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Squaring circular supply chain management: A comprehensive overview of emerging themes and trends

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Abstract

Circular supply chain management (CSCM) is the revolutionary integration of circular principles into supply chain management and the supply chain environment to achieve zero waste and outperform traditional supply chain sustainability models in advancing supply chain circularity. This study examines CSCM and the corresponding literature to highlight key research themes and trends. An advanced iteration of the Systematic Science Mapping analysis methodology has been designed and implemented with a Named Entity Recognition approach to extract relevant information from scientific articles. Key themes are revealed such as essential capabilities for circularity in the supply chain, circular business models, sustainable supplier selection and blockchain technology's role. The article gives insights into current research and identifies emerging trends in CSCM. This exploration aims to provide a nuanced understanding of CSCM's transformative power and shed light on its practical implications.

KEYWORDS

bibliometrics, circular, circular economy, closed-loop, supply chain management, supply chain management, systematic science mapping

1 | INTRODUCTION

Circular economy (CE) has received increasing attention in recent years as a potential improvement on the current linear production and consumption model (Andersen, 2007; Ghisellini et al., 2016; Scarpellini et al., 2019). CE is a closed-loop system that can create a more sustainable future by minimising waste and using finite resources more efficiently (Lieder & Rashid, 2016; Paladini et al., 2021). Essentially, CE aims to ensure that resources remain in use for as long as possible through product redesign, material reuse and waste reduction, among other sustainable practices (Ghisellini et al., 2016; Sandin & Peters, 2018). For its part, supply chain management (SCM) is the planning and controlling of all the activities involved in producing and delivering a product or service, from raw materials to the end customer (Chen & Paulraj, 2004). The literature emphasises the importance of strategic SCM for firms seeking to improve their profitability and competitive position while offering opportunities for strategic entrepreneurship (Hult et al., 2007; Ketchen &

Abbreviations: AI, artificial intelligence; AR, augmented reality; CBM, circular business model; CE, circular economy; CPS, cyber-physical system; CSC, circular supply chain; CSCM, circular supply chain management; CSCMP, Council of Supply Chain Management Professionals; EEE, electrical and electronic equipment; EoL, end-of-life; I4.0, Industry 4.0; IoT, Internet of Things; JCR, Journal Citation Reports; k-NNG, k-nearest neighbour graph; LCA, life cycle assessment; NER, named entity recognition; NLP, natural language processing; RQ, research question; SC, supply chain; SCM, supply chain management; SJR, Scimago Journal Rank; SLNA, systematic literature network analysis; SLR, systematic literature review; SME, small and medium-sized enterprise; SSM, Systematic Science Mapping; WoS, Web of Science.

Craighead, 2020). An appropriate SCM strategy can also improve operational results through greater process efficiency, lower inventory levels, higher customer satisfaction, better quality, cost reductions and better delivery (Martin & Towill, 2000).

The amalgamation of CE and SCM has created the concept of circular supply chain management (CSCM) (Canning, 2006; De Angelis et al., 2018). The CSCM value chain operates in a circle from raw material sourcing to waste disposal. This involves significant changes in supply chain relationships including moving away from product ownership towards a greater emphasis on leasing and service-based strategies enabled by digital systems. Closer collaboration is required between different supply chain partners and beyond their immediate industrial boundaries, including suppliers, product designers and regulators. CSCM also implies procurement policies transcending legal requirements to include circular economy principles (De Angelis et al., 2018). CSCM offers many benefits, including waste reduction, resource conservation, improved resilience and the mitigation of environmental impacts (De Angelis et al., 2018; Mangla et al., 2018). Therefore, integrating CE principles into SCM provides a significant opportunity to create a more sustainable and resilient future. However, for organisations and policymakers to support CSCM adoption and drive positive change effectively, they must first understand the complexities and challenges of its implementation.

Some recent studies have explored different features of CSCM research. While some authors have focused on CSCM from a general perspective (Masi et al., 2017; Theeraworawit et al., 2022; A. Zhang et al., 2023), others have addressed more specific issues. These include reviews of the role of Industry 4.0 (I4.0) technologies in CSCM (Agrawal et al., 2022; Gebhardt et al., 2022; Rusch et al., 2023), the drivers, barriers and enablers of CE in the supply chain (SC) (Govindan & Hasanagic, 2018; Qazi & Appolloni, 2022), SC circularity in the food industry (Do et al., 2021; Q. Zhang et al., 2022) and CE and SC business models (Centobelli et al., 2020; Geissdoerfer et al., 2018; Lüdeke-Freund et al., 2019), among others.

The extensive body of literature on CSCM reflects the increased emphasis in recent years on implementing and managing these systems (De Angelis et al., 2018; Lahane et al., 2020; Montag, 2022). This growing research interest in CSCM also corresponds to significant interest from firms increasingly seeking more efficient SC management models (Centobelli et al., 2020). Extending circularity along the SC has been demonstrated to improve sustainable performance by leveraging collaborative practices (Jraisat, Upadhyay, et al., 2023), digital SC technologies (M. Sharma et al., 2022) and emerging Industry 4.0 technologies (Jraisat, Jreissat, et al., 2023; Sahoo et al., 2023; Upadhyay et al., 2023), among other factors. As the field continues to evolve and grow, it is vital to keep up-to-date with the latest developments and research (Farooque, Zhang, Thürer, et al., 2019).

In light of the existing literature, this study seeks to address the following research question: What are the main findings and prevailing research directions in the CSCM field? This general question has been broken down into three distinct sub-questions focused on the specific aims of the research: (RQ1) How can the findings in the CSCM literature be grouped? (RQ2) How has the importance of the identified clusters evolved over time and what are the most relevant research lines today? and (RQ3) What gaps and avenues for future research emerge from the existing literature on CSCM? Therefore, the purpose of this study is to analyse the research literature on CSCM to (a) comprehensively understand the existing knowledge in the field by grouping the research contributions into thematic clusters, (b) offer both academics and practitioners insights into the key issues surrounding CSCM and how these have evolved, (c) pinpoint gaps that require further investigation and (d) leverage previous research efforts and advance understanding of the field.

Various methods exist to analyse the research literature in a field. To achieve the objectives set out in this study and contribute to knowledge on CSCM, we integrate the initial stages of a structured literature review with bibliometric analysis (Kraus et al., 2024) using natural language processing (NLP) with named entity recognition. This combined approach serves a dual purpose: firstly, it facilitates a clustering analysis and the construction of a thematic evolution map by pinpointing the most influential and pertinent contributions, thereby allowing focused strategic research endeavours. Secondly, it ensures that the evaluation of existing studies is consistent and rigorous, enhancing their value for comprehending the current state of research and establishing benchmarks for methodological excellence. Therefore, this study endeavours to provide a comprehensive overview of the current CSCM literature through the design and implementation of an advanced iteration of Systematic Science Mapping (SSM) analysis (Núñez-Merino et al., 2022). This method provides insights into the current state of research by identifying thematic clusters and analysing how research has evolved over time, thus enhancing the methodology's potential to identify the challenges and opportunities associated with implementing CSCM and providing recommendations for future research.

The remainder of this paper is organised as follows: Section 2 presents the fundamental concepts central to the study, while Section 3 describes the novel SSM analysis. Section 4 reports the main findings of the SSM analysis and Section 5 provides a discussion of the results, the major implications of the study and emerging challenges in the CSCM field. Finally, Section 6 offers some conclusions and future research lines.

2 | CONCEPTUAL FRAMEWORK

2.1 | Key concepts

This section explains the key concepts essential for understanding this research. Starting with an overview of the CE concept and its evolution over time, it goes on to present a concise conceptualisation of the SCM strategy. Finally, it offers some insights into the CSCM concept.

2.1.1 | Circular economy

CE represents a paradigm shift in economic and environmental thinking with the transformation of traditional linear production and consumption models into a more sustainable and resource-efficient approach (Andersen, 2007; Dey et al., 2020). The concept has evolved, transitioning from the initial focus on 'green' practices, which mainly involved reducing the negative environmental impacts of linear systems, to a broader perspective that encompasses 'sustainability' and aims to balance social, economic and environmental factors. However, it did not stop there; it progressed further towards 'circularity', emphasising the regenerative and restorative aspects of economic activities (Hussain & Malik, 2020). CE practices now include not only waste reduction but also the design of products for durability, ease of repair and recyclability, as well as the creation of closed-loop systems where materials flow continuously around the production-consumption-recycling cycle (Kirchherr et al., 2023; Upadhyay et al., 2023).

