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Supply chain collaboration and green supply chain management: A bibliometric review, 2000–2023

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Background: In the context of digital transformation and sustainable development, it is increasingly important to understand the relationship between Supply Chain Collaboration (SCC) and Green Supply Chain Management (GSCM). This study aims to clarify the convergence between the two sectors that play a pivotal role in modern supply chain management.

Objectives: The objective of the study is to analyse research trends on SCC-GSCM, identify prominent authors, countries, journals, as well as core research topics and trends.

Method: The study used bibliographic analysis based on 1724 articles published in the Scopus database in the period 2000–2023.

Results: The results show that the convergence between SCC and GSCM increased markedly, especially in the period 2019–2023 with a compound annual growth rate (CAGR) of 19.57%. Four main thematic clusters were identified: (1) strategic collaboration in sustainable supply chains; (2) application of GSCM in the industrial sector; (3) environmental collaboration and supply chain performance; (4) digital transformation and expansion of SCC-GSCM.

Conclusion: Technology 4.0 is identified as the main driving factor for the SCC-GSCM convergence process, contributing to building a smart cooperation model and optimising sustainable efficiency.

Contribution: The study provides a data platform that guides further research, and provides practical implications for leveraging technology to promote collaboration and improve sustainable supply chain performance.

Keywords: supply chain collaboration; green supply chain management; bibliometric analysis; literature review; research trend.

Introduction

Global supply networks are becoming more complicated; companies have to deal with constraints from tight environmental rules, supply chain interruptions, and the need to increase operational efficiency and sustainability (Seuring & Müller 2023). Recent events such as coronavirus disease 2019 (COVID-19), geopolitical conflicts and economic downturns have underlined the frailty of conventional supply networks; therefore, companies must have a more flexible adaptation strategy to be competitive (Ivanov 2021). Regulatory frameworks, exemplified by the EU's Carbon Border Adjustment Mechanism (CBAM), anticipated to be fully operational by 2026, are intensifying pressure on enterprises to implement Green Supply Chain Management (GSCM) strategies for compliance, while simultaneously enabling firms to sustain a competitive edge (European Commission 2023).

Not only helping businesses comply with environmental regulations, GSCM also provides a long-term competitive advantage, enhancing its presence in the global market (Dubey et al. 2022). Meanwhile, Supply Chain Collaboration (SCC) plays a key role in reducing operating costs, optimising energy and reducing CO_2 emissions, and is an important foundation for innovation and risk management in green supply chains (Zhang, Zhang & Liu 2023).

The SCC develops a platform to assist companies in more successfully implementing green initiatives (Flygansvær, Dahlstrom & Nygaard 2019). While reducing obstacles to environmental

standard compliance, information exchange and decision-making coordination within the SCC can enhance the efficacy of GSCM strategy implementation (Zhaolei, Wang & Zhang 2023).

In addition, the strong development of modern technology is creating fundamental changes in supply chain management, promoting SCC and GSCM in the direction of more transparency, accuracy and efficiency (Chauhan, Parida & Dhir 2022). Technologies such as IoT, Big Data, Blockchain and AI not only improve operational monitoring and optimisation but also open up opportunities to enhance coordination among supply chain partners to systematically implement sustainability strategies (Handoyo 2023; Muduli et al. 2020).

Although previous studies have mentioned the link between SCC and GSCM, the majority still focus on each individual impact, and there is no systematic approach to analyse the development of this relationship over time (Geng, Mansouri & Aktas 2017). At the same time, no research has evaluated the role of Industry 4.0 in the convergence between SCC and GSCM, nor has it examined the extent to which digital technologies can promote connectivity between the two sectors (Li, Dai & Cui 2020). To address that gap, the study employed bibliometric analysis on 1724 papers from Scopus (2000–2023) to:

- systematise information regarding SCC-GSCM and assess the interrelationship between the two domains
- determine the authors, journals and articles that have significantly influenced SCC-GSCM research
- analyse research trends, particularly on the impact of digital transformation and Industry 4.0 on the convergence of SCC and GSCM.

This article contributes to scholarly knowledge and management practice by offering data-driven insights that help academics and practitioners understand the evolution and dynamics of sustainable and cooperative supply chains. The outcomes guide strategic decisions in operations and supply chain management as well as future directions for theory and practice.

