BER www.berjournal.com ISSN: 2619-9491
BUSINESS AND ECONOMICS RESEARCH JOURNAL

Business and Economics Research Journal Vol. 17, No.3, 2026 pp. 403-432 doi: 10.20409/berj.2026.504

The Evolution of Circular Supply Chain Management Research Through the Lens of Sustainable Development Goals: A Bibliometric Review

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Abstract: *The circular economy is a pivotal framework for integrating economic growth with environmental sustainability. Given that the circular economy requires a transition from traditional linear production systems to regenerative and resource-efficient patterns, the transformation of supply chains is substantial. In such a context, circular supply chain management (CSCM) becomes a significant mechanism for implementing circular economy principles. Understanding how CSCM research contributes to broader sustainability objectives, particularly the United Nations Sustainable Development Goals (SDGs), has therefore become increasingly important. This study aims to review the CSCM literature, identify major research trends, and evaluate the field from an SDG perspective. We conducted a bibliometric analysis of 1,210 articles published in journals indexed in the Web of Science database between 2010 and November 2025. Using VOSviewer, the intellectual structure of the field was visualized through analyses of countries, institutions, journals, authors, and documents. The findings reveal that CSCM research is primarily aligned with SDG 9, SDG 12, and SDG 13, and is increasingly characterized by themes of digital transformation, supply chain resilience, and risk management. Based on these insights, a future research agenda is proposed to support both academic research and practical implementation.*

Keywords: Circular Economy, Supply Chain Management (SCM), Sustainable Development Goals (SDGs), Sustainability, Closed-loop Supply Chains, Bibliometric Analysis

JEL: Q56, C38

Received : 24 March 2026
Revised : 11 June 2026
Accepted : 25 June 2026

Type : Research

1. Introduction

In a linear economic framework, human actions and consumption habits drive the entire system, generating unanticipated, long-term environmental consequences. These consumption patterns exacerbate existing environmental problems globally (Garcia et al., 2021; Kirchherr et al., 2017; Rockström et al., 2009). The *circular economy* (CE), a paradigm that integrates environmental sustainability with economic growth goals, has gained significant prominence in recent times. Principles, such as minimizing waste and promoting the efficient use of natural resources, are central to the circular economy concept (MacArthur, 2013; Morseletto, 2020). In this context, it is of great importance to align supply chain practices with circular economy principles (Mangla et al., 2018).

Supply chain management (SCM) refers to the effective coordination of material, information, and financial flows across multiple companies so that every consumer is provided with high-quality end-consumer

Cite this article as: Koç, E., & Aksoy, M. (2026). The evolution of circular supply chain management research through the lens of sustainable development goals: A Bibliometric review. *Business and Economics Research Journal, 17*(3), 403-432. http://dx.doi.org/10.20409/berj.2026.504

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goods (LeMay et al., 2017; Mentzer et al., 2001). This requires all stakeholders in the chain to collaborate (Barratt, 2004; Simatupang & Sridharan, 2002) to achieve effective coordination. Supply chain performance can be significantly enhanced through the integration and coordination of supplier and customer activities, even among vertically linked entities (Power, 2005).

Sustainability issues over the last few decades have reinforced the necessity of combining SCM and circular economy principles. Constructing a fully circular supply chain remains challenging in practice; however, the principles of the circular economy concerning resource conservation and material recovery are consistent with sustainable supply chain objectives (Genovese et al., 2017). Consequently, the integration of CE principles into SCM has become increasingly important. This intersection has made circular supply chain management (CSCM) a prominent concept in academic, industrial, and policy arenas (Geissdoerfer et al., 2018).

At its core, CSCM is a design strategy that seeks to optimize resource flows in circular processes rather than within traditional linear supply chains. CSCM encompasses a set of processes (Azmi et al., 2024; Zarbakhshnia et al., 2022) that enable products to be reused, recycled, repaired, and made more durable (Aarikka-Stenroos et al., 2022; Cahyadi et al., 2024; Rabbi & Amin, 2024). CSCM can provide a competitive advantage while promoting sustainability through production processes that minimize waste across sectors such as food, textiles, and electronics (Ciccullo et al., 2023; Mishra et al., 2023). Therefore, Circular Supply Chain Management (CSCM) serves as a comprehensive management strategy with both environmental and economic benefits. The development of this model as a whole will be driven by partnerships and institutional capacity supported by regulatory frameworks and technological resources from governments and companies (Sami et al., 2023). Digitalization, data analytics, and advanced technologies are essential to the management of circular supply chains (Duan et al., 2025; Dwivedi et al., 2023). All of these aspects together reinforce the importance of CSCM for environmental sustainability and economic resilience. A thorough review of existing literature is necessary to uncover research gaps and provide guidance for practitioners.

In recent years, many bibliometric and review studies have investigated the relationship between sustainability, circular economy, and supply chain management from various perspectives. Theeraworawit et al. (2022) studied sustainable supply chain management (SSCM) in the context of the circular economy and the basic intellectual structure and research streams of the field. Similarly, Yu et al. (2022) investigated the relationship between SSCM and green technologies and highlighted technological innovation, environmental management, and closed-loop supply chains. More specifically, Zhang et al. (2023) conducted a bibliometric literature review of CSCM focusing on the intellectual structure, citation patterns, and evaluation of the field. A recent study by Cano et al. (2025) combined bibliometric analysis and literature review to explore CSCM performance assessment methods and performance measurement frameworks. While these studies have made significant contributions to the literature, several gaps remain. First, existing bibliometric studies have mainly focused on specific aspects of CSCM research, such as intellectual structure, thematic development, technological innovation, and performance assessment. Thus, relatively little attention has been paid to providing a more complete overview of publication performance, collaboration patterns, conceptual development, and sustainability orientation within a single analytical framework. Second, although various studies have been conducted on CSCM research, there is limited evidence regarding the relationship between CSCM research and the United Nations Sustainable Development Goals (SDGs). Accordingly, a more comprehensive assessment is needed that not only maps the intellectual and social structure of the field but also evaluates its contribution to broader sustainability objectives.

To fill these gaps, this study provides a comprehensive bibliometric analysis of the CSCM literature, including an SDG-oriented perspective. The bibliometric approach allows for a systematic analysis of large datasets and multi-dimensional examination of research trends, collaboration patterns, and conceptual orientations within the literature. This study examines the CSCM literature through a comprehensive framework based on the 1,210 articles published in the Web of Science (WoS) database between 2010 and 2025. The analysis addresses (i) the performance of the literature based on output and citations, (ii) collaboration patterns at the author-institution-country level, (iii) the conceptual clusters and thematic development areas, and (iv) the connection of the CSCM literature to the sustainability agenda through the

United Nations Sustainable Development Goals. Accordingly, this study seeks to address the following research questions:

RQ1. *How has CSCM research evolved over time, and what do publication and citation patterns indicate about its scholarly development and influence?*

RQ2. *Which authors, institutions, and countries are most prominent in the CSCM domain, and how are these actors positioned within the field's collaboration networks?*

RQ3. *What are the most recurrent concepts in CSCM studies, and how do these concepts cluster to form the field's conceptual structure?*

RQ4. *Which documents and journals are most influential in CSCM research, and what do citation patterns reveal about the field's core theoretical foundations?*

RQ5. How does CSCM research align with the United Nations Sustainable Development Goals (SDGs), and what does this reveal about its contribution to sustainability?

This approach builds upon the findings of prior studies, highlights contemporary trends in the literature, and underscores the intellectual, social, and conceptual structure of the rapidly evolving CSCM research domain. Consequently, the study contributes to a more comprehensive understanding of the current state of the field. Performance analyses and scientific mapping techniques applied to the extensive WoS dataset provide a detailed overview of academic output in CSCM, including collaboration patterns and conceptual trends. This evaluation offers valuable insights into the development and structure of the field.

This study makes a valuable contribution to the growing body of CSCM bibliometric literature. While recent bibliometric analyses have examined circular economy and supply chain themes from various angles (Cano et al., 2025; Hettiarachchi et al., 2022; Theeraworawit et al., 2022; Zhang et al., 2022), the present study extends existing research in several aspects. First, by covering the period from 2010 to 2025, the study provides a broader perspective on the historical development and recent evolution of CSCM research. Second, the explicit SDG-alignment framework—mapping CSCM research against all 17 United Nations Sustainable Development Goals—represents an additional analytical perspective that has received limited attention in previous bibliometric studies. Third, by integrating co-authorship, keyword co-occurrence, and citation analysis within a unified framework, this study provides a more comprehensive mapping of the intellectual, social, and conceptual structure of the CSCM field than prior single-method reviews. Fourth, the identification of resilience, risk management, and digital twin technologies as emerging thematic frontiers adds a forward-looking perspective to the analysis. Together, these features position the present study as an updated, and multi-dimensional, and policy-relevant contribution to CSCM scholarship.

The study is organized as follows: Section 2 provides a theoretical overview of the circular economy and examines supply chain management from a circular economy perspective. Section 3 outlines the research methodology employed in the bibliometric analysis. Sections 4 and 5 present the findings and discussion, respectively. Finally, section 6 concludes the study by summarizing the main findings, identifying research gaps, and outlining directions for future research.

