CI. Unlike much of the existing literature, which focuses on individual CEPs, this study emphasizes the importance of integrating circular practices, digital technologies, and synergistic implementation mechanisms, thereby offering a broader perspective on CSCM in the CI. Nevertheless, compared with Benachio et al. (2020) analysis of the theory-practice gap, this study provides relatively limited discussion of practical implementation cases. Similarly, although this study adopts a more practice-oriented approach than the systematic framework proposed by Kirchherr et al. (2017), it does not examine non-technical factors, such as cultural, institutional, and organizational dimensions, in sufficient depth (Ajibike et al., 2023). Accordingly, future research should focus on three key directions: (1) conducting cross-national, multi-case empirical studies to validate CEP implementation models and evaluate the effectiveness of digital technologies; (2) examine the interactions among technology, policy, organizational factors, and culture to establish a more comprehensive CSCM framework; and (3) developing localized CSCM strategies tailored to the needs of developing countries. Advancing these research directions will help the CI accelerate its transition toward a more efficient CE and strengthen its contribution to global sustainability goals.

CONCLUSION, LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study adopted the SLR methodology to systematically review and analyze the research trends, practice models, implementation status, and research gaps of CSCM in the CI. The findings identify eight major CEPs within the CSCM framework, namely CD, CP, WM, ISS, IS, MP, CBMs, and IM. Among these, CD, CP, and CBMs have received greater attention, whereas downstream practices such as ISS and WM remain comparatively underexplored. In addition, digital technologies, particularly BIM and MPs, have attracted considerable academic interest, highlighting their important role in supporting the CE transformation of the CI.

The review further reveals a clear disconnect between theoretical development and practical implementation in the existing literature, underscoring the need for more empirical case-based research and deeper investigation into the synergies among multiple circular practices. Furthermore, the geographical distribution of existing studies remains uneven, with developing countries continuing to be underrepresented. Future research should therefore give greater attention to the diverse needs and contexts of different countries and regions to support the broader and more effective implementation of CSCM practices worldwide.

Despite its contributions, this study has several limitations. First, the review was based on selected databases, search strings, and screening criteria, which may have excluded relevant studies published in other databases, grey literature sources, or non-English publications. Second, although the SLR methodology provides a systematic and transparent approach, the classification of CEPs and research themes may still involve a degree of subjective interpretation. Third, this study focused primarily on academic literature and therefore may not fully capture emerging industry practices, policy initiatives, or implementation experiences that have yet to be documented in scholarly publications.

In light of these limitations, several directions for future research are proposed. First, future studies could broaden the scope of data sources by incorporating grey literature, industry reports, policy documents, and non-English publications to provide a more comprehensive understanding of CSCM development. Second, more empirical and case-based research is needed to examine how different CEPs are implemented in real construction projects and to evaluate their environmental, economic, and social impacts. Third, future research should further investigate the integration and synergies among multiple circular practices, particularly the interactions between CD, WM, ISS, and digital technologies. Finally, greater attention should be given to developing countries and region-specific contexts, where institutional, economic, technological, and cultural conditions may significantly influence the adoption and implementation of CSCM practices.

In summary, by systematically reviewing the current state of research and emerging trends in CSCM within the CI, and by clarifying the implementation status of CEPs and the challenges associated with their adoption, this study provides a comprehensive synthesis of the field and offers a clear theoretical framework and future research directions. It is hoped that these findings will support the more effective implementation of CSCM, thereby facilitating the CE transformation and sustainable development of the CI.

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.

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