Thus, this work improves theoretical and practical knowledge in operations, logistics and supply chain management, thus fitting the goals and scope of the Journal of Transport and Supply Chain Management.

Literature review

Relationship between supply chain collaboration and green supply chain management in the context of sustainable development

Escalating environmental challenges and regulatory compliance are compelling organisations to include SCC and GSCM to enhance operational performance and guarantee sustainable development (Seuring & Müller 2023). Supply Chain Collaboration denotes the partnership among supply chain participants to enhance operations and resources and establish a competitive edge (Simatupang & Sridharan 2002), whereas GSCM emphasises the incorporation of environmental considerations throughout the entire value chain, encompassing product design, production, distribution, and recovery and recycling (Ahmad et al. 2022).

Multiple empirical studies have demonstrated that the SCC serves as the cornerstone for advancing GSCM via three primary mechanisms: information sharing, decision synchronisation and alignment of interests among partners (Dubey et al. 2022). This relationship enhances economic efficiency and enables enterprises to comply with environmental regulations by optimising supply chains and reducing resource waste (Flygansvaer et al. 2019). Conversely, GSCM imposes greater demands on SCCs, necessitating innovative collaboration methods among partners to achieve sustainability objectives. Research indicates that enterprises with effective supply chain coordination not only enhance resource optimisation but also reduce environmental detriments (Govindan & Hasanagic 2018).

Although SCC and GSCM are closely related, the majority of studies still focus on individual factors rather than analysing their convergence under an overall theoretical framework (Govindan & Hasanagic 2018). Therefore, a systems approach is needed to evaluate the integration between SCC and GSCM in the context of sustainable development.

The amalgamation of SCC and GSCM has attracted increased attention; yet, theoretical concerns remain insufficiently explored. The Resource-Based View (RBV) promotes the development of internal competencies and cooperative benefits, whereas Transaction Cost Economics (TCE) emphasises minimising opportunism and safeguarding transactions, often discouraging open information exchange (Shibin et al. 2020). Institutional Theory highlights compliance with environmental regulations, which might impose financial limitations or contradict goals of economic efficiency (Cassely et al. 2020). A concrete manifestation of these conflicts is the trade-off between data transparency, which fosters green collaboration, and concerns about information leakage or control. Furthermore, the pursuit of sustainability may lead to cost inefficiencies unless underpinned by technology or policy-based safeguards (Tognetti, Grosse-Ruyken & Wagner 2015). These conceptual tensions indicate the necessity for a pluralistic theoretical framework capable of reconciling various logics and directing future research on the convergence of SCC and GSCM.

Fundamental facilitators of supply chain collaboration-green supply chain management integration: Technological and organisational

Catalysts

The amalgamation of SCC and GSCM is propelled by technical advancements as well as organisational or

institutional influences. Although Industry 4.0 technologies have transformed coordination and the execution of sustainability initiatives, current research underscores the significance of non-technological factors, including policy frameworks, corporate culture and internal competencies. This section analyses these complementing enablers to offer a more thorough perspective on SCC-GSCM convergence.

Technology 4.0 as a catalyst for supply chain collaboration-green supply chain management convergence

Technology 4.0 includes smart systems and digital platforms characterised by automation, real-time connectivity and big data processing (Berges, Ramírez-Durán & Illarramendi 2021). These technologies are reshaping the way we collaborate and implement sustainability strategies in the supply chain, creating new impetus for more effective integration of SCC and GSCM (Handoyo 2023; Muduli et al. 2020). Within the fundamental technologies of Industry 4.0, IoT delivers real-time data and aids enterprises in monitoring energy usage, regulating emissions and enhancing waste management, hence facilitating the alignment of sustainability plans across supply chain collaborators (Muduli et al. 2020). By leveraging thorough analysis, streamlined production processes and improved demand forecasting, Big Data has become a key enabler of effective stakeholder collaboration (Kamble, Gunasekaran & Dhone 2020). Similarly, deploying artificial intelligence within logistics and industrial automation enhances decision-making across the entire supply chain, which, in turn, fosters sustainable operational efficiency (Chauhan et al. 2022). Furthermore, blockchain technology reinforces stakeholder trust by improving transparency and traceability, as well as supporting adherence to environmental regulations, thereby maximising the benefits of the SCC (El-Kassar & Singh 2019).