2. Literature Review

2.1. Circular Economy and Sustainable Development

Circular economy (CE) has emerged as an innovative paradigm for sustainability over the past decade, both in academic literature and on global policy agendas (Geissdoerfer et al., 2017). As an alternative to the traditional linear "take–produce–consume–dispose" model, CE is a holistic economic approach that aims to retain resources within the economic system for as long as possible, reduce value loss, and eliminate waste. Murray et al. (2017: 370) define CE as *"an economic model that strategically organizes and oversees the planning, sourcing, procurement, production, and recycling processes to optimize both ecosystem functioning and human well-being,"* while Webster (2015: 16) defines it as *"an economy that is restorative by design and aims to maintain products, components, and materials at their highest utility and value at all times."* These

definitions demonstrate that CE offers an inclusive transformation model that prioritizes both ecosystem health and human well-being. The primary objective of CE is to protect the environment by promoting resource-efficient practices and eliminating waste (Nikanorova & Stankevičienė, 2020). This is accomplished through recycling, reuse, repair, and remanufacturing practices. The concept is based on three core principles: eliminating waste and pollution, circulating products and materials, and regenerating natural systems (Caprian et al., 2023).

CE has become a key component of sustainable development discussions and is closely related to global policy frameworks. The literature indicates that CE, as a model for mitigating environmental impacts and enhancing resource efficiency, is closely aligned with the Sustainable Development Goals (SDGs) outlined in the United Nations' "Transforming Our World: The 2030 Agenda for Sustainable Development" document (Ghisellini et al., 2016; Panchal et al., 2021; United Nations, 2015). The SDGs are a set of goals that aim to address major global challenges, including poverty, inequality, climate change, environmental degradation, peace, and justice. The principles of CE are closely aligned with these goals (Rodriguez-Anton et al., 2019; Sharma et al., 2021). Numerous studies (Panchal et al., 2021; Schroeder et al., 2019) consistently highlight the strong relationship between SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) and the circular economy.

Recent research indicates that the CE–SDG relationship encompasses not only alignment but also a strategic, mutually reinforcing framework. Aleksić et al. (2023) contend that circular economy implementations support the achievement of the Sustainable Development Goals, while Val Verde and Avilés-Palacios (2021) assert that CE is a pivotal catalyst for advancing the SDGs. Schroeder et al. (2019) demonstrate that CE contributes to the SDGs through improved resource utilization, reduced carbon intensity, and waste reduction. These findings show that CE is not only a means of reducing environmental impacts but also an important mechanism for achieving global sustainable development objectives.

The effects of CE are not limited to environmental and social dimensions; they also generate direct economic benefits. Geissdoerfer et al. (2017) assert that CE principles transform business models, supply chain structures, and innovation methodologies, establishing a foundational framework for sustainable economic endeavors. Recent empirical studies also show that CE practices improve organizational and operational performance. Rodríguez-González et al. (2022), Nosková et al. (2024), and Munteanu et al. (2024) argue that CE strategies reduce costs, improve process efficiency, and enhance firms' competitiveness. These findings demonstrate that CE represents both a sustainability-oriented and economically beneficial transformation model.

The connection between CE and digital technologies has received increasing attention in recent literature. Numerous studies have demonstrated that Industry 4.0 technologies—such as the Internet of Things (IoT), big data analytics, artificial intelligence, blockchain, and cyber-physical systems—are essential instruments for enabling circular economy applications (Lin et al., 2025; Nascimento et al., 2024; Santiago et al., 2023). These technologies enhance the effectiveness and scalability of CE by enabling real-time monitoring of material and information flows, optimizing operational processes, and improving product lifecycle management.

In this broader framework, the circular economy is viewed as more than merely an approach to reducing environmental impacts. Rather, it represents a multidimensional transformation model that promotes economic development, social well-being, technological innovation, and progress toward Sustainable Development Goals.

2.2. Circular SCM and Related Concepts

The shift to a circular economy represents a fundamental transformation that supports sustainable development and has significant implications for supply chain management (SCM) (Del Giudice et al., 2021). An examination of research regarding the incorporation of the circular economy perspective into the supply chains indicates that terms such as "green supply chain management," "sustainable supply chain management," and "closed-loop supply chain management" remain the primary focus in the literature (Khan

et al., 2021; Mardani et al., 2020; Stindt et al., 2016; Su et al., 2019). While each of these concepts explains certain aspects of circularity, they fail to fully capture the comprehensive system transformation of CE. Green supply chain management focuses on minimizing the environmental impact of supply chain activities (Ahmed et al., 2020; Green et al., 2012). It encompasses various practices, including eco-design, material sourcing and selection, manufacturing, transportation, distribution, and end-of-life management, with the aim of enhancing environmental sustainability and resource efficiency throughout the supply chain (Adhitya & Halim, 2011; Aziziankohan et al., 2017; Seman et al., 2012). Sustainable supply chain management focuses on broader organizational performance and strives to improve a company's long-term results (Koberg & Longoni, 2019; Wu et al., 2018). By integrating environmental, social, and economic objectives throughout supply chain processes, it has emerged as an important approach for improving supply chain sustainability (Carter & Rogers, 2008; Sánchez-Flores et al., 2020). A closed-loop supply chain (CLSC) refers to the planning, implementation, and control of supply chain activities aimed at maximizing value creation throughout a product's life cycle while managing different types and quantities of product returns (Guide & Wassenhove, 2009). Reverse logistics activities, such as coordinating product returns and recovering, reusing, recycling, and reintegrating materials into production processes, are the primary concerns of CLSC management (Bhatia et al., 2020; Kazemi et al., 2019).

These concepts collectively represent multiple dimensions of circular economy philosophy, highlighting the complex interrelationships among environmental responsibility, organizational performance, and resource optimization within supply chain management. These various approaches, although valuable for understanding specific aspects of circularity, cannot comprehensively capture the essence of CE (Alkhuzaim et al., 2021; Genovese et al., 2017; Hazen et al., 2021). At this point, circular supply chain management (CSCM) has gained increasing prominence in the literature. Circular supply chain management is defined as "the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems" (Farooque et al., 2019: 884). This approach introduces an innovative and compelling perspective to supply chain sustainability by systematically integrating circular strategies into supply chain management (Faisal, 2023). It emphasizes the transformation of products and resource flows to establish ecologically and economically sustainable relationships (Genovese et al., 2017). These practices encompass the conversion of waste into valuable resources, the mitigation of resource-intensive production and consumption patterns, and the reduction of carbon footprints - all of which are fundamental to the goals of the circular economy (Khandelwal & Barua, 2020). Furthermore, circular economy principles extend the scope of green supply chain management by promoting approaches that maintain resource flows within quasi-closed systems (Nasir et al., 2017).

In recent years, technological and digital enablers have become increasingly prominent in the CSCM literature. Industry 4.0 technologies (IoT, sensor networks, automation, data analytics), blockchain-based traceability solutions, and digital twin applications significantly increase the effectiveness of circular supply chains. For example, Garrido-Hidalgo et al. (2019) and Jum'a et al. (2024) demonstrated that IoT-based monitoring systems improve operational performance in waste-to-energy conversion chains. Quayson et al. (2023) detailed the role of blockchain in ensuring traceability, transparency, and data integrity, while emphasizing that organizations must strengthen their dynamic capabilities for the technology to generate meaningful value. Polimetla et al. (2025) demonstrated that digital twins represent another important technology that is transforming CSCM practices, enabling the real-time simulation of material flows and operational processes.

Another prominent theme in the contemporary CSCM literature is supplier resilience and risk management. Circular systems are more susceptible to risk factors such as quality variability, uncertainty in return flows, and supply continuity. Bag and Mangla (2025) and Krstić et al. (2024) argue that risks are more complex in circular supply chains, necessitating new decision-support mechanisms. The relationships among supplier resilience, flexibility, sustainability, and supply chain performance have also attracted increasing scholarly attention. Collectively, these studies demonstrate that CSCM is no longer viewed solely through the lens of environmental sustainability but is increasingly associated with research themes, including digitalization, risk management, supplier resilience, performance measurement, and dynamic capabilities.

Therefore, CSCM is increasingly regarded as one of the most comprehensive approaches for implementing circular economy principles within supply chains.

3. Research Methodology

Bibliometric analysis is a quantitative research methodology that utilizes mathematical and statistical techniques to analyze scientific literature (Arora & Chakraborty, 2021; Zupic & Čater, 2015). It examines publications—including articles and books—through statistical processes to identify trends and patterns in a given research area. Statistical tools allow researchers to analyze publication outputs and citation structures to map the research landscape (Thelwall, 2008; Vogel & Güttel, 2013). In this study, bibliometric analysis is employed to systematically map the intellectual structure, thematic evolution, and collaborative networks of the CSCM field.

Building on this foundation, this approach has become an essential research strategy across scientific disciplines. It utilizes both quantitative and algorithmic methods to reduce subjective bias and provide more reliable findings (Öztürk & Gürler, 2021; Pritchard, 1969; Small, 1999), and is complemented by other literature review strategies such as meta-analysis and systematic reviews (Ali et al., 2021; Zupic & Čater, 2015). Whereas traditional approaches largely concentrate on small-group studies and individual research details, bibliometric methods focus on the broader patterns of scholarly contributions, enabling a macro-level understanding of a field's development (Bahoo et al., 2020; Öztürk, 2021; Wang et al., 2021).

The present study analyzes the scientific literature on circular supply chain management (CSCM) through bibliometric analysis. The Web of Science (WoS) Core Collection was chosen as the data source due to its extensive coverage, high-quality indexing standards, and extensive literature of peer-reviewed publications (Pranckute, 2021; Zhu & Liu, 2020). In addition to the general indexing approach, its major citation indexes, including SCI-Expanded, SSCI, AHCI, and CPCI, provide comprehensive coverage of research in management, sustainability, and supply chain-related fields (Singh et al., 2021).

The data used in this study were retrieved from the Web of Science (WoS) Core Collection database. The dataset was created on 24 November 2025 following a predefined search strategy. The literature search was conducted using the “All Fields” search option, and the keywords “supply chain management*” and “circular economy*” were combined with the Boolean operator AND to identify studies addressing both supply chain management and circular economy topics. The analysis covers the period between 2010 and 2025. The year 2010 was selected as the starting point because the concept of the circular economy gained substantial visibility in both academic and policy literature after this date. Preliminary screening also revealed that the number of publications related to the topic before 2010 was relatively limited, whereas the post-2010 era was characterized by a structured and rapidly expanding body of literature.