2.1.2 | Supply chain management and sustainability principles

According to the Council of Supply Chain Management Professionals (CSCMP), SCM involves the strategic planning and control of every aspect of sourcing and acquiring goods, the transformation of these resources and the efficient management of all logistical functions. It includes coordination and cooperation with various partners in the supply chain, including suppliers, intermediaries, third-party service providers and customers (Gibson et al., 2005). Originally centred on streamlining operations and minimising costs, SCM gradually expanded to embrace network-wide collaboration and emphasise partnerships and trust among stakeholders (LeMay et al., 2017). Furthermore, environmental and social concerns led to the integration of sustainability principles and the recognition of the need to manage supply chains in a way that respects ecological limits and societal well-being (Fernando, Halili, et al., 2022; Jæger et al., 2021; Jraisat, Upadhyay, et al., 2023).

2.1.3 | Circular supply chain management

CSCM is a strategic framework that extends traditional SCM practices to align with the principles of CE. It encompasses the design, execution and optimisation of supply chain activities to prioritise resource efficiency, waste reduction and the continuous reuse, refurbishment and recycling of materials (Farooque, Zhang, Thürer, et al., 2019). CSCM seeks to minimise the negative environmental impacts of production and consumption by encouraging resource regeneration and waste reduction throughout the supply chain (De Angelis et al., 2018). In its early stages, CSCM predominantly concentrated on eco-efficiency and sought to minimise waste and pollution in supply chain processes. However, as the circular economy gained prominence, CSCM expanded its focus to take on a holistic view that included the redesign of products, materials and business models to encourage circularity (Batista et al., 2018; Ferasso et al., 2020). This evolution highlights a growing emphasis on collaboration, innovation and stakeholder engagement across supply chain networks (Braz & Marotti de Mello, 2022; Jraisat, Upadhyay, et al., 2023; Sahoo et al., 2023).

2.2 | Theoretical approaches to the research problem

Literature reviews and bibliometrics are two distinct but complementary approaches that have been consolidated as essential tools for understanding the state of knowledge in a specific research area (Garcia-Buendia, Moyano-Fuentes, Maqueira-Marín, & Cobo, 2021; Núñez-Merino et al., 2020). While literature reviews focus on analysing and synthesising existing knowledge on a given topic to identify trends, research gaps and areas for future research (Tranfield et al., 2003), bibliometrics focuses on the quantitative analysis of scientific production, including the number of publications and citations received, and collaboration between authors, among other aspects (Garcia-Buendia, Moyano-Fuentes, Maqueira-Marín, & Cobo, 2021).

Relevant methodologies for literature reviews include the systematic literature review (SLR) method and the scoping review (Kraus et al., 2024). One of the strengths of systematic literature reviews is to allow an in-depth analysis of a selection of articles relevant to answering one or more research questions through a preliminary review of article titles and abstracts (Denyer & Tranfield, 2009; Tranfield et al., 2003).

The main objective of bibliometrics is to measure the impact and visibility of research in a specific area (Kraus et al., 2024). In this sense, bibliometric tools have evolved to allow the detection of key themes through the analysis of keyword co-occurrence in articles and the identification of clusters of articles through bibliographic coupling techniques or co-citation analysis (Moral-Muñoz et al., 2020). The principal bibliometric analysis tools are BibExcel, Biblioshiny, CiteSpace, SciMAT, Sci2 Tool, ScientoPy and VOSviewer (Moral-Muñoz et al., 2020).

However, both literature reviews and bibliometrics have their limitations. On the one hand, in literature reviews, the researchers' interpretation and synthesis of the literature can be subjective, which can affect the objectivity of a review's results (Kraus et al., 2024). In addition, this method is time-consuming, which may make it difficult to cover all the available literature (Núñez-Merino et al., 2022). On the other hand, bibliometrics focuses on the quantitative analysis of scientific output and provides only a limited understanding of an overview of an area of knowledge (Moral-Muñoz et al., 2020). Another relevant bias that particularly affects bibliometrics is that it is limited to the use of only one database, which may affect the coverage of the research analysed (Garcia-Buendia, Moyano-Fuentes, Maqueira-Marín, & Cobo, 2021; Núñez-Merino et al., 2020).

Two relevant methods have emerged that merge these two approaches to synthesise the state of the art: systematic literature network analysis (SLNA) (Strozzi et al., 2017) and systematic science mapping (Núñez-Merino et al., 2022). Both methods combine the

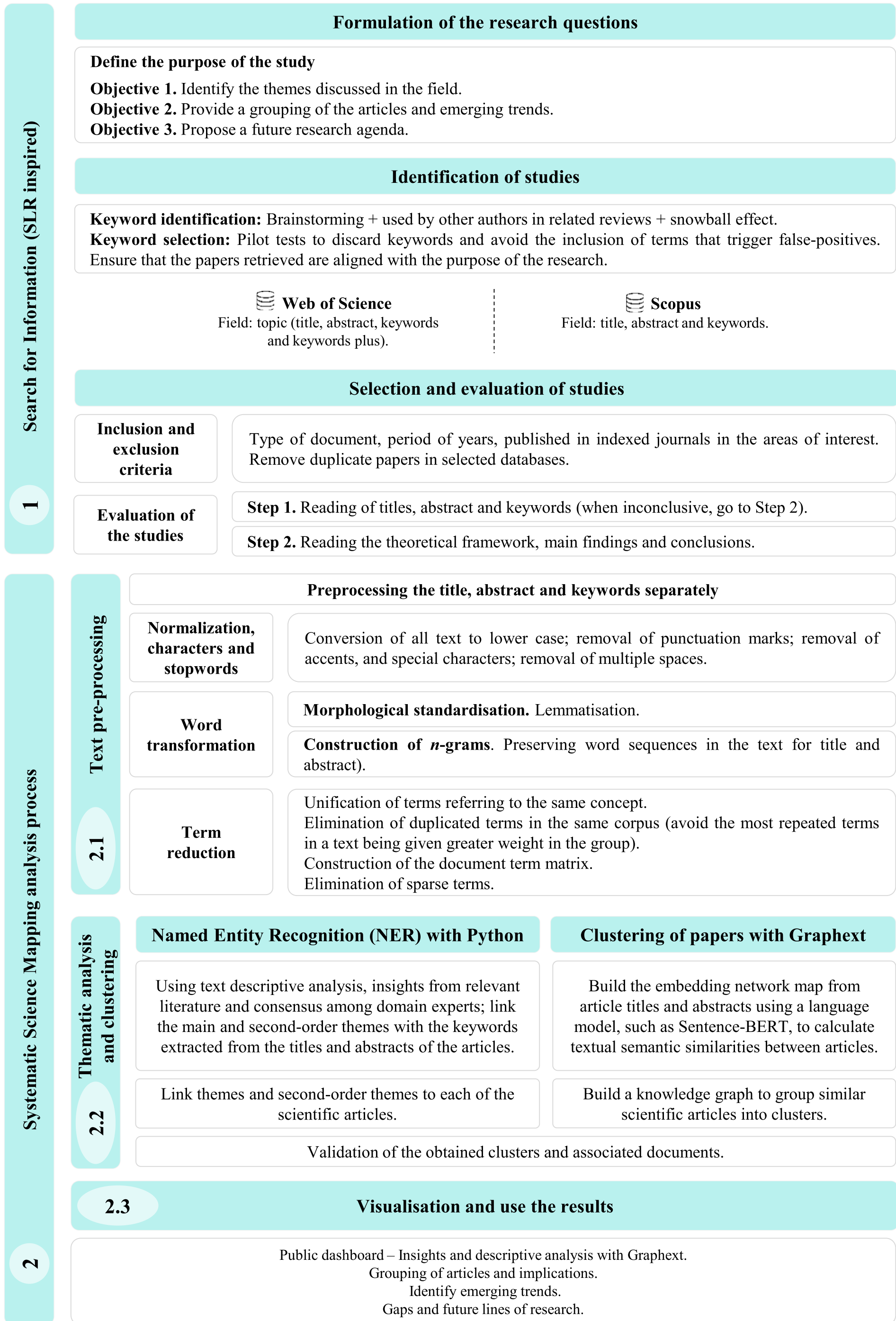

FIGURE 1 SSM analysis methodology. Adapted from Núñez-Merino et al. (2022).

advantages of literature reviews while addressing the main limitations of literature reviews and bibliometric techniques. SLNA only allows the content of a single database to be analysed and employs network analysis techniques to study keyword co-occurrence in both the author and citation networks (Strozzi et al., 2017). However, SSM enables the content of multiple databases to be analysed simultaneously. It uses natural language processing (NLP) techniques to analyse the textual content of article titles, abstracts and keywords to extract the main themes and group them into clusters with similar themes (Núñez-Merino et al., 2022). In addition, SSM uses the Graphext general-purpose data science tool, which allows an interactive graph with nodes representing articles and other relevant metadata, such as authors, journals, year of publication, impact factor, number of citations, etc. to be shared publicly. This means that articles can be selected according to one or more of these criteria (Núñez-Merino et al., 2022).