Using technology 4.0 has major benefits in improving operational efficiency and helping businesses follow ever strict environmental regulations (Governindan & Soleimani 2017).

However, the process still faces many challenges such as disparities in technological capabilities between partners (Choksy, Sinkovics & Sinkovics 2017), high investment costs and the risk of over-reliance on data, which can reduce supply chain flexibility in the face of unforeseen fluctuations (Chen et al. 2017; Liao & Kuo 2014).

Despite this, recent research trends show an increasingly strong convergence between SCC, GSCM and technology 4.0, opening up opportunities for businesses to not only comply with environmental regulations but also increase their competitive advantage through sustainable coordination (Farooque, Zhang & Liu 2019). However, most of the current research still mainly focuses on individual factors; there is not yet a complete systematic analysis of the development of SCC-GSCM over time and the impact of technology 4.0 in this convergence process. Thus, SCC and GSCM not only have a mutual relationship but are also increasingly driven by technology 4.0. Smart SCC-GSCM technology integration helps businesses satisfy sustainability criteria while also providing them with a long-term competitive advantage. However, there has yet to be a comprehensive evaluation of the SCC-GSCM convergence process over time under the impact of technology 4.0. This study provides an in-depth examination of SCC-GSCM during the past 20 years, clarifying the role of technology 4.0 as a catalyst for this convergence and providing guidance for future research and practical applications.

Non-technological drivers of supply chain collaboration-green supply chain management integration

Although digital technologies increasingly facilitate collaboration, a growing body of work shows that the long-term success of sustainable supply-chain collaboration depends at least as much on policy conditions, organisational culture and firm capabilities as on Industry 4.0 tools. A systematic review by Saeed and Kersten (2019) frames these influences as 'external' (market, social and especially regulatory pressure) and 'internal' (strategy, culture and resources). Empirical and conceptual studies published since 2000 confirm and refine that taxonomy.

Regulation sets the outer boundary for what firms must or can do in sustainable supply chains. Qualitative synthesis of policy research shows that stringent, well-enforced instruments such as carbon caps or pollution taxes push companies to green their supply networks, whereas lax enforcement or low perceived risk weakens the incentive to collaborate (Darnall, Seuring & Zhu 2019). Analytical modelling suggests that the effect is not merely punitive: carbon subsidies or tax-rebate schemes can align partners' interests, because sharing a subsidy and meeting a joint emissions target improves both profit and environmental outcomes (Ding, Huang & Tang 2016). In short, coherent policy frameworks create the 'regulatory pressure' that initiates and sustains SCC-GSCM initiatives.

Inside the firm, culture determines how far such pressures translate into practice. A mixed-method study in the United Kingdom and Greek food sectors finds that clan, hierarchical and adhocracy cultures – those that value teamwork, structured coordination and innovation – each raise sustainable supply chain performance, whereas a purely market-oriented culture does not (Osei, Yildiz & Boakye 2023). Similar patterns appear in Moroccan manufacturing: survey data show that the same three culture types foster GSCM adoption, while national culture shows no direct effect (Iddik 2024). These results suggest that a learning oriented, collaborative ethos is an essential complement to regulatory incentives.

Whether cultural commitment produces measurable gains ultimately depends on organisational capabilities. Survey evidence from 230 Korean manufacturers demonstrates that collaborative capability – an ability to coordinate closely with partners – amplifies the financial returns of GSCM practices (Hwang 2013). Multi-case research in

Colombian firms further reveals that stakeholder pressure has pushed companies to build new skills in eco-innovation and CSR-oriented processes (Chacón Vargas & Moreno Mantilla 2016). A recent scientometric review identifies 'sustainable organisational capabilities' as an emergent research cluster and calls for deeper inquiry into how such capabilities are cultivated (Orioli & Veríssimo 2023).

Taken together, this literature converges on three insights. Firstly, well-designed and enforced policies catalyse collaboration by altering firms' risk-reward calculus. Secondly, cultures that privilege learning, structure and shared purpose convert external pressure into collective action, whereas misaligned cultures stall progress. Thirdly, the gains from SCC-GSCM materialise only when firms invest in the routines, skills and relational capabilities that allow partners to co-create value. These non-technological drivers therefore constitute both critical levers and potential bottlenecks in the continuing convergence of SCC and GSCM.