The initial search yielded 1,342 records. To enhance the scientific rigor, reliability, and completeness of the dataset, several inclusion and exclusion criteria were applied. In the first stage, only publications classified as article, review article, and early access were retained, reducing the number of records to 1,251. Subsequently, publication types such as book chapters, retracted publications, and proceedings papers were excluded from the dataset. Furthermore, only studies published in peer-reviewed journals and written in English were included in the analysis. English-language publications were selected because English represents the dominant language of international scientific communication and ensures greater comparability and accessibility of the literature. As a result of the screening and filtering process, a final publication set consisting of 1,210 publications was obtained. These publications formed the basis for the bibliometric analyses conducted in this study.

The final publication set was exported in plain text format to ensure compatibility with the bibliometric analysis software. VOSviewer (version 1.6.20) was employed for data visualization, network mapping, and scientific knowledge structure analysis. Following established bibliometric approaches (Rejeb et al., 2022; Vošner et al., 2017), the study was conducted in two complementary stages: performance analysis and scientific mapping. Performance analysis was used to evaluate the productivity and impact of the CSCM literature through indicators such as annual publication trends, leading authors, institutions,

countries, journals, and citation performance. Scientific mapping was employed to reveal the intellectual, social, and conceptual structure of the field by examining co-authorship networks, collaboration patterns, citation relationships, and thematic linkages within the literature. This combined approach provides a systematic overview of CSCM research, enabling the identification of influential contributors, collaboration structures, knowledge clusters, and emerging research themes. Consequently, it offers a deeper understanding of the evolution and knowledge structure of the CSCM field (Arruda et al., 2022; Donthu et al., 2021).

4. Results

This section presents the findings of the bibliometric analyses conducted on the final dataset and examines the visualizations that reveal the intellectual, social, and conceptual structure of the CSCM literature. The analyses are organized into two complementary components: performance analysis and scientific mapping (Farooq, 2023; Pranckute, 2021).

4.1. Performance Analysis

Performance analysis utilizes bibliometric indicators based on publications and citations to assess the scientific performance of a research field and provide insights into its development (Pranckute, 2021). This method evaluates scientific output through both qualitative and quantitative indicators associated with bibliometric data (Öztürk & Gürler, 2021).

In this study, performance analysis was conducted on 1,210 articles included in the final sample. It includes both productivity and citation-based impact indicators, such as the number of papers published over time, the most productive authors, countries, institutions, and journals, as well as citation performance measures. Based on the performance analysis, Figure 1 presents the distribution of publications on the topic over time.

Figure 1 illustrates a marked upward trend in CSCM publications between 2010 and December 2025. While the number of publications remained relatively limited during the 2010–2017 period, a significant acceleration was observed in the literature after 2017. A notable expansion occurred particularly between 2019 and 2021, and the 2022–2025 interval became the most productive phase in the field. The peak of 226 publications in 2025 reflects the growing scholarly attention devoted to CSCM and highlights the increasing maturity of the research domain. There are various global developments behind this growth in publication output. First, the circular economy approach has begun to be seen as a promising response to resource scarcity, waste management, and environmental sustainability problems, increasing researchers' interest in the topic. Additionally, international initiatives such as the United Nations Sustainable Development Goals (SDGs) and the European Union Circular Economy Action Plan have encouraged research on sustainable production and consumption systems. Furthermore, supply chain disruptions during the COVID-19 pandemic highlighted the importance of resilience, resource efficiency, reverse logistics, and circular supply chain practices. Finally, the proliferation of digital technologies such as Industry 4.0, the Internet of Things (IoT), blockchain, and big data analytics has facilitated the implementation of circular supply chain practices and contributed to the expansion of research in this area.

According to the Web of Science database, a total of 1,210 publications on CSCM were authored by 3,267 researchers. As shown in Table 1, A. Kumar appears is the most productive author with 25 publications. A. Kumar is followed by J. Sarkis with 23 publications and R. K. Singh with 22 publications. The table also includes researchers who have contributed more than 10 publications to the field. The studies of leading researchers are largely concentrated in circular economy, sustainable supply chain management, green logistics, and resource efficiency themes. In particular, Sarkis's pioneering studies in sustainable supply chain management and Kumar and Singh's research focusing on circular economy applications have made significant contributions to the CSCM literature. These findings suggest that the field is largely shaped by sustainability and operational efficiency considerations.

Figure 1. Publications Over the Year

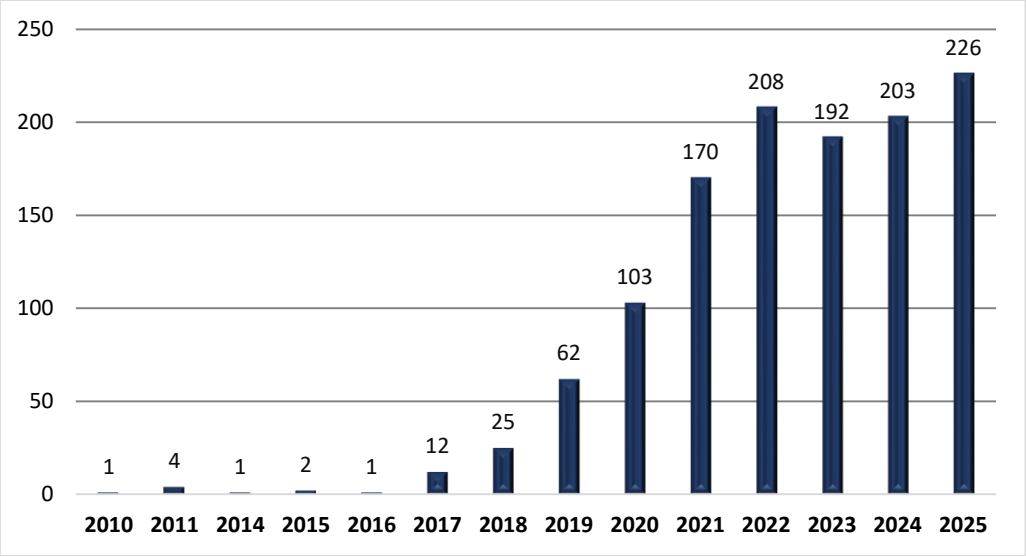


Table 1. Authors with more than 10 Papers

No	Authors	Number of Publications	%
1	Kumar, A.	25	2.06
2	Sarkis, J.	23	1.90
3	Singh, RK.	22	1.81
4	Bag, S.	20	1.65
5	Raut, RD.	19	1.57
6	Garza-reyes, JA.	18	1.48
7	Mangla, SK.	17	1.40
8	Seuring, S.	16	1.32
9	Jabbour, CJC.	15	1.24
10	Luthra, S.	15	1.24
11	Tseng, ML.	15	1.24
12	Gupta, S.	14	1.15
13	Jabbour, ABLD.	14	1.15
14	Sharma, M.	14	1.15
15	Khan, SAR.	11	0.90

To examine the institutional distribution of CSCM research, Figure 2 presents the leading institutions contributing to the literature. A total of 1,579 institutional affiliations were identified across the 1,210 publications. The number of institutional affiliations exceeds the number of publications because each co-author's affiliation is counted separately. The Indian Institute of Management (IIM) System ranks first with 65 publications, followed by the National Institute of Technology (NIT) System with 36 publications and the Indian Institute of Management Mumbai with 35 publications. Other highly productive institutions include the Management Development Institute (MDI), the Indian Institute of Technology (IIT) System, the University of Derby, the University of Johannesburg, and Worcester Polytechnic Institute.

In particular, the prominence of India-based institutions in the top rankings may be associated with the country's growing academic and political interest in circular economy, sustainable production, and resource efficiency issues. Additionally, the strong research infrastructure of institutions such as IIM, IIT, and NIT in management, engineering, and sustainability disciplines may have contributed to their strong

publication performance in CSCM research. These findings suggest that institutional research performance in the CSCM is related not only to academic capacity, but also to broader sustainability priorities and industrial transformation efforts.

Figure 2. A Top 20 Institutions of Authors

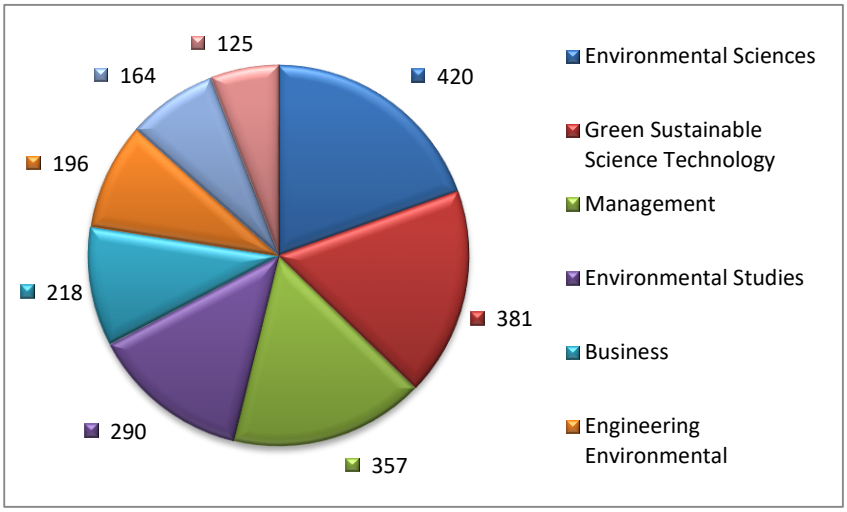
For academic journals that publish CSCM-related studies, the distribution of publications provides important insights into the disciplinary scope and maturity of the literature. Table 2 presents the distribution of CSCM-related articles across academic journals and shows that the research area is interdisciplinary. The 1,210 studies included in the dataset were published in 287 WoS-indexed journals. This shows that CSCM studies extend beyond the traditional boundaries of supply chain management and are closely related to other fields such as sustainability, environmental management, production economics, and industrial engineering. This broad journal distribution further indicates that the literature has developed through strong interactions among multiple disciplines. The prominence of sustainability- and environment-focused journals, in particular, reveals that CSCM research is concentrated on areas such as resource efficiency, waste reduction, and environmental performance. This finding suggests that CSCM is increasingly viewed not only as an operational management approach but also as a strategic research domain contributing to the SDGs.