To address the limitation of the interpretability of the results, both methods select a subset of the most relevant and influential articles in each identified cluster for their in-depth analysis (Núñez-Merino et al., 2022; Strozzi et al., 2017). This allows a more detailed and meaningful understanding of the themes and trends identified in the literature review.

3 | METHOD

An SSM analysis based on the methodological approaches to the research problem described in the previous section will be used to answer the research questions raised. As mentioned above, we combine the preliminary phases of a structured literature review with bibliometric analysis. An adaptation of SSM analysis (Núñez-Merino et al., 2022) has been designed and implemented as a methodological approach to achieve the abovementioned objectives. SSM is an innovative methodology that combines the initial phases of an SLR (Denyer & Tranfield, 2009; Tranfield et al., 2003) with NLP and graph visualisation techniques to conduct a literature review and is particularly relevant given the enormous volume of scientific production that currently exists (Núñez-Merino et al., 2022). This.

SSM methodology has been refined by incorporating cutting-edge NLP techniques with a named entity recognition (NER) model to enhance the effectiveness of information extraction from documents. Also, an embedding-based language model has been introduced to determine semantic similarity among the scrutinised documents. This similarity measure is then used to construct clusters. Using NLP techniques allows large article sets to be analysed without researcher subjectivity influencing the results (Núñez-Merino et al., 2022). The adaptations to the methodology are specifically related to the thematic analysis and clustering processes, as will be explained in Section 3.3.

SSM analysis employs programming languages such as R or Python in tandem with Graphext, a no-code platform (https://www.graphext.com/) that can be used to create powerful data science projects. The platform enables the reviewed literature to be clustered in knowledge graphs and the development of a publicly accessible dashboard (Núñez-Merino et al., 2022).

Figure 1 summarises the SSM analysis methodology adopted in the present study. SSM analysis has two main stages, information search and the SSM analysis process, which are described below. A more detailed description of these stages can be found in Núñez-Merino et al. (2022).

3.1 | Information search

In this stage, the research objectives are formulated as in an SLR: studies are identified and documents are selected and assessed for inclusion (Denyer & Tranfield, 2009; Tranfield et al., 2003). In this particular case, this was done jointly by this paper's authors in an interactive review process. First, the scope, purpose and objectives of the review have to be defined. This study was guided by the research questions specifically formulated to identify the main findings and current research trends in the CSCM field.

The initial steps of an SLR allowed us to identify and select articles directly linked to the objectives set for this research. Any studies not related to the objectives of the review were discarded. Criteria were established to determine the studies that should be considered in the review (inclusion criteria) and those that should be discarded without further ado (exclusion criteria) (Denyer & Tranfield, 2009). The Web of Science (WoS) and Scopus databases were used to identify the literature as they are the most relevant in the study area (Garcia-Buendia, Moyano-Fuentes, & Maqueira-Marín, 2021). Search strings were designed to identify documents that included the terms 'circular*' AND 'supply chain*' in the abstract. The searches were conducted in the first week of 2023 and were limited to articles, articles in press and reviews written in English and published at any time in 2022. Next, the articles were assessed. This consisted of examining the title, abstract and keywords to identify which documents were related to the research question and which were not. The latter were discarded. When this analysis was inconclusive, the theoretical framework, main results and conclusions were examined, and the entire article was read if necessary.

Applying the above-mentioned inclusion and exclusion criteria yielded a total of 2,368 publications from a total of 2,922 works initially identified in WoS and Scopus. Subsequently, 1,099 duplicate papers found in the two databases were removed, leaving a set of 1,823 studies. Lastly, only papers published in journals indexed in the Journal Citation Reports (JCR) and/or Scimago Journal Rank (SJR) were selected to guarantee their quality (Núñez-Merino et al., 2020). After rejecting articles that did not comply with the research objectives, a total of 1,128 papers were obtained for analysis.

3.2 | Systematic science mapping analysis process

3.2.1 | Text processing

Text pre-processing is a basic task in NLP and consists of making changes to the text to enable the information to be computer-processed using a text mining technique (Silge & Robinson, 2017). R and Python are suitable tools for this as they include libraries and functions that facilitate the process. In the context of the methodology applied in this research, the following steps were applied to the titles and abstracts of the papers: normalisation with the elimination of special characters and stop-words (meaningless words); word transformation, and reduction of terms (Núñez-Merino et al., 2022).

3.2.2 | Thematic analysis and clustering

Named entity recognition (NER) is a rapidly evolving field that makes significant contributions to various natural language applications, particularly in tasks related to information extraction (A. Goyal, Gupta, & Kumar, 2018). One crucial aspect of this is the recognition and classification of named entities. NER models enable the identification and extraction from unstructured text of entities relevant to the analysed domain or context and their classification into pre-defined categories, including persons' and organisations' names, locations, monetary values, medications, pathologies, etc. Python was used to construct a rule-based model for NER through text descriptive analysis, insights from the relevant literature and the consensus of domain experts. The main and second-order themes were linked to the keywords extracted from the article titles and abstracts. In the context of this study, the main research themes identified were, among others, CE practices (composed of second-order themes such as recycling, consumption, reuse, etc.), supply chain management process (production, logistics, purchasing, etc.) and sectors (manufacturing, agri-food, construction sector, etc.). The main identified themes and second-order themes (see Appendix A) have been used to identify specific features in the research area to facilitate the identification of distinct and very specific emerging trends. These themes also helped to provide a broad interpretation of each cluster.

The end goal of this stage is to group or cluster similar analysed articles using the Graphext tool (Núñez-Merino et al., 2022). A cluster contains a broad collection of articles that systematically explore analogous facets of the topic. An embedding network map is built from the titles and abstracts of the articles using a language model such as sentence-BERT (Reimers & Gurevych, 2019) to calculate textual semantic similarities between articles. Using this data, a knowledge graph is created to group similar scientific articles into clusters. This process uses the k-nearest neighbour graph (k-NNG) and forceAtlas2 algorithms for force-directed graph design.

3.2.3 | Visualisation and interpretation of the results

Graphext enables a dashboard to be publicly shared in which each of the articles included in the literature review can be examined in depth. Readers can dig deeper into each of the main and second-order themes identified and the way that themes are combined to generate each of the clusters detected in Graphext (Núñez-Merino et al., 2022). Each of the nodes in the visualisation corresponds to a document that can be identified by its reference and includes a link to the online publication. The size of the node can be defined based on some quantitative variables selected to represent the paper's quality, for example, the average number of citations per year. Other metadata extracted from the databases are also available in Graphext and can be used singly or in combination to filter the articles: year, author/s, journal, number of citations and JCR and/or SJR impact index.

Therefore, the applied methodology and the built-in Graphext dashboard enable an in-depth examination of the documents and subject areas covered by the set of analysed articles. Uplift modelling, often referred to as incremental modelling, is a statistical method that measures the variation or change in the behaviour or interest of a group of individuals or subjects over time (Gutierrez & Gérardy, 2017). The uplift metric (*) in the Graphext dashboard was used to identify the thematic focus of each of the clusters identified. This metric measures the difference in the frequency of occurrence of the most used themes or keywords –extracted from the titles and abstracts of all the documents using NLP techniques – in the analysed cluster compared to the total set of articles in the analysis. The most relevant papers were selected from each cluster to validate the interpretation and perform in-depth content analysis, i.e., papers with the most citations weighted by the number of years since publication and/or papers published in journals with the highest impact index.

(*) Uplift formula = (selection % /total %) - 1.The uplift metric was used to identify emerging trends by comparing the second-order themes with the highest uplift values in 2022 to the total set of articles in the analysis.

4 | RESULTS: CLUSTERING ANALYSIS, THEMATIC EVOLUTION AND CURRENT TRENDS

4.1 | Clustering analysis

SSM analysis enabled the identification of 11 distinct thematic clusters in the CSCM field. As described in the previous section, Graphext was used to generate the different clusters from the keywords extracted from the titles and abstracts of the analysed articles. Figure 2 shows the dashboard constructed with Graphext. Each cluster's contextualisation and significance are discussed below in detail.