Research methodology

Bibliometric analysis

A scientific approach called bibliographic analysis examines quantitative data from scholarly publications including books and papers (Pritchard 1969). Performance analysis and scientific mapping are the two primary techniques of this method (Baier-Fuentes et al. 2019; Piñeiro-Chousa et al. 2020).

Based on the quantity of publications, citations and indicators like h-index (Hirsch 2005), impact factor and cite score, performance analysis evaluates the importance of authors, journals, organisations and nations. Performance analysis was used in this work to authors, journal sources, records and keywords. Through the following approaches, co-citation (Small 1973), bibliographic connection (Kessler 1963), co-occurrence of keywords (Callon, Law & Rip 1986) and co-authorship-scientific mapping depict knowledge links in the developing scientific system (Small 1997). Three primary approaches such as co-citation, bibliographic link and co-occurrence of keywords are used in this work.

VOSviewer 1.6.16 (Van Eck & Waltman 2010) and Bibliometrix (Aria & Cuccurullo 2017) were the two analysis tools employed. VOSviewer helps to visualise knowledge maps; Bibliometrix offers a complete analytical tool. Both instruments provide unambiguous presentation of the knowledge network, therefore facilitating efficient data interpretation.

Data collection

Selected for their popularity and strong concentration on economics, management and social sciences, this research gathers SCC data on GSCM using the Scopus database (Martín-Martín et al. 2018; Zhu & Liu 2020). Scopus chooses papers according on standards comparable to those of other trustworthy sources such as Web of Science (Hallinger & Nguyen 2020).

We optimised the search by including synonyms and related phrases. For 'collaboration', we added 'cooperation', 'partnership', 'coordination', 'integration', 'alliances' and 'networking'. For 'green supply chain management', we included 'GSCM', 'sustainable supply chain', 'eco-friendly supply chain' and 'environmental supply chain'.

Search query was designed as follows: TITLE-ABS-KEY ((('collaboration' OR 'cooperation' OR 'partnership' OR 'coordination' OR 'integration' OR 'alliances' OR networking)) AND ((('green supply chain' OR 'GSCM' OR 'sustainable supply chain' OR 'eco-friendly supply chain' OR 'environmental supply chain')).

AND (LIMIT-TO (SUBJAREA, 'BUSI') OR LIMIT-TO (SUBJAREA, 'DECI') OR LIMIT-TO (SUBJAREA, 'SOCI') OR LIMIT-TO (SUBJAREA, 'ECON') OR LIMIT-TO (SUBJAREA, 'ARTS') OR LIMIT- TO (SUBJAREA, 'MULT')) AND (LIMIT-TO (DOCTYPE, 'ar')) AND (EXCLUDE (PUBYEAR, 2024)).

The authors evaluated the system using the PRISMA approach to guarantee consistency and completeness in the assessment process. In systematic research (Pahlevan-Sharif, Mura & Wijesinghe 2019), the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach is extensively employed in processes including reading the literature, finding relevant studies, choosing studies, collecting data and synthesising results. Figure 1 presents the PRISMA-based document screening method.

Our first search from the Scopus database produced 1724 articles; subsequently, we extracted data from a limited number of articles, including the author's name, title, keywords, abstract, publication source, organisation, country,

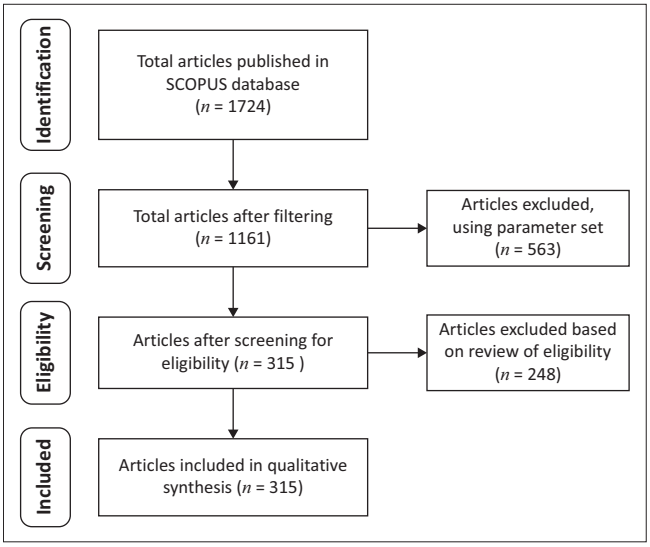


FIGURE 1: PRISMA diagram for supply chain collaboration-green supply chain management resource screening (2000–2023).