Table 2. List of Major Journals

Journal Name	Number of Publications
Journal of Cleaner Production	147
Sustainability	114
Business Strategy and the Environment	74
International Journal of Production Economics	38
Sustainable Production and Consumption	33
Production Planning Control	28
Technological Forecasting and Social Change	21
Computers Industrial Engineering	19
Resources Conservation and Recycling	19
Benchmarking an International Journal	18
Journal of Environmental Management	18
Supply Chain Management: An International Journal	18
Environmental Science and Pollution Research	17
Environment Development and Sustainability	16
Journal of Enterprise Information Management	16
International Journal of Logistics Management	15

The Journal of Cleaner Production (147 articles) and Sustainability (114 articles) are the journals that have published the most articles in this field (as seen in Table 2). The emphasis on sustainability and environmental management in both journals suggests that the theoretical foundation of CSCM studies is largely derived from the sustainability literature. The fact that Business Strategy and the Environment has published 74 articles demonstrates how closely circular supply chains are linked to strategic management, business model innovation, and sustainable competitiveness. Articles published in production- and engineering-oriented journals, such as the International Journal of Production Economics, Production Planning & Control, and Computers & Industrial Engineering, further indicate the growing importance of CSCM in operational processes and industrial applications. Likewise, the presence of Resources, Conservation and Recycling and the Journal of Environmental Management among the leading journals highlights the strong environmental orientation of the field. Moreover, publications in Supply Chain Management: An International Journal and the International Journal of Logistics Management demonstrate that circularity has gained greater prominence within the mainstream supply chain literature. Overall, the distribution of publications across leading journals indicates that CSCM research has achieved a broad and increasingly diverse disciplinary presence. These findings suggest that CSCM has evolved into a mature and interdisciplinary research domain that integrates sustainability, environmental management, operations management, and logistics perspectives. The diversity of publication outlets reflects the increasing recognition of CSCM as both an environmental sustainability approach and a strategic management tool for improving organizational performance and competitiveness.

Figure 3. Web of Science Categories

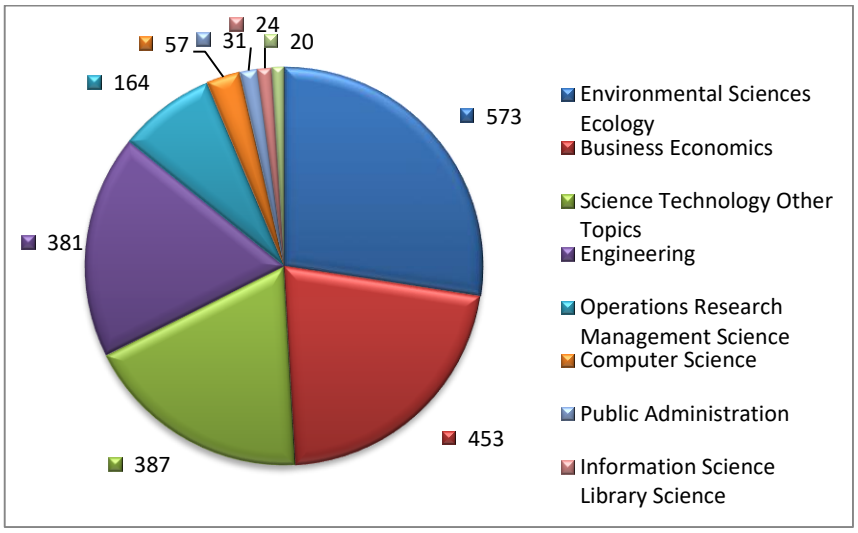


The distribution of studies across Web of Science (WoS) categories provides insights into the thematic structure and diversity of CSCM literature. Examining these categories helps identify the main research areas and demonstrates the multidisciplinary nature of the field. Figure 3 presents the distribution of articles across the major Web of Science (WoS) categories. It displays only the eight categories with the highest number of publications. The analysis shows that the 1,210 articles are distributed across 63 different WoS categories, highlighting the broad thematic scope of CSCM research. Environmental sciences ranks first with 420 articles, followed by green sustainable science technology with 381 articles and management with 357 articles. Other categories that make substantial contributions to the CSCM literature include environmental studies (290 articles), business (218 articles), engineering environmental (196 articles), operations research management science (164 articles), and engineering industrial (125 articles). This distribution indicates that CSCM literature spans a wide range of disciplines, bringing together environmental, managerial, and engineering perspectives. The prominence of environmental sciences and green sustainable science and technology categories suggests that environmental sustainability, resource efficiency, and waste management are at the core of CSCM research. However, the high number of publications in management, business, and operations

research categories reveals that circular supply chains are evaluated not only in terms of environmental benefits but also in terms of business performance, competitive advantage, and strategic decision-making processes. The significant share of engineering categories in the literature indicates that CSCM applications are closely related to production processes, process design, and technological transformation initiatives. These findings reveal that CSCM literature has an interdisciplinary character that brings together environmental, managerial, and technical aspects.

As seen in Figure 4, environmental sciences ecology is by far the most represented research area, with 573 publications. This demonstrates that environmental impacts and sustainability-focused approaches are among the fundamental drivers of the CSCM literature. Business economics, with 453 publications, ranks second, highlighting the strong connection between CSCM and economic performance as well as business applications. The substantial contributions from science technology other topics (387 publications) and engineering (381 publications) further underscore the role of technological and engineering-based solutions in CSCM research. Furthermore, decision-making and optimization-oriented fields such as operations research management science (164 publications) also account for a significant share of the literature. More specialized areas, including computer science, public administration, information science library science, and energy fuels, contribute to the thematic diversity of the field. Overall, the distribution of 1,210 publications across 32 research areas indicates that CSCM literature has developed as a multidisciplinary and broad research domain. This diversity suggests that CSCM is examined from multiple theoretical and practical perspectives.

Figure 4. Research Area Distribution



The distribution of research areas suggests that CSCM has gradually evolved from a predominantly environmental sustainability-oriented topic into a broader research domain encompassing managerial, technological, and operational dimensions. In particular, the strong representation of business economics, engineering, and operations research management science reflects the growing focus on cost management, operational efficiency, resource optimization, and competitive advantage alongside environmental objectives. Furthermore, the presence of computer science and information technology perspectives in the literature indicates that Industry 4.0, big data analytics, artificial intelligence, and digital traceability applications are gaining greater prominence in CSCM research. This trend suggests that CSCM is emerging as an integrated area of research that combines sustainability objectives with technological innovation and operational transformation.

Examining the geographical distribution of publications provides valuable insights into the global diffusion of CSCM research and the level of academic interest in the field. Such an approach helps identify

the leading countries and assess the international visibility of CSCM literature. Table 3 shows the number of publications in the CSCM field by country. It includes the top 18 countries with the highest number of publications. The dataset contains 1,210 publications from 103 different countries, which indicates that CSCM research has a wide international reach. India has the most publications (267), followed by the UK (236), China (200), and Italy (125). These four countries are among the most significant contributors to the literature. The USA (United States of America) (106 publications), France (95 publications), Australia (82 publications), and Brazil (67 publications) are also important contributors. This distribution demonstrates that CSCM studies are attracting interest from both developed and developing countries. The rising research output from emerging economies such as India, China, Pakistan, and Bangladesh reflects the increasing scholarly engagement with circular supply chain applications within these countries. Conversely, strong academic engagement in developed nations, including the UK, the USA, France, and Germany, indicates that the topic is receiving growing attention in relation to sustainability, policy development, and corporate strategy. The country distribution suggests that CSCM research has developed a global and multi-centric landscape, attracting scholarly attention across diverse geographical and economic contexts.

In particular, India's leading position in the CSCM literature may be associated with the country's strong focus on sustainable development, resource efficiency, and waste management. Similarly, China's high ranking may reflect the influence of its long-standing circular economy policies and green transformation initiatives. The strong publication performance of the United Kingdom and other European countries may also be linked to policy frameworks that encourage research on sustainability and circular economy practices. Overall, these findings suggest that the development of CSCM research is influenced not only by academic interest but also by broader economic, environmental, and policy-related factors.