4.1.1 | Capabilities and key drivers of circular supply chain management (cluster 1)

Cluster 1 contains 216 papers that analyse the capabilities and key drivers of SC circularity. Implementing CE requires high levels of innovation and technology. Organisations have to collaborate to find common solutions (Calicchio Berardi & Peregrino de Brito, 2021; Gebhardt et al., 2022) to integrate circularity into the current value chain and infrastructure. Although most companies perceive that they may not be able to implement CE, some researchers argue that companies can achieve this by developing a set of capabilities, such as dynamic capabilities (Chari et al., 2022; Stekelorum et al., 2021; Q. Zhu et al., 2010), or through enablers, such as the implementation of different SC integration strategies oriented towards raw material self-sufficiency (Di Maria et al., 2022; Pinto & Diemer, 2020) and vertical and horizontal collaboration between different industrial sectors (Bimpizas-Pinis et al., 2022; Schultz et al., 2021). Data analytics capabilities (Bag & Rahman, 2023) and flexibility-related capacity building in sustainable SCs play a key role in developing these enablers by addressing the operational challenges of CE (Bai et al., 2020; Edwin Cheng et al., 2022).

FIGURE 2 CSCM research field. Available at: https://public.graphext.com/5a9287ccd198bd83/index.html.

4.1.2 | Business models in circular economy (cluster 2)

Cluster 2 comprises 213 papers that explore the topic of circular business models (CBMs) in the SC and examine the factors that facilitate and hinder the implementation of CSCM practices. Regarding developing and implementing CBMs, some authors argue that organisations must implement specific managerial practices for each business model dimension -value creation, value transfer and value capture- to successfully design a CBM (Homrich et al., 2018). Hofmann (2019) critically explores the theoretical foundations of CBMs, including the legitimacy of CBMs, the modes of value creation and offerings and the core principles of CBM integration into daily business, while Geissdoerfer et al. (2018) focuses on the sustainability performance of CBMs and circular supply chains (CSCs) and finds that different CBMs drive CSCs in different loops: closing loops, slowing loops, intensifying loops, narrowing loops and dematerialising loops. In this line, some authors have proposed six major CBM patterns to support the closing of resource flows: repair and maintenance, reuse and redistribution, refurbishment and remanufacturing, recycling, cascading and repurposing and organic feedstock business model patterns (Lüdeke-Freund et al., 2019). Specifically, Lopes de Sousa Jabbour et al. (2019) examine the implications of adopting CBMs in operations management decision-making processes in the areas of product design, production planning and control and logistics/SCs, while Vermunt et al. (2019) identify the barriers that CBMs face.

4.1.3 | Circularity in the food supply chain (cluster 3)

Cluster 3 is composed of 161 publications and focuses on the themes of circularity in the food SC and effective food waste management. Regarding food waste, Teigiserova et al. (2020) explore the definitions of food surplus, waste and losses and propose a CE framework for managing food surplus and waste throughout the SC. Coderoni and Perito (2020) evaluate the impact of socio-demographic and psychological factors on consumer engagement in food waste-related CE practices in the SC. Santagata et al. (2021) examine the trade-offs and opportunities of food waste conversion pathways and their environmental impact. On the technological side, some authors explore the role of digital platforms that exploit technologies for the transfer and recovery of discarded resources between SC actors -as circularity brokers- in bridging circularity gaps in the food SC (Ciulli et al., 2020) and the range of technologies available for preventing food waste and loss and the role of collaboration in the SC (Ciccullo et al., 2021). In more specific contexts, Sharma et al. (2019) examine the challenges to implementing CE practices in food SCs in emerging economies, particularly in India, including poor government policies and a lack of technology and farmer knowledge and awareness as the primary obstacles. Similarly, Farooque, Zhang, and Liu (2019) analyse the barriers to integrating CE into food SC management in China and highlight weak environmental regulations and a lack of SC actor collaboration.

4.1.4 | Resource reuse in the circular supply chain (cluster 4)

Cluster 4 consists of 115 papers that analyse solutions and the relevance of resource reuse for SC circularity. Resource reuse involves extending the life cycle of products or materials by using them again for the same or a different purpose without any significant alteration, thus maximising their utility and value. Waste is a valuable resource that has been accumulated over time. The conversion of organic waste into resources such as plastics and food SC waste presents some interesting and practical opportunities (Clark, 2017). The aim is to reduce dependence on fossil-based raw materials and improve waste management practices to reduce the environmental impact (Nicholson et al., 2021). A range of raw materials derived from renewable energies (bio-waste, biomass) can be converted into a variety of useful products, including chemicals, materials and fuels similar and sometimes identical to those obtained from oil (Clark, 2017). Several authors describe technological solutions and transformation processes to integrate plastic waste into the plastic production CE (Jing et al., 2021) and transform plastic waste into material for rechargeable lithium-ion batteries to the benefit of environmental sustainability and CE (Mirjalili et al., 2023).

4.1.5 | Material flow and waste management in the circular supply chain (cluster 5)

Cluster 5 comprises 95 publications that examine waste and material flow management in the CSC. Waste management involves efficient handling, treatment and disposal of materials at the end of their life cycle which cannot be further reused or recycled and minimises the environmental impact of discarded materials. Pan et al. (2015) review different waste-to-energy SC technologies, including combustion, gasification and anaerobic digestion, and propose strategies for overcoming the challenges posed by technology, finance, institutions and regulation. Hahladakis and Iacovidou (2018) explore the relationship between the perception of quality as remaining functionality and the potential for recycling materials, components and products in the CSC. Regarding sustainable packaging, Meherishi et al. (2019) find a lack of consideration of product-packaging interactions. From a competitive perspective, Paes et al. (2019) perform a SWOT (strengths, weaknesses, opportunities and threats) analysis of organic waste management using CE principles, highlighting strengths such as resource recovery and environmental benefits and weaknesses such as logistics costs, SCM and the lack of technical standards. More recently, some authors have investigated the barriers and success factors in the implementation of waste prevention and recycling in various industries and highlighted the importance of illustrating the economic benefits of circular practices, better data sharing and increased cooperation between key players (Salmenperä et al., 2021). CE solutions for e-waste management have also been explored that emphasise the importance of recovering and classifying minerals through urban mining, i.e. a form of closed-loop SC management (Xavier et al., 2021).

4.1.6 | Strategic supplier selection in the circular supply chain (cluster 6)

Cluster 6 comprises 90 publications and explores the impact of supplier selection on the way that CSC works. Several authors have proposed models designed to streamline the decision-making process for supplier selection in the CSC context. Some have focused on life cycle assessment (LCA), with an emphasis on the role of transport, waste handling and usability in the environmental impact (Prosman & Sacchi, 2018), while others address economic, social and circular factors to evaluate and prioritise sustainable suppliers in CSCs (Kannan et al., 2020). Specifically, Mina et al. (2021) provide a model to evaluate and rank suppliers for the transition to CSC. Some of the proposed supplier selection and order allocation models pursue cost efficiency and environmental savings (Govindan et al., 2020), minimisation of total network costs, environmental effects and lost sales while maximising job opportunities and sustainable supplier purchases (Khalili Nasr et al., 2021), total cost minimisation, carbon emission minimisation and procurement value maximisation (Feng & Gong, 2020), among others.

4.1.7 | Electrical and electronic equipment and its circular supply chain (cluster 7)

Cluster 7 contains 78 papers on electrical and electronic equipment (EEE) and rare earth materials, particularly in the battery industry. Some enablers have been found for the intersection of CE and the EEE SC, including digitalisation, government intervention, servitised business models and SC management (Bressanelli et al., 2021). Reducing primary material extraction through technology-driven substitution and reduction and policy-driven strategies has also been investigated (Baars et al., 2020). Specifically, Garrido-Hidalgo et al. (2020) evaluate the information requirements for the end-of-life (EoL) management of electric vehicle battery packs and the capabilities of the Internet of Things (IoT) to satisfy these. Glöser-Chahoud et al. (2021) emphasise the need for industrial disassembly systems to achieve higher levels of circularity in the EoL treatment of electric vehicle battery systems, while Thompson et al. (2021) set out the barriers to the disassembly of lithium-ion battery cells and stress the importance of design for disassembly as the key to improving the circularity of the lithium-ion battery SC. In the field of solar photovoltaics, Watari et al. (2020) perform a comprehensive review of the factors that promote and hinder progress in the EoL management of solar photovoltaic panel and battery energy storage systems in terms of material flows and SCM practices, while Gautam et al. (2021) study the potential consequences of EoL solar photovoltaic e-waste disposal in India, a developing nation with no proper strategy for managing SC e-waste.