year of publication, and reference list, saved in Win format (UTF-8) tab-delimited file.

We search continuously utilising criteria like document type, language, publication date and PRISMA study topic. We only selected English-language articles, particularly in domains like business, management and accounting, economics, decision science, social sciences, arts and humanities, and transdisciplinary research published before the end of 2023. In total, 1161 studies met the follow-up study criteria.

Next, the initial screening process is carried out based on established criteria. Based on the methodology of Gümüş, Gençoğlu and Şahin (2020), we look at the title and summary of each article to determine suitability. We discussed achieving a consensus where the choice or deletion of the item differed. Out of 1161, the end product was 315 papers that finally satisfied the requirements. To do a bibliographic study, we collect information on authors, titles, keywords, abstracts, publishing sources, organisations, nations, year of publication and reference lists of these papers in the parts that follow.

Analysis software

We extracted the bibliographic data from 315 specifically chosen Scopus publications into a composite Excel file. We examine an overview of SCCs in GSCM using Excel, including geographic distribution, growth curves and descriptive metrics, including article genre and author count by nation.

We use the VOSviewer tool to perform a co-citation analysis and citation links. This software is prevalent in scientific research; VOSviewer helps visualise citation and co-citation networks and provides a visual map better to understand the structure and research trends in this field.

Our first search from the Scopus database produced 1724 articles; subsequently, we extracted data from a limited number of articles, including the author's name, title, keywords, abstract, publication source, organisation, country, year of publication and reference list, saved in Win format (UTF-8) tab-delimited file.

Methodological integration and analytical logic

To enhance the transparency and robustness of the bibliometric procedure, this study followed a structured and replicable three-phase methodology that connects data sourcing, analytical design and result interpretation in a coherent flow.

Firstly, data were systematically retrieved from the Scopus database using an inclusive search protocol combining keyword synonyms for both 'supply chain collaboration' and 'green supply chain management'.

For screening and selection, the PRISMA framework (Moher et al. 2009) was used to guarantee scientific rigour. In order to improve reliability and lessen selection bias, this procedure involves two independent reviewers evaluating each article's relevance and discussing any disagreements.

Secondly, the two main pillars of bibliometric methodology performance analysis and science mapping were applied to the cleaned dataset of 315 articles (Cobo et al. 2011; Pritchard 1969). While VOSviewer was utilised for sophisticated mapping of keyword co-occurrence, bibliographic coupling and co-citation associations, Bibliometrix was utilised to produce descriptive statistics and performance indicators (such as top authors, journals, and institutions). To guarantee comparability among clusters, clustering parameters (such as minimum keyword occurrence = 5) and resolution thresholds were standardised.

Thirdly, thematic mapping was used to visualise and interpret the intellectual and conceptual structure of the SCC-GSCM domain. Drawing on the method by Cobo et al. (2011), the thematic diagram plotted clusters based on centrality (degree of connection to other topics) and density (degree of internal development), which allowed us to distinguish between motor themes, emerging areas and niche topics. This mapping enabled a nuanced discussion of research trajectories and thematic transitions over time, as shown in 'Results and discussion' section.

This methodological design integrates rigour and clarity by connecting conventional bibliometric techniques with visual and statistical results. It guarantees replicability and renders the findings comprehensible to readers who may lack familiarity with the technicalities of bibliometric science, thus mitigating worries regarding complexity and augmenting the article's overall effect.

Following this robust methodological framework, the subsequent section delineates the principal conclusions obtained from the bibliometric study. Through the integration of performance indicators and scientific mapping tools, we elucidate the evolution, intellectual framework and thematic priorities of the SCC-GSCM