Table 3. Countries by CSCM Publications

No	Countries	Number	%	No	Countries	Number	%
1	India	267	22	**10**	Spain	56	5
2	England	236	20	**11**	Malaysia	52	4
3	China	200	17	**12**	Pakistan	49	4
4	Italy	125	10	**13**	Finland	38	3
5	USA	106	9	**14**	Bangladesh	35	3
6	France	95	8	**15**	Sweden	35	3
7	Australia	82	7	**16**	Netherlands	34	3
8	Brazil	67	6	**17**	South Africa	32	3
9	Germany	62	5	**18**	Taiwan	31	3

Examining CSCM publications through the lens of the United Nations Sustainable Development Goals (SDGs) provides valuable insights into the field’s contribution to the global sustainability agenda. In this context, Table 4 presents the alignment of CSCM-related publications with the United Nations Sustainable Development Goals (SDGs). The results indicate a strong emphasis on goals related to industrial transformation, sustainable production and consumption, and climate action. The literature is associated with fifteen different SDGs, demonstrating the broad sustainability orientation of CSCM research. SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) are the three most prominent goals. Together, they account for more than half of all publications. Their dominance suggests that CSCM studies primarily focus on technological innovation, resource efficiency, circular production systems, and emission reduction—issues that lie at the core of contemporary sustainability agendas. The substantial contributions to SDG 11 (Sustainable Cities and Communities) and SDG 7 (Affordable and Clean Energy) further underscore the field’s relevance to urban sustainability and clean energy transitions. In contrast, SDGs related to ecosystem protection, basic human needs, and social welfare—such as SDG 14 (Life Below Water), SDG 15 (Life on Land), SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), and SDG 4 (Quality Education)—are represented to a much lesser extent. Even lower coverage is observed for socially focused SDGs, including SDG 3 (Good Health and Well-Being), SDG 8 (Decent Work and Economic Growth), SDG 17 (Partnerships for the Goals), SDG 1 (No Poverty), and

SDG 5 (Gender Equality). This distribution indicates that CSCM research remains heavily concentrated on environmental and industrial sustainability themes, while the social dimension of sustainable development receives comparatively limited attention. In addition, 161 publications (13.31%) could not be directly associated with a specific SDG. This finding suggests that some studies address broader sustainability challenges without explicitly referring to SDG frameworks.

The limited coverage of SDG 1, SDG 5, and SDG 8 is particularly noteworthy, highlighting an important gap in the current CSCM literature. While substantial research efforts have been devoted to resource efficiency, waste reduction, emission mitigation, and circular production systems, issues such as labor conditions, worker well-being, social inclusion, gender equality, and social value creation remain relatively underexplored. This imbalance may partly reflect the greater ease of measuring environmental and economic outcomes compared with social impacts. Consequently, future research should place greater emphasis on the social implications of CSCM practices to support a more balanced and comprehensive understanding of sustainable development.

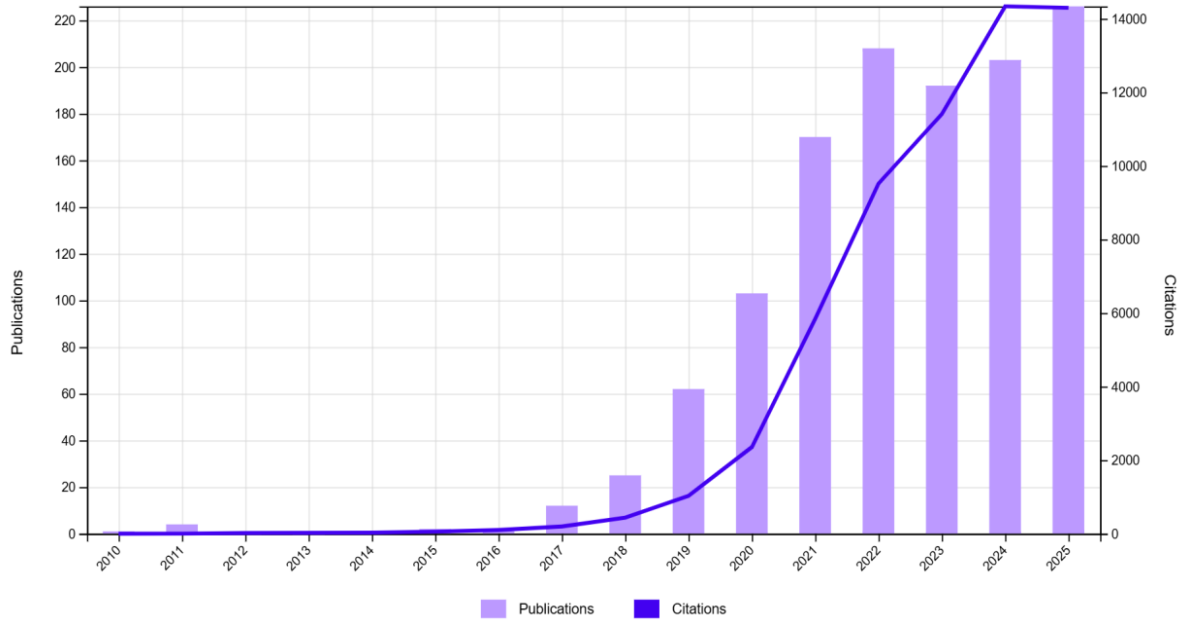
Table 4. SDG's Addressed in CSCM Literature

Sustainable Development Goals	Number of publications	% of 1,210
09 Industry Innovation And Infrastructure	851	70.331
12 Responsible Consumption And Production	805	66.529
13 Climate Action	625	51.653
11 Sustainable Cities And Communities	617	50.992
07 Affordable And Clean Energy	602	49.752
14 Life Below Water	35	2.893
15 Life On Land	34	2.81
02 Zero Hunger	23	1.901
06 Clean Water And Sanitation	21	1.736
04 Quality Education	15	1.24
03 Good Health And Well Being	14	1.157
08 Decent Work And Economic Growth	7	0.579
17 Partnerships For The Goals	6	0.496
01 No Poverty	2	0.165
05 Gender Equality	2	0.165

In the final stage of the performance analysis, citation reports obtained from the WoS database were evaluated and showed that the CSCM literature has a strong academic impact. The 1,210 publications in the dataset received a total of 60,080 citations (52,585 excluding self-citations), averaging 49.65 citations per publication, indicating that the literature is widely cited internationally. Furthermore, citations from 30,480 different documents demonstrate that CSCM research has attracted attention from a broad and interdisciplinary scientific community. The annual citation trends presented in Figure 5 show a substantial increase, particularly after 2015. This acceleration coincides with major international developments related to sustainability, circular economy policies, and technological transformation.

The rapid increase in citation numbers suggests that CSCM has become an increasingly influential research area among academics, policymakers, and practitioners. In particular, growing attention to climate change mitigation, resource scarcity, sustainable production, and circular economy strategies may have contributed to the rising prominence of CSCM research. Furthermore, the field's connections with disciplines such as environmental sciences, business, engineering, and logistics have likely contributed to its broad citation base. Overall, the citation performance of the literature indicates that CSCM has evolved into a mature research domain with substantial interdisciplinary influence.

Figure 5. Annual Citation Numbers of CSCM Articles



Identifying the most highly cited publications is essential for understanding the intellectual development and knowledge structure of the CSCM field. Citation analysis helps identify studies that have shaped the direction of research and contributed to both theoretical and practical knowledge. In this regard, Table 5 presents the most influential studies in the CSCM literature. The most-cited work is Ghobakhloo (2020), which has received 1,156 citations, averaging 192.67 citations per year. This finding highlights the growing importance of digitalization and Industry 4.0 themes within the broader CSCM scholarship. Following this, Genovese et al. (2017) made a foundational contribution by linking sustainable supply chain management to the broader transition to a circular economy, reflected in 938 citations. The systematic review by Merli et al. (2018), with 806 citations, significantly strengthened the theoretical foundations of the field, while the study by Kouhizadeh et al. (2021), cited 803 times, underscores the increasing relevance of blockchain technologies in enabling sustainable and transparent supply chain practices. Similarly, the work of Geissdoerfer et al. (2018), with 731 citations, has become a key reference point for understanding the intersection between circular business models and supply chain structures. The remaining prominent publications—Cucchiella et al. (2015), Farooque et al. (2019), Esmaeilian et al. (2020), Manavalan and Jayakrishna (2019), and Nascimento et al. (2019)—demonstrate the prominence of IoT applications, Industry 4.0 technologies, e-waste management, conceptual framework development, and blockchain innovations within CSCM literature. The concentration of highly cited studies between 2015 and 2021 illustrates the period during which CSCM emerged as a rapidly expanding research domain.

When the highly cited studies are evaluated collectively, three fundamental research streams emerge within the CSCM literature: (i) conceptual studies on circular economy and sustainability, (ii) research addressing digital transformation and Industry 4.0 technologies, and (iii) research focusing on transparency, traceability, and resource efficiency in supply chains. The strong presence of blockchain, Internet of Things, and digitalization themes among the most-cited publications indicates that CSCM studies have become increasingly intertwined with technological transformation. This finding suggests that the literature is no longer concerned solely with environmental sustainability objectives but also with digital innovation and operational performance improvement.

Table 5. List of Most Cited Publications

Title	Author(s)/Year	Total Citations	Average per Year
Industry 4.0, digitization, and opportunities for sustainability	Ghobakhloo (2010)	1156	192.67
Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications	Genovese et al. (2017)	938	104.22
How do scholars approach the circular economy? A systematic literature review	Merli et al. (2018)	806	100.75
Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers	Kouhizadeh et al. (2021)	803	160.6
Business models and supply chains for the circular economy	Geissdoerfer et al. (2018)	731	91.38
A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements	Manavalan & Jayakrishna (2019)	607	86.71
Exploring Industry 4.0 technologies to enable circular economy practices in a manufacturing context A business model proposal	Nascimento et al. (2019)	600	85.71
Recycling of WEEEs: An economic assessment of present and future e-waste streams	Cucchiella et al. (2015)	578	52.55
Circular supply chain management: A definition and structured literature review	Farooque et al. (2019)	528	75.43
Blockchain for the future of sustainable supply chain management in Industry 4.0	Esmaeilian et al. (2020)	505	84.17

The temporal distribution of the most cited publications reveals that the majority were published between 2015 and 2021. This concentration suggests that CSCM is a relatively young yet rapidly evolving scholarly domain that has experienced substantial growth over the last decade. The prominence of themes such as digital transformation, Industry 4.0, blockchain, IoT, circular economy principles, and sustainable business models highlights the field's dual technological–sustainability orientation.