4.1.8 | The textile industry and its circular supply chain management (cluster 8)

Cluster 8 comprises 51 papers that examine CSCM in the textile and fashion industry. Although the CE model prevails in this sector, it is highly polluting, and this has triggered a line of research on CSC. Jia et al. (2020) identify drivers, barriers, practices and indicators of sustainable performance when applying CE in the textile and apparel industry. Knowledge of CE is found to be crucial for implementing sustainable SC manufacturing practices in the leather industries in Bangladesh (Moktadir et al., 2018). The most important obstacles to transitioning to CE in this sector are the lack of collecting, sorting and recycling, reluctance to accept the CE model and uniformity- and standardisation-related issues (I. Kazancoglu et al., 2022). The role of inter-firm collaboration in the textile industry has also been explored, emphasising the role of collaborative supplier–buyer innovation factors and product design in determining the output speed and quantity of circular products to be sold, taken back and ultimately regenerated (Franco, 2017). In this line, Fischer and Pascucci (2017) examine how requirements for transitioning to CE create new organisational forms in inter-firm collaborations. Sandvik and Stubbs (2019) explore the drivers and inhibitors of a textile-to-textile recycling system in the Scandinavian fashion industry and suggest that digital technologies can improve sorting and recycling technology, while Brydges (2021) maps the implementation of CE principles and strategies in the Swedish fashion industry. The influence of morally grounded traits on consumer attitudes and engagement with circular fashion offerings from fashion corporations and SCs has been empirically explored to endorse the take-make-use-reuse system (Ki et al., 2021).

4.1.9 | The ecological side of the circular supply chain (cluster 9)

Cluster 9 includes 47 publications focused on the ecological and environmental aspects of CSC. The green SCM and CE fields have been linked since mutual applications can be achieved (Liu et al., 2018). Kazancoglu et al. (2018) propose a conceptual framework to assess green SCM performance from the environmental, economic, logistics, operational, organisational and marketing perspectives, while Karaman et al. (2020) find that the relationship between green logistics performance and sustainability reporting is stronger in weak corporate governance environments. Li et al. (2021) study the impact of contracting, designing and marketing on green product SCs comprising manufacturers and retailers. Focusing on eco-innovation, Kiefer et al. (2019) examine how resources, competencies and dynamic capabilities impact the various forms of eco-innovation, revealing that participation in green SCs, a corporate culture supportive of eco-innovation, technology-push and market-pull and internal financial resources can drive eco-innovation, while cooperation, organisational learning, ISO ecological certification and technological path dependency are obstacles. CE enablers have been explored in the context of small and medium-sized enterprises (SMEs), with a focus on the relationships between institutional pressures, eco-innovation, green SCM practices, CE capability, big data-driven SCs and performance (Bag et al., 2022). Lastly, Shen et al. (2020) explore the relationship between price and quality in consumer choice for green and non-green products in an environmental impact and social welfare analysis.

4.1.10 | The role of blockchain technology in circular supply chain management (cluster 10)

Cluster 10 consists of 44 papers and focuses on the impact of information technologies, specifically blockchain, on CSC. The most researched technology in CSCM, blockchain is relevant for its ability to provide traceability and facilitate smart contracts, its significant agility and its guarantee of model circularity. Upadhyay et al. (2021) review the current and potential contribution of blockchain to CE from the perspective of sustainability and social responsibility and find that it provides several advantages such as reducing transaction costs, improving performance and communication along the SC and reducing the carbon footprint. In this line, some authors focus on the benefits of blockchain technology for making the SC sustainable, including key benefits such as data privacy, decentralisation, SC resilience and improved sustainability, among others (Mukherjee et al., 2022). Nandi et al. (2021) investigate the role of blockchain technology in supporting CSC tracking, tracing and responsiveness by enhancing location, agility and digitisation capabilities. Specifically, technology scaling has been identified as the key barrier to blockchain technology implementation in remanufacturing tasks (Govindan, 2022). Kayikci, Gozacan-Chase, et al. (2022) examine the critical success factors for implementing blockchain-based CSCs and highlight the role of network collaboration, while Huang et al. (Huang et al., 2022) identify technical capability, technological maturity and technological feasibility as critical success factors for blockchain-enabled CSCM implementation. Wang et al. (2020) develop a blockchain-enabled CSCM system architecture to address economic, environmental and social responsibility issues across pre-production, production and post-production stages, while Prajapati, Jauhar, et al. (2022) develop a framework for a blockchain and IoT technology-based virtual closed-loop SC to maximise total expected revenue while considering a variety of costs.

4.1.11 | Reverse logistics in the circular supply chain (cluster 11)

Cluster 11 consists of 18 papers and focuses on the challenges and opportunities of reverse logistics and closed-loop systems in the CSC. Some authors propose reverse logistics models that integrate I4.0 facilities with a CE-based reverse logistics network (Rajput & Singh, 2022). Some models that help with decision-making in reverse logistics consider the acquisition of used products, grading for determination of product quality and reprocessing disposition (Lechner & Reimann, 2020). Others are intended to improve the selection of sustainable logistics service providers (A. Gupta et al., 2022) and rank sustainable third-party logistics (3PL) service providers in a closed-loop SC (Zarbakhshnia et al., 2023). Specifically, Prajapati, Pratap, et al. (2022) develop a model to reduce total cost and maximise revenue in a closed-loop SC while prioritising sustainability in both forward and reverse e-commerce goods flows. The critical success factors of reverse logistics and their impact on value creation in the CSC have also been studied, with some authors highlighting the importance of relationship management (Julianelli et al., 2020). Focusing on sustainability, Fernando, Shaharudin, and Abideen (2022) explore the mediator role of CE-based reverse logistics in the relationship between sustainable resource commitment and financial performance, while Shahidzadeh and Shokouhyar (2022) find that consumers and other SC stakeholders play a critical role in achieving more sustainable reverse logistics.

The clustering analysis reveals four major research areas in the CSCM literature: (1) enablers for CSCM (clusters 1, 2 and 10), (2) circular SCM sectors (clusters 3, 7 and 8), (3) circular logistics (clusters 5, 6 and 11) and (4) environmental sustainability (clusters 4 and 9).

4.2 | Thematic evolution and current trends

This section explores the key themes that have emerged in CSCM and sheds light on their implications and potential directions for research and practice.

There have been some substantial shifts in the dynamic CSCM landscape in recent years. To gain insights into the emerging themes and trends in this field, our study focuses on the uplift scores of second-order themes, with articles from the last calendar year (i.e. 2022) taken as the reference point. These uplift scores indicate the extent to which some specific second-order themes have gained prominence in the last year.

The main themes with the most significant increase in interest are technologies, capabilities, challenges, enablers and barriers, critical success factors, circular economy practices, SC structure and stakeholders. Below, we detail the second-order CSCM themes.

Two major technologies, augmented reality (AR) and cyber-physical systems (CPS), experienced a remarkable surge in their significance in CSCM in 2022. AR achieved an exceptional uplift score of 143.1%, reflecting its exponential growth and impact on enhancing operational efficiency, minimising errors and refining decision-making processes in SCs. CPS, which integrates physical processes with digital systems, has also achieved outstanding success with an uplift score of 143.1%. This reveals the potential of these systems to drive I4.0. Thus, I4.0 technologies (85.83%) are in the first place (Di Maria et al., 2022; Lopes de Sousa et al., 2022; Yu et al., 2022), closely followed by digital technologies with an uplift score of 77.65% (Okorie et al., 2023; Rusch et al., 2023). These technologies include the adoption of smart contracts (73.65%) and blockchain (58.76%) to provide enhanced transparency and security in SC operations (Huang et al., 2022; Mukherjee et al., 2022; Xie et al., 2023). Artificial Intelligence (AI) is being increasingly used for demand forecasting, route optimisation and risk management in SCs, with an uplift score of 65.75% (Agrawal et al., 2022; Huang et al., 2022; M. Tseng et al., 2022). The prevalence of these technologies in the sustainable SCM literature increased significantly in 2022, indicating a growing trend in this field.

In the CSCM domain, some capabilities have progressively gained prominence over the last year. With an uplift score of 54.7%, SC resilience has attracted great attention due to the disruption caused by the COVID-19 pandemic and increased global market volatility (Chari et al., 2022; Mukherjee et al., 2022). Firms are currently putting greater emphasis on SC resilience tactics to better accommodate and tackle unforeseen difficulties. Flexibility (Edwin Cheng et al., 2022; Nayal et al., 2022; M. Sharma et al., 2023) and dynamic capabilities (Chari et al., 2022; Lu et al., 2022; Nayal et al., 2022) have emerged as crucial attributes in CSCM, with uplift scores of 49.6% and 45.86%, respectively. These qualities provide organisations with the necessary agility to swiftly adapt to market shifts and emerging trends. Technological capability has also become a central theme in 2022 with an uplift score of 45.86% (Ishizaka et al., 2023; Momeni et al., 2022). The effective implementation of state-of-the-art technologies is pivotal in bolstering SC operations and requires not only technological proficiency but also the acquisition of SC resilience, flexibility and dynamic capability.

The greatest challenges in the CSCM context are achieving carbon neutrality (143.1%) (Z. Zhang & Yu, 2022) and embracing Industry 5.0 (143.1%) (Ghobakhloo et al., 2022; Ivanov et al., 2022). These challenges highlight the critical significance of reducing carbon footprints and integrating humans and machines to achieve sustainable production. Zero emissions (82.33%) (Okorie et al., 2023) and digital transformation (62.07%) (Nudurupati et al., 2022; Okorie et al., 2023) also gained prominence in 2022, reflecting the urgent need for more sustainable practices and adaptation to an increasingly digital world. Additionally, security (42.3%) (Ersoy et al., 2022; Villagrán-Zaccardi et al., 2022) and I4.0 (36.92%) (Kayikci, Kazancoglu, et al., 2022; Lopes de Sousa et al., 2022) present emerging challenges as SCs become more digitally connected and organisations address robust cybersecurity measures while adopting smart manufacturing. These rising scores indicate a noticeable escalation in the significance of these challenges to CSCM research and underscores their growing importance in the pursuit of CSCM.

Our analysis identifies a significant reduction in interest in some CE-related practices such as recycling, repair, remanufacturing, reuse and recovery in 2022. However, sustainable packaging emerged as a major topic, with a considerable rise in interest and an uplift score of 35.06% (Z. Zhu et al., 2022). Also, the 11.06% increase in the practice of waste valorisation reflects the growing emphasis on deriving value from waste materials and demonstrates the evolving field of sustainability and CSCM research.

The role of energy resources in the CSC is critical as they are the bedrock of the system's sustainability and efficiency. The most conspicuous is sustainable energy, whose uplift score of 89.08% indicated a rise in interest in eco-friendly energy sources (X.-C. Wang, Foley, et al., 2022). Other sustainable options, including biofuel (68.03%), clean energy (62.07%), nitrogen (41.81%) and wind (41.81%) also gained prominence, highlighting an effort to incorporate both eco-friendly and cleaner energy alternatives into SCs (Fernando, Tseng, et al., 2022; Ghosh et al., 2022; Wongsirichot et al., 2022). The increase in uplift scores for these resources reflects their growing importance in CSCM research, as evidenced by a significant surge in their application over the previous year.

There has been a slight uptick in interest regarding emissions, including gas emissions, pollution and greenhouse gas emissions. This increased focus demonstrates a growing awareness and commitment to addressing environmental concerns in SCs. Our research analysis supports this trend, showing a consistent but slight increase in attention directed at emissions-related themes in the CSCM context.

In the evolving landscape of CSCM, the critical success factors have undergone significant changes in 2022. In particular, the emphasis on traditional themes such as risk management, competitive advantage, relationship management and knowledge-sharing has diminished. Instead, there has been a paradigm shift, with self-sufficiency emerging as the dominant theme (Kaufmann et al., 2022) with an impressive uplift score of 82.33%. Top management (Yamoah et al., 2022) and vertical integration (Münch et al., 2022) have also received significant attention, with respective uplift scores of 62.07% and 45.86% highlighting their critical roles.

The context in which SCM operates is also crucial. Emerging economies have seen a 31.97% increase in relevance in 2022, underlining their growing role in global SCs. Similarly, SMEs have experienced a significant 21.55% rise in importance. The impact of the COVID-19 pandemic and the subsequent post-pandemic landscape also contribute significantly, accounting for 10% of the overall context.

Enablers and barriers are critical CSCM research areas for making SCs more sustainable. Themes such as transparency (Govindan, 2022) and traceability (De Giovanni, 2022) gained substantial attention with uplift scores of 37.76% and 33.31%, respectively. Information-sharing continued to be relevant with a 21.51% uplift score (Sonar et al., 2022). Conversely, barriers to SC operations achieved an uplift score of 18.68%, highlighting the challenges that organisations face (Govindan, 2022; J. X. Wang, Burke, & Zhang, 2022). On the other hand, there was a slight reduction in collaboration, indicating a shift in focus away from cooperative efforts (Sudusinghe & Seuring, 2022).

The SC's design and structure are instrumental in promoting effective CSCM. This underlines the increasing significance of technology-oriented approaches. Note that the digital SC has attracted significant interest (Dwivedi & Paul, 2022), with a significant uplift score of 143.1%. At the same time, there was a marked uplift of 40.74% in SC design, which highlights its increasing significance in the field (Park et al., 2022). In contrast, there was a noticeable decrease in the importance placed on sustainability-related concepts, including sustainable SCs, green SCs and reverse SCs, suggesting a change in priorities.

Effective CSCM relies heavily on active stakeholder engagement and collaboration as stakeholder participation is crucial for achieving sustainable outcomes. There was a noticeable increase in the focus on logistics service providers and employees (Zarbakhshnia et al., 2023) in this research theme, as confirmed by the rise in their uplift scores. Conversely, there was a conspicuous decline in attention given to second-order themes related to competitors, consumers and end-users, highlighting the changing dynamics underlying stakeholder relationships.

Regarding the theoretical approaches and research methodologies used in current CSCM research, while it can be observed that a wide variety of quantitative and qualitative research methods are currently being used to address CSCM, theoretical frameworks are uncommon (2% of papers). The range of theoretical approaches used is also limited. The most frequent is the stakeholder approach, which is also the approach that launched the study of Corporate Social Responsibility. This is followed by the institutional approach and, finally, two approaches related to the theoretical framework of resources and capabilities.

In summary, our analysis of emerging trends and themes in CSCM highlights the field's dynamic nature. As organisations strive to navigate an ever-evolving landscape, staying informed about these themes becomes imperative for effective CSCM.

5 | DISCUSSION, IMPLICATIONS AND LIMITATIONS

5.1 | Contributions to theory and practice

The literature review results have significant implications for academia. This paper classifies eleven thematic clusters identified by SSM analysis into four research lines. It also pinpoints the aspects of the identified research lines on CSCM that have been and continue to be investigated. This enables the identification of topics that have been extensively researched in the past year and those that have lost ground.

This novel literature analysis on CSCM differs from previous literature reviews on this topic in several ways: (i) the literature on the topic has been gathered from multiple databases, which broadens previous research (Farooque, Zhang, Thürer, et al., 2019; Lahane et al., 2020; Theeraworawit et al., 2022), (ii) the concept 'circular supply chain' is considered in the data search, which broadens previous research tightly focused on CE or sustainable SC (Cerqueira-Streit et al., 2021; Farooque, Zhang, Thürer, et al., 2019; Masi et al., 2017; Taghikhah et al., 2019), (iii) our literature analysis on CSCM uses a general approach without focusing on specific issues such as the conceptualisation, definitions and principles of CSCM, which differentiates it from previous works (De Angelis et al., 2018; Lengyel et al., 2021; Montag, 2022; A. Zhang et al., 2021) and (iv) grouping the papers into thematic clusters provides a general map of research on CSCM, which distinguishes our study from others that contribute specific CSCM archetypes (Batista et al., 2018).

Designing and implementing a new SSM analysis applied to a literature review on CSCM has allowed us to create a research map that identifies clusters of articles revolving around the same theme. Specifically, 11 clusters have been identified that group together related research topics on CSCM. Subsequently, Graphex has been used to obtain a graphical representation of the 11 topics, with a visual image of each cluster's importance based on the number of articles it contains and the proximity of contributions made in each.