The dataset's H-index of 128 further confirms that CSCM research derives its scholarly influence not only from a few seminal publications but also from a broad body of highly cited studies that collectively contribute to the field's academic impact. Overall, citation patterns indicate that CSCM has become an increasingly visible and influential area of inquiry, shaped by both scientific developments and the increasing relevance of sustainability-oriented supply chain practices.

4.2. Scientific Mapping

The purpose of scientific mapping is to comprehend the intellectual, social, conceptual, and evolutionary dynamics of the relevant literature (Arruda et al., 2022; Van Eck & Waltman, 2013). The following analyses were carried out to ascertain the relationship networks among scientific entities based on their associations:

- To reveal the social structure of the research field, *"co-author analysis",*
- To uncover the conceptual structure of the research field, *"co-occurance analysis",*
- To unveil the intellectual structure of the research field, *"citation analysis".*

4.2.1. Co-Author Analysis

Co-author analysis provides a systematic way to examine the collaborative structure of scientific research by mapping relationships among authors and identifying interaction patterns that emerge during the research process (Öztürk & Gürler, 2021; Singh & Bashar, 2021). In this approach, co-authorship between two researchers on one or more publications creates a collaborative link, and the strength of this link increases with the number of shared publications. The total link strength (TLS) represents the overall intensity of collaboration (Glanzel & Schubert, 2004; Wang et al., 2019).

This study conducted a co-author analysis at the author level to investigate the collaborative relationships among individual researchers contributing to the CSCM field. A minimum requirement of five publications per author was set, and first names were abbreviated to initials to avoid inconsistencies arising from alternative spellings of the same name. According to these standards, 85 of the 3,214 authors met the inclusion threshold, and 72 of them made up a connected and coherent co-author network. Figure 6 presents the network visualization generated using VOSviewer. The visualization reveals a dense collaborative structure characterized by active co-authorship patterns and cross-disciplinary interactions. A. Kumar is in the most central position in the network, as shown in Table 6. He has the highest total link strength (TLS = 45). This centrality indicates not only his frequent collaborations but also his function as a liaison among various research groups. S. Luthra and Y. Liu show similar patterns. Their high TLS values (36 and 35, respectively) indicate their important role in facilitating knowledge exchange across institutions and research communities. The prominence of authors such as S.K. Mangla, J. Sarkis, and S. Bag reflects the importance of the research on environmental sustainability, digital transformation, and green supply chain management. These authors have played an essential role in the development and dissemination of major research themes, and their strong collaborative ties have facilitated their diffusion and advancement within the literature.

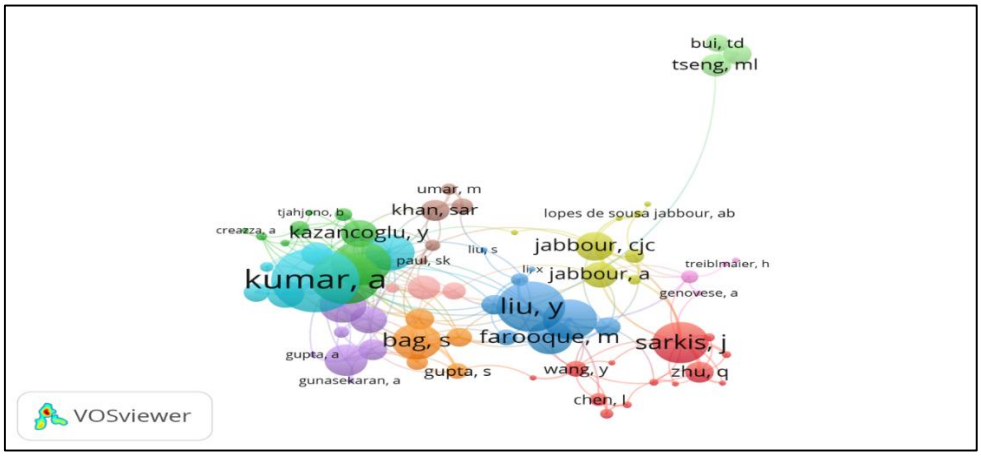
Table 6. Co-author Analysis – Top Ten Authors by Link Strength

Author	Documents	Citations	Total Link Strength
Kumar, A.	25	1080	45
Luthra, S.	15	1593	36
Liu, Y.	18	1933	35
Mangla, Sk.	16	1872	31
Sarkis, J.	23	3882	29
Zhang, A.	15	2029	28
Bag, S.	20	2161	25
Garza-Reyes, Ja.	17	1618	25
Sharma, M.	14	496	24
Farooque, M.	9	1355	23

The co-author network consists of 11 clusters that represent distinct yet interconnected research communities, indicating that CSCM research advances through collaborative, overlapping areas of inquiry rather than isolated groups. Cluster 1 forms the central core of the network, led by scholars such as Sarkis and Zhu, and focuses on green supply chain management and environmental performance. Clusters 2 and 3 build upon this foundation with studies on sustainability-oriented operations, digital transformation, and Industry 4.0 technologies, shaped by authors including Luthra, Mangla, Liu, and Farooque. Clusters 4 and 5 contribute research on corporate sustainability, green business models, and logistics–operations performance, while Cluster 6 highlights circular economy practices and performance measurement through authors such as Kumar and Garza-Reyes. Clusters 7 and 8 address technological capabilities, supply chain resilience, risk management, and green logistics. Less prominent clusters—such as those emphasizing European theoretical developments, sustainability in emerging markets, and technology-driven sustainability—demonstrate the geographic and thematic diversity of the field. Key bridging researchers, including Kumar, Luthra, Liu, Sarkis, Jabbour, and Tseng, connect these clusters and facilitate the exchange of ideas and methods across different research communities. Overall, the clustering structure reflects a well-

integrated, interdisciplinary research landscape that supports the development of CSCM into a mature and cohesive field.

Figure 6. Network Map of Authors



Following the author-level analysis, institutional co-authorship patterns were examined to understand better the organizational foundations of scholarly cooperation within the CSCM field. Using a minimum threshold of five publications per institution, 140 out of 1,650 institutions met the inclusion criteria, and 127 of these formed an interconnected network, as visualized in Figure 7. This high level of institutional connectivity indicates that CSCM research is supported by a broad and collaborative academic infrastructure rather than by a small number of isolated centers. As shown in Table 7, institutions such as Asia University, the University of Derby, London Metropolitan University, China Medical University, and Universiti Kebangsaan Malaysia act as major partnership hubs, demonstrating strong external linkages and active participation in cross-institutional research networks. Their high total link strength values reflect sustained engagement in joint scientific production, emphasizing the increasingly global and interdisciplinary nature of CSCM scholarship. Overall, the institutional collaboration landscape reveals a diverse and geographically dispersed ecosystem in which partnerships across regions and disciplinary traditions play a key role in advancing CSCM research.

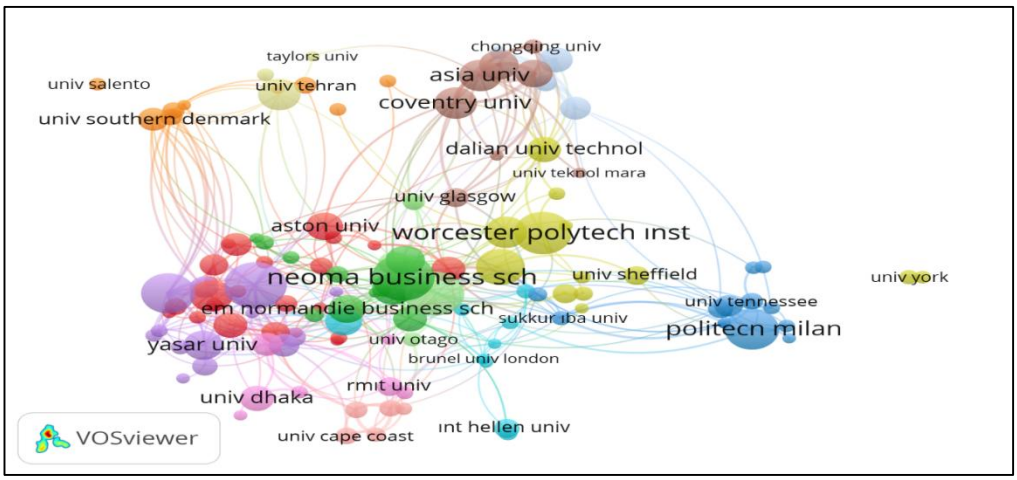
Table 7. Co-author Analysis - Top Ten Universities by Link Strength

Organization	Documents	Citations	Total Link Strength
Asia University	15	1051	43
University of Derby	22	1668	42
London Metropolitan University	19	631	41
China Medical University	13	953	39
Universiti Kebangsaan Malaysia	14	934	36
Coventry University	15	1224	33
Ilma University	12	1269	29
University of Southern Denmark	11	531	28
Doon University	10	440	26
Changan University	11	1161	25

The institutional network consists of 13 clusters that reflect the regional and thematic collaborations shaping the global development of CSCM research. These clusters show that academic organizations do not work in isolation; instead, they form broad partnerships across different continents and thematic domains. For instance, collaborations between European and Indian technological universities and between Western European business schools and Latin American institutions point to strong international links centered on

engineering, sustainability, and management. Likewise, Asian–European partnerships focusing on industrial engineering and sustainable production highlight how shared technological and environmental challenges foster cross-regional cooperation. The participation of organizations from Southeast Asia, the Middle East, Africa, and Latin America further demonstrates the global significance of CSCM. These regions contribute diverse perspectives and practical insights, enriching the research landscape with different economic and industrial experiences. Several smaller but influential clusters—such as those involving Delft University of Technology and Tsinghua University—show that leading universities often drive methodological and conceptual advances, even when they collaborate within more compact groups. Overall, the cluster structure reveals a globally connected and multidisciplinary institutional network. The presence of strong hubs alongside emerging research groups supports active knowledge exchange and indicates that CSCM is a well-integrated field shaped by broad international engagement.