Content analysis of the topics in each cluster was performed to respond to RQ1. This enabled 11 thematic clusters to be classified into four major research lines. The first major research line focuses on CSCM enablers, from capabilities that act as CSCM drivers to the use of I4.0 digital and information technologies as a mechanism to facilitate CSCM and the development of operational practices for the different business model dimensions. The second research line deals with circular SCM sectors with an emphasis on CSCM applied to sectors where circularity and sustainability are clearly of greater importance today, e.g. the food and textile and fashion sectors and the battery industry/EEE. The third major research line highlights the role of circular logistics. This line revolves around the importance of logistical functions and processes in CSCM, ranging from investigations into the significance of selecting suppliers respectful of or involved in the circular economy to the importance of managing material flows and waste management according to CE principles and the need to consider reverse logistics. Lastly, the fourth major research line addresses environmental sustainability and involves clusters concerned with resource reuse and the need to emphasise CSCM's ecological perspective.

To address RQ2, an analysis was carried out of the temporal evolution of the importance given to the identified lines of research in the literature, observing that the focus of attention has changed over time. In 2022, the enablers line emphasised the importance of cooperation (Q. Zhu et al., 2010), transparency (Centobelli et al., 2022), resilience (Bag et al., 2019), innovation (Vence & Pereira, 2018), flexibility (Edwin Cheng et al., 2022) and the use of technologies such as big data (S. Gupta et al., 2019) and blockchain (Upadhyay et al., 2021) as key capabilities for making advances in CSCM. It also highlighted aspects related to human resources, such as leadership and top management commitment (Moktadir et al., 2020) and knowledge-sharing (Sawe et al., 2021).

The second line, focused on the role of the sector or context, underscored the importance of studying disruptive events such as those caused by COVID-19 (Adelodun et al., 2021). It also explored the role of emerging economies in CSCM (Moktadir et al., 2018) and emphasised the need for further research in the food sector to cover aspects such as food waste (Principato et al., 2019), food production and consumption (Coderoni & Perito, 2020) and food security (Y. Wang et al., 2021). In addition, it suggested studying other sectors with a significant environmental impact, such as construction (Ricciardi et al., 2020), gas (Barrett et al., 2018) and automotive industries (Baars et al., 2020).

The third line, which stressed the importance of logistics functions and processes, continued to highlight the analysis of CSCM procurement (Govindan et al., 2020), transport (Bekrar et al., 2021), distribution (Liao et al., 2020), planning (Cristóbal et al., 2018), packaging (Hahladakis & Iacovidou, 2018) and inventory functions (Ponte et al., 2019).

In the last line, which addressed environmental sustainability, research in 2022 still emphasised traditional topics such as recycling (De Corato, 2020), consumption (M.-L. Tseng et al., 2020), reuse (Vadakkepatt et al., 2021) and reduction (S. Goyal, Esposito, & Kapoor, 2018), while including more current issues such as recovery (O'Connor et al., 2016) and end-of-life (Ioannidou et al., 2020). Emissions (Nicholson et al., 2021), carbon dioxide (AliAkbari et al., 2021) and pollution (Lappa et al., 2019) remained top priorities in this line.

Our literature review also has managerial implications. For practitioners, our work offers a comprehensive overview of the current state of knowledge of the CSCM field and enables the identification of best practices and existing barriers. This information can inform decision-making on the implementation of circular supply chain practices and enhance circular supply chain performance.

5.2 | Pathways for future research

Regarding RQ3, the analysis has identified research gaps that need to be closed and lines of future research that should be addressed. Regarding gaps, research on CSCM is tightly focused on environmental impact, and it would be beneficial for the focus to be broadened and aligned with sustainable development goals related to resource use (water, energy) or responsible production and consumption. In addition, while research on CSCM has incorporated some aspects of the impact of environmental uncertainty, such as the role of COVID-19 or the growing influence of emerging economies, it would be useful to analyse unforeseen events with a global impact, such as the Ukraine war or the Israel-Palestine conflict, and the effect that these events have on CSCM due to multinational companies' relocation strategies. Similarly, only limited research exists on how the concentration levels of specific sectors or the role of agglomeration economies in science and technology parks affect CSCM. Furthermore, most papers that have studied the role of digital technologies in the I4.0 domain have focused on studying some specific technologies. There is a pending need to analyse how progress in business connectivity across the SC and product life cycle could affect CSCM. In the research line on the importance of logistical functions and processes, it would be relevant to examine the roles of strategic purchasing and suppliers in CSCM. Regarding the line on the roles of the sector and context, the role of the company's ownership structure must be examined, i.e. an investigation of how the presence of more socially orientated organisational forms such as cooperative societies or family businesses influences the spread of CE practices throughout the SC.

In other respects, the literature on CSCM has made very limited use of management-related theoretical approaches to develop the articles' theoretical frameworks. Further, in this sense, the CSCM literature can be observed to have made minimal use of theoretical strategic management approaches that are particularly useful for SCM (Hitt, 2011). Thus, in the future, theories such as those based on resource and capability theory, for example, the Resource

Orchestration theory (Sirmon et al., 2007) and the relational view of the resource-based theory (Prajogo et al., 2016) should be used to explain how the deployment of CE principles throughout the supply chain could translate into improved firm competitive performance. Similarly, organisational learning theory (March, 1991), which -as was predictable- has been successful in explaining how firms can better learn from their external suppliers and foster innovations (Rothaermel et al., 2006), could be used.

5.3 | Limitations

The following limitations are inherent in this work. The SSM analysis was restricted to a limited set of research papers, so it may not have captured all of the current CSCM research landscape. We exclusively reviewed academic journal articles to maintain a high standard, deliberately excluding sources such as conference papers, industry reports, books and book chapters. Thematic contextualisation of the research clusters was based on the authors' subjective interpretation and other researchers may have different opinions. The discussion of each cluster only analysed a limited sample of the articles in the cluster, those with the highest average number of citations per year and published in journals with high impact factors. Lastly, article analysis was limited to information in the abstracts and titles, which may not be a fair reflection of the full scope and depth of the research.

Overall, this study enriches the understanding of CSCM by providing a comprehensive analysis, offering practical insights and advancing knowledge in the field.

6 | CONCLUSIONS

This work gives insights into the current state of research and identifies the challenges and opportunities associated with implementing CSCM. This study makes significant contributions to the CSCM field:

Our study conducts a comprehensive overview of CSCM research through clustering analysis and constructing a thematic evolution map. These analytical approaches offer a holistic understanding of the field and its development over time. The thematic clusters identified in this research encompass a range of topics related to CSCM grouped into four major research lines. These revolve around CSCM enablers, the application of CSCM considering the sector and context in which it is applied, the importance of logistical functions and processes and environmental sustainability. Moreover, the study highlights the hot topics in CSCM and those in which interest is waning.

This work provides valuable insights for researchers and practitioners, with a detailed examination of the themes researched in CSCM. This information can guide future research endeavours and inform decision-making processes in real-world SCM practices. Additionally, this study contributes to advancing knowledge on CSCM by unravelling emerging themes and trends. It identifies areas that require further exploration and highlights potential directions for future research, enabling researchers to delve deeper into unexplored aspects of CSCM.

Lastly, this paper also proposes a methodology that enhances a previously proposed methodology or technique by incorporating NLP with NER. Our adaptation includes building an NER model for information extraction and thematic analysis. This replaces the tasks performed by SciMAT in Núñez-Merino et al. (2022) and gives researchers a more flexible choice of relevant topics for study and a solid theoretical basis for research design. The most significant improvement involves implementing a pre-trained language model to measure semantic similarity between articles. Unlike the initial version of SSM, which used various text preprocessing techniques to extract keywords from the document's abstract and title, the current model acts directly on the original text. Models such as this have contributed significantly to the development of modern language models, including large language models (LLMs). The validity and relevance of our research results emphasise the impact of this recent evolution in bibliometric studies and literature reviews, which have progressed from an analysis based solely on author-defined keywords to a wider analysis based on document titles and abstracts. It is conceivable that as NLP and generative artificial intelligence techniques progress in the future, it will be possible to analyse SSM with LLMs, which would allow full article texts to be processed.

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APPENDIX A: 1: MAIN THEMES IDENTIFIED

Main themes	Second-order themes by frequency
Capability (282 papers, 25%)	Innovation (166 papers), Capability (79), Resilience (53), Flexibility (13), Agility (12), Supply chain resilience (11), Dynamic capability (10), Technological capability (5), Interoperability (4), Supply chain flexibility (4), Alliance capability (2), Ambidexterity (2), Absorptive capacity (1)
Challenges (700 papers, 62%)	Challenge (298), Sustainable development (126), Industry 4.0 (87), Risk (77), Uncertainty (66), Disruptions (56), Economic development (49), Climate change (47), Complexity (45), Security (41), Environmental concern (27), Digitalisation (22), Global warming (20), Decarbonisation (18), Emissions reduction (17), Human health (17), Zero waste (16), Sustainable production and consumption (15), Environmental degradation (12), Technological development (12), Zero emissions (12), Sustainable consumption (11), Transition to circular economy (11), Cost reduction (9), Energy transition (8), Variability (8), Carbon neutrality (7), Digitisation (7), Digital Transformation (6), Bullwhip effect (5), Volatility (4), Vulnerability (4), Industry 5.0 (2)
Circular economy practices (731 papers, 65%)	Recycling (309), Consumption (187), Reuse (163), Recovery (115), Reduce (113), End of life (94), Life cycle assessment (87), Remanufacture (83), Circular practices (74), Industrial Symbiosis (33), Repair (18), Material circularity (12), Redesign (12), Sustainable design (11), Waste valorisation (11), Product service system (10), Regenerate (10), Plastic packaging (9), Sustainable packaging (9), Waste prevention (9), Refurbishment (6), Restore (4)
Context (151 papers, 13%)	Covid-19 pandemic (55), Emerging Economy (35), Crisis (28), Global economy (17), Economy transition (13), Post pandemic (13), SMEs (12), Startup (7), Industrial revolution (5)
Critical success factors (135 papers, 12%)	Supplier selection (27), Competitiveness (22), Competitive advantage (20), Critical success factors (18), Leadership (15), Top management (15), Relationships management (7), Knowledge-sharing (6), Strategic planning (6), Vertical integration (5), Horizontal collaboration (4), Risk management (4), Self-sufficiency (4), Competitive strategy (3), Vertical collaboration (3), Human resources (2)
Emissions (212 papers, 19%)	Emissions (140), Carbon dioxide (98), Pollution (53), Greenhouse gas emissions (47), Environmental footprint (44), Gas emissions (30)
Enablers & Barriers (325 papers, 29%)	Barriers (127), Collaboration (119), Cooperation (52), Traceability (31), Transparency (30), Monitoring (29), Decentralisation (14), Integration (13), Information-sharing (12), Information transparency (3)
Energy resources (340 papers, 30%)	Energy (205), Carbon (110), Gas (64), Biomass (51), Fuel (51), Water (50), Electricity (26), Renewable energy (26), Fossil fuel (22), Photovoltaic (19), Biofuel (13), Nitrogen (12), Wind (12), Bioenergy (11), Sustainable energy (9), Biodiesel (8), Clean energy (6), Biogas (4)
Food (137 papers, 12%)	Food waste (92), food production (34), food security (31), circular food (15), food packaging (12), sustainable food (12)

(Continues)

Main themes	Second-order themes by frequency
Foundations (891 papers, 79%)	Sustainability (379), Circularity (361), Green (186), Life cycle (145), Circular business model (76), Renewable (60), Environmental sustainability (50), Circular economy principles (39), Circular economy transition (39), Bioeconomy (35), Circular economy strategy (32), Sustainable production (24), Triple Bottom Line (24), Circular model (23), Circular bioeconomy (21), Circular product (20), Ecology (19), Value creation (18), Corporate Social Responsibility (16), Economic sustainability (16), Industrial ecology (16), Social sustainability (16), Environmental management (15), Reverse flow (13)
Materials (212 papers, 19%)	Raw material (86), Plastic (61), Material flow (45), Recyclable materials (14), Critical material (13), Biodegradable (12), Packaging material (12), Bioproducts (5), Composite material (5), Construction material (4), Material extraction (4)
Operations management process (813 papers, 72%)	Production (543), Decision-making process (147), Logistics (120), Transportation (75), Distribution (69), Planning (66), Packaging (56), Inventory (44), Product design (36), Purchasing (35), Procurement (24), Material flow analysis (22), Delivery (21), Co-design (14), Operations management (14), Redistribution (11), Eco-design (10), Maintenance (10), Remanufacture (8), Supply chain implementation (7), Servitisation (5), Quality management (4), Standardisation (4)
Performance (596 papers, 53%)	Performance (259), Cost (194), Environmental performance (190), Efficiency (138), Economic performance (37), Social performance (35), Sustainable performance (31), Productivity (26), Energy efficiency (22), Firm performance (15), Operational performance (15), Economic (12), Supply chain performance (12), Social & environmental (12), Economic & environmental performance (11), Financial performance (10), Key Performance Indicator (9), Performance Measurement System (9), Sustainability assessment (9), Environmental assessment (8), Eco-efficiency (6), Logistics performance (4), Delivery performance (3)
Research methods (635 papers, 56%)	Literature review (202), Case study (183), Systematic literature review (118), Optimisation (68), Dematel (44), Sensitivity analysis (41), Bibliometrics (36), Structural equation modelling (36), Questionnaire (32), Simulation (32), Content analysis (28), Mixed integer-linear programming (27), Semi-structured interview (27), Delphi method (23), Multi-criteria decision-making (22), Best worst method (21), Mathematical model (20), Regression analysis (20), Analytic hierarchy process (18), Fuzzy Dematel (18), Interpretive structural modelling (15), Multiple case study (13), Thematic analysis (13), Focus group (12), Fuzzy analytic hierarchy (12), Game theory (12), Cluster analysis (10), Depth interview (9), Fuzzy Delphi (9), Multi-objective mixed integer (8), Expert interview (7), Factor analysis (7), Fuzzy best worst method (7), Analytic network process (5), Artificial neural network (5), Input–output table (4), Multi-objective optimisation (4), Data envelopment analysis (3)
Resource management (168 papers, 15%)	Natural resource (53), resource consumption (33), energy consumption (22), renewable resource (13), resource use (13), energy source (12), energy use (12), available resource (7), energy storage (7), power generation (7), primary resource (6), resource extraction (6), secondary resource (6), energy saving (5)
Supply chain structure (478 papers, 42%)	Closed-loop supply chain (103), Sustainable supply chain (102), Supply chain network (63), Reverse logistics (62), Value chain (53), Ecosystem (52), Circular supply chain (43), Green supply chain (40), Reverse supply chain (32), Global supply chain (28), Supply chain design (19), Linear supply chain (12), Short supply chain (9), Traditional supply chain (9), Dual channel (6), Supply chain configuration (6), Complex supply chain (4), Digital supply chain (4), Focal firm (4), Open-loop supply chain (3)
Sector (634 papers, 56%)	Agri-food industry (188), Manufacturing industry (81), Construction sector (64), Gas industry (64), Automotive industry (56), Retail sector (55), Oil industry (53), Metal industry (46), Textile industry (44), Battery industry (36), Chemical industry (30), Fashion industry (29), Electronic industry (28), Pharmaceutical industry (14), Wood sector (14), Transport sector (11), Multi-sector (9), Coffee industry (8), OEM industry (8), Plastic industry (7), Dairy industry (6), Healthcare (6), Paper industry (6), Leather industry (5), Packaging industry (5), Humanitarian (4), Recycling industry (4), Cement industry (3), Clothing industry (3), Aerospace sector (2), Furniture industry (2)
Stakeholders (600 papers, 53%)	Governance (242), Stakeholders (173), Consumers (150), Suppliers (98), Society (78), Customers (72), Partnerships (25), Competitors (24), Employee (14), End-user (10), Logistics provider (10), Relationships management (10), Service provider (8)
Technologies (386 papers, 34%)	Technologies (293), Blockchain (49), ERP (47), Internet of Things (47), Big Data (41), Industry 4.0 Technologies (38), Digital Technologies (26), Artificial Intelligence (22), Cloud Computing (15), 3D Printing (13), Machine Learning (11), Additive manufacturing (10), Information Technology (9), Digital Twin (7), Information Systems (7), Smart contract (7), Building Information Modelling (6), Robotics (6), Distributed Ledger Technology (5), Sensors (5), Virtual Reality (5), Biotechnology (4), Digital Platform (4), Smart Technologies (4), Augmented Reality (3), Cyber-Physical Systems (3), Drones (2), RFID (2)
Theoretical background (18 papers, 2%)	Stakeholder theory (8), institutional theory (7), dynamic capability theory (3), resource orchestration theory (2)
Waste (472 papers, 42%)	Waste (472), Electronic waste (200), Waste management (117), Food waste (72), Waste flow (28), Plastic waste (22), Organic waste (18), Solid waste (17), Supply chain waste (11), Waste production (11), Waste treatment (11), Demolition waste (6), Industrial waste (6), Municipal solid waste (5), Household waste (4)