Figure 7. Institutional Overview of the Co-author Analysis Network



The author and institution-level analyses collectively reveal a research domain that is collaborative, internationally distributed, and thematically integrated. The presence of strong hubs, influential bridging scholars, and dense inter-institutional partnerships suggests that CSCM is advancing through collective knowledge creation rather than isolated individual efforts. This interconnected structure not only accelerates the diffusion of new ideas but also strengthens the theoretical and methodological foundations of the literature. Ultimately, the co-author networks suggest that CSCM has evolved into a mature, multi-regional, and multidisciplinary scholarly domain characterized by extensive knowledge exchange and sustained international engagement.

4.2.2. Co-Occurrence Analysis

Co-occurrence analysis was conducted to identify the conceptual structure of the CSCM research domain and to reveal how key themes and concepts interact to shape the field. As emphasized in previous studies, co-occurrence analysis helps uncover the intellectual foundations of a discipline and provides insights into its conceptual evolution over time (Deng & Xia, 2020; Koç, 2021; Öztürk, 2021).

For this analysis, using a threshold of at least ten occurrences, 77 keywords out of 1,895 met the inclusion criteria and formed the basis of the analysis. These keywords collectively demonstrated a total link strength of 2,746, indicating a dense and highly interconnected conceptual landscape. Within this structure, the *circular economy* clearly emerges as the central theme, appearing 659 times and reaching a total link strength of 1,116. This overwhelming prominence suggests that circularity has become the primary lens through which CSCM is currently theorized and operationalized. As shown in Table 8**,** the strong link strength of *sustainability* (598), *supply chain management* (338), and *Industry 4.0* (276) further illustrates how environmental objectives, managerial practices, and technological innovation are intertwined in shaping the

dominant research agenda. These patterns indicate not only the frequency of certain terms but also the depth of their conceptual influence. For instance, the strong position of *Industry 4.0* signals that digital transformation is no longer a peripheral topic but a core driver of supply chain circularity. Similarly, the visibility of keywords such as *barriers*, *systematic literature review*, *blockchain*, and *sustainable supply chain management* suggests growing scholarly attention to both the enabling mechanisms and the practical obstacles associated with implementing circular and sustainable systems. In other words, the field is moving beyond theoretical discussions to address real-world operational challenges, technological enablers, and evidence-based approaches.

Table 8. Keyword Co-occurance Analysis -Ten Words by Link Strength

Keyword	Occurrences	Total Link Strength
Circular Economy	659	1116
Sustainability	264	598
Supply Chain Management	172	338
Industry 4.0	105	276
Sustainable Development	67	149
Barriers	55	128
Systematic Literature Review	53	123
Supply Chain	52	118
Blockchain	43	106
Sustainable Supply Chain Management	60	106

Keyword co-occurrence networks provide insight into the development of the abstract and thematic structure of a research field. Examining keyword co-occurrence patterns is important for understanding the intellectual structure of the CSCM literature. Figure 8 visualizes the co-occurrence network of the 77 high-frequency keywords, which are organized into seven distinct thematic clusters. These clusters collectively describe the core intellectual structure of circular economy and sustainability research within the CSCM domain. The clusters highlight:

(1) Circular economy practices and environmental sustainability;

(2) Digital technologies, innovation, and dynamic capabilities;

(3) Advanced technologies such as AI, big data, IoT, and Industry 4.0;

(4) Barriers, drivers, and challenges in manufacturing and recycling;

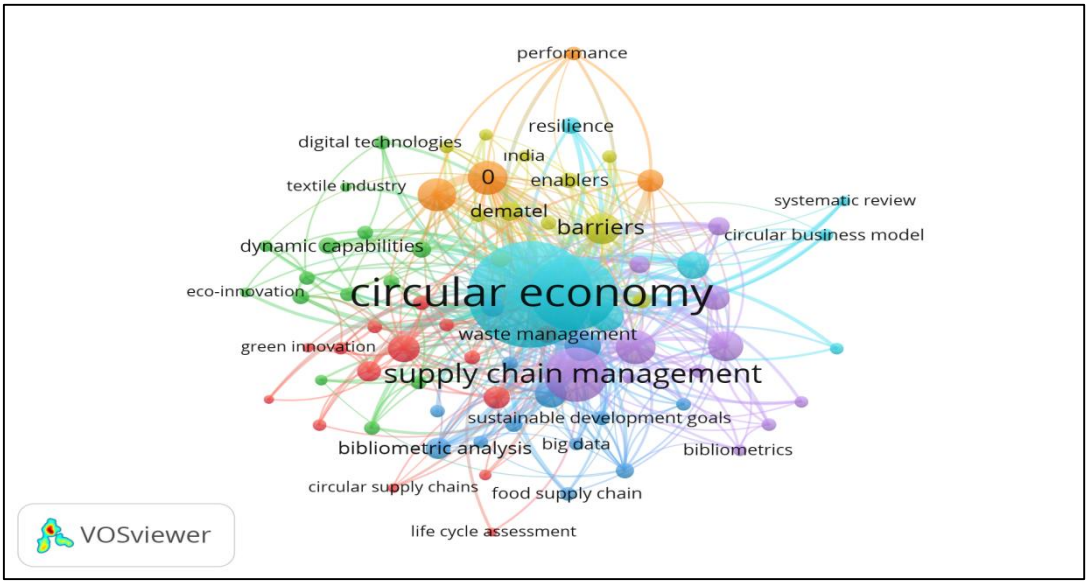
(5) Green and reverse logistics within closed-loop supply chains;

(6) Circular business models and resilience; and

(7) Performance-oriented circular supply chain approaches linked to Industry 4.0.

These clusters further confirm that CSCM research is based on principles revolving around circularity, sustainability, and technological transformation. The presence of numerous technology-related concepts suggests that digital tools and advanced analytics play a central role in enabling sustainable supply chain management. Meanwhile, the prominence of clusters addressing barriers and drivers suggests that researchers increasingly recognize the complexity of implementing circular strategies in real-world industrial settings.

Figure 8. Co-occurrence of Author Keywords



4.2.3. Citation Analysis

The influence of authors and studies within a specific discipline is often measured by the number of citations they receive. Citation analysis evaluates publications and authors based on citation frequency (Yilmaz, 2021). Citation analysis can be conducted at the levels of authors, journals, institutions, and countries, and is based on citations received from other researchers (Wang et al., 2019).

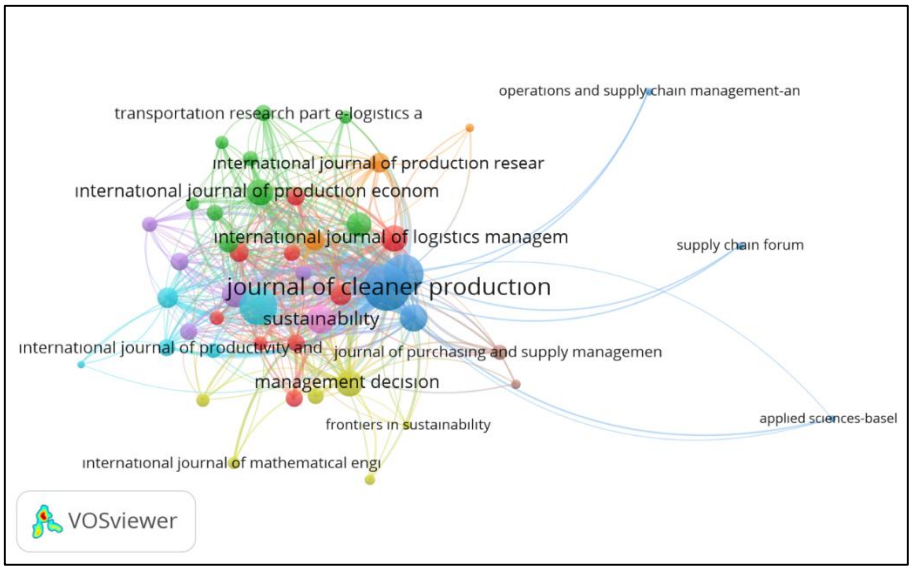
In this study, citation analysis was conducted at the journal level to map the intellectual foundations of the CSCM field and to identify the leading journals that play a central role in knowledge dissemination. A minimum threshold of 5 documents per journal was applied, resulting in 46 qualifying journals out of 287. The citation linkages among these journals were then analyzed to uncover structural relationships and patterns of scholarly influence. The results indicate that the *Journal of Cleaner Production* holds the most prominent position in the network. As seen in Table 9**,** this journal accounts for 147 articles, 16,745 citations, and a total link strength (TLS) of 892, positioning it as the leading publication outlet in the CSCM literature. It serves as a major platform for disseminating high-impact research within the CSCM domain, hosting many of the most highly cited and theoretically influential studies. It is followed by *Production Planning & Control* and *Business Strategy and the Environment*, both of which play important roles in linking sustainability research with production systems, operations management, and strategic decision-making. Other publication outlets—including *Sustainability*, *Sustainable Production and Consumption*, *Management Decision*, *International Journal of Logistics Management*, *International Journal of Production Economics*, *Technological Forecasting and Social Change*, and *Supply Chain Management: An International Journal*—also contribute substantially to the conceptual and methodological development of the field.

Table 9. Citation Analysis - Top Ten Journals

Source	Documents	Citations	Total Link Strength
Journal of Cleaner Production	120	9424	621
Production Planning & Control	20	1586	352
Business Strategy and The Environment	32	1058	227
Sustainability	82	1337	169
Sustainable Production and Consumption	29	759	122
Management Decision	10	683	144
International Journal of Logistics Management	13	284	127
International Journal of Production Economics	31	1830	153
Technological Forecasting and Social Change	14	736	117
Supply Chain Management-An International Journal	8	328	97

Figure 9 shows the journal co-citation network and the intellectual structure of CSCM research. The identified journals are grouped into nine thematically coherent clusters. The first two clusters form the core of this network, emphasizing environmental sustainability, green production systems, and advanced manufacturing—indicating that ecological performance and production-oriented sustainability remain central concerns in the field. The next two clusters integrate sustainability and circular economy perspectives with logistics, supply chain management, innovation studies, and technological forecasting, illustrating how CSCM has evolved toward a more interdisciplinary orientation where operational efficiency, digital transformation, and environmental objectives converge. The remaining clusters reflect complementary but essential themes, including managerial decision-making, circular business models, environmental policy and risk assessment, sector-specific sustainability applications, and broader socio-economic dimensions.

Figure 9. Co-citation Network Analysis (journals)



The presence of journals focusing on governance, behavioral factors, and institutional dynamics indicate that CSCM research increasingly acknowledges the importance of organizational capabilities and policy frameworks in enabling circular and sustainable practices. Ultimately, these nine clusters demonstrate the diversity and cohesion of the CSCM intellectual structure, highlighting the multiple dimensions of CSCM and its strong conceptual connections with other disciplines.

5. Discussion

The results of the analysis confirm that the CSCM literature has been on an accelerating trajectory, with publication volumes increasing sharply after 2022 and continuing to grow through 2025. This aligns with prior work documenting the field's rapid conceptual development (Farooque et al., 2019; Gao et al., 2024; Lahane et al., 2020). Having firmly established its theoretical foundations, CSCM is now in a phase of intensive applied and empirical development. Because previous reviews largely relied on data from before 2020, they were insufficient to capture the profound impact of the COVID-19 pandemic on supply chain vulnerabilities and the subsequent surge in resilience-focused research. The present study distinguishes itself from existing literature by capturing a new wave of research driven by (i) systemic supply chain disruptions, (ii) accelerating digitalization investments, and (iii) the materialization of national circular economy policies.

One of the most striking findings is the significant shift in the thematic focus of CSCM research. Early studies concentrated primarily on conceptual frameworks centered on environmental benefits, green supply chains, and closed-loop systems (Geissdoerfer et al., 2018; Genovese et al., 2017). However, the present analysis reveals that the literature has progressively shifted toward technology-driven operational solutions over the past five years. The prominence of *Industry 4.0, blockchain,* the *Internet of Things (IoT), big data, and digital twin* technologies in the keyword co-occurrence network demonstrates that digital transformation is now regarded as a fundamental enabler of circular supply chains. These technologies enhance visibility, traceability, and decision-making throughout product life cycles, while supporting reverse logistics, resource recovery, and circular business models. Consequently, digitalization should be viewed not merely as a complementary technology trend but as a core mechanism that makes circular supply chain practices operationally feasible and economically sustainable (Duan et al., 2025; Polimetla et al., 2025; Quayson et al., 2023).

The keyword network further indicates the emergence of a new thematic orientation linking circularity, digitalization, and supply chain robustness. The growing prominence of concepts such as systemic risk, disruption, and vulnerability suggests that CSCM is progressively being conceptualized not only as an environmental sustainability approach but also as a strategic framework for managing uncertainty and strengthening network flexibility. This finding is particularly relevant in the post-COVID-19 context, where circular supply chain configurations are widely recognized for their potential to reduce dependency on virgin resources, strengthen recovery functions, and improve organizational resilience. These insights align with Bag and Mangla (2025) and Upadhyay et al. (2021), confirming that the technology–circularity nexus has become one of the dominant research stream in the CSCM literature. Furthermore, digital technologies support adaptive capacities by improving information sharing, coordination, and responsiveness among supply chain partners. The ability to identify disruptions at an early stage, monitor material availability, and coordinate reverse flows enhances the responsiveness of circular supply chains under conditions of uncertainty. Consequently, digital transformation simultaneously drives environmental sustainability objectives, operational continuity, risk management, and long-term competitive advantage.

The performance analysis and co-authorship mapping results reveal a notable transformation in the global CSCM scholarly landscape. The high scientific output of countries such as the United Kingdom, the United States, India, and China demonstrates that CSCM has become a globally relevant domain garnering significant interest from both developed and emerging economies. This pattern reflects the growing importance of circular economy practices in major production and innovation hubs of global supply chains. At the same time, the joint authorship networks indicate a relatively mature and interconnected research community. Authors such as A. Kumar, J. Sarkis, and S.K. Mangla occupy central positions within the cooperation structure, serving as intellectual bridges connecting sustainability, technology, and supply chain management perspectives. These findings emphasize the progressively international and interdisciplinary nature of CSCM inquiry and suggest that future advances in the field will continue to be shaped by cross-border partnership and knowledge exchange.

Another contribution of the study is the examination of CSCM research through the lens of the United Nations Sustainable Development Goals (SDGs). The findings reveal a strong concentration of publications

associated with SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). This pattern confirms the close relationship between CSCM and environmental sustainability objectives, aligning with previous studies highlighting the role of circular economy practices in advancing sustainable production systems and climate-related goals (Schroeder et al., 2019). However, the analysis also demonstrates that socially oriented goals such as SDG 1 (No Poverty), SDG 5 (Gender Equality), and SDG 8 (Decent Work and Economic Growth) remain substantially underrepresented in the CSCM literature. While considerable progress has been made in addressing environmental and economic facets of sustainability, the social pillar of circular supply chains has received comparatively limited scholarly attention. This imbalance highlights a significant opportunity for future research to integrate human-centric concerns into CSCM frameworks and explore how circular supply chains can contribute not only to environmental protection and economic performance but also to broader social development outcomes.

Overall, the findings indicate that CSCM is evolving into a mature and multidisciplinary field that integrates environmental sustainability, digital transformation, operational resilience, and strategic supply chain management. The convergence of these themes reflects the growing recognition that circular supply chains can simultaneously address resource efficiency, technological innovation, organizational adaptability, and broad sustainability goals. As governments and organizations steadily accelerate their circular economy transitions, CSCM is poised to remain a critical area of academic inquiry and managerial practice in the coming years.

6. Conclusion

This study provides a comprehensive bibliometric assessment of CSCM literature based on 1,210 publications indexed in the Web of Science Core Collection between 2010 and 2025. The findings demonstrate that CSCM has evolved from a niche sustainability concept into a mature and multidisciplinary scholarly domain. The analysis reveals a clear transition from concept-oriented discussions to technology-enabled, resilience-focused inquiry, reflecting the growing importance of digital transformation, supply chain adaptability, and circular economy implementation in both academic and managerial contexts. Crucially, the analysis further indicates that although CSCM literature is strongly aligned with environmental and innovation-related sustainability objectives, the social dimension of the discipline remains comparatively underexplored.

From a theoretical perspective, this study contributes to the literature by providing an updated mapping of the intellectual structure and development trajectory of this field through 2025. The results highlight the increasing integration of circularity, digitalization, and resilience, suggesting that CSCM is increasingly being conceptualized as an integrated framework that simultaneously addresses environmental sustainability, operational performance, and organizational adaptability. Moreover, the SDG-based analysis offers additional insights into the literature's normative orientation by identifying both well-established and underrepresented thematic domains.

The findings also provide important implications for practice and policy. For managers, the results emphasize that successful circular supply chain implementation requires not only environmental commitment but also investments in digital capabilities that enhance visibility, traceability, coordination, and resilience. For policymakers, the outcomes underline the importance of promoting circular economy policies that balance environmental objectives with broader social sustainability concerns, particularly those related to employment quality, inclusion, and equitable development.

This study is subject to certain limitations. The analysis was restricted to English-language publications indexed in the Web of Science Core Collection and may therefore not fully capture relevant contributions published in other databases or languages. Furthermore, while bibliometric methods are effective in identifying publication trends, collaboration patterns, and the intellectual structure of a research field, they do not provide an in-depth assessment of the methodological characteristics and empirical findings of individual papers.

Future research may extend the current understanding of CSCM in several directions. In particular, greater attention should be devoted to the social dimensions of sustainability, including labor standards, gender equality, and social inclusion, which remain underrepresented in the existing literature. Further empirical studies are needed to examine the real-world implementation of emerging digital technologies, such as blockchain, artificial intelligence, and digital twins, and their implications for resilience and circular supply chain performance. Finally, comparative studies across different institutional and regional contexts would contribute to a more comprehensive perspective on how CSCM practices support both organizational resilience and the achievement of Sustainable Development Goals.

Declarations and Disclosures

Ethical Responsibilities of Authors: The authors of this article confirm that their work complies with the principles of research and publication ethics.

Conflicts of Interest: No potential conflict of interest was reported by the authors.

Funding: The authors received no financial support for the preparation and/or publication of this article.

Author Contributions: The authors confirm contribution to the article as follows: Conceptualization and design, E. Koç and M. Aksoy; data collection, M. Aksoy; analysis of data and interpretation of results, E. Koç and M. Aksoy; writing the first draft of the manuscript, E. Koç and M. Aksoy; review and editing, E. Koç. The manuscript/article was read and approved by all the authors, and all authors accepted responsibility for their article.

Plagiarism Checking: This article was screened for potential plagiarism using a plagiarism screening program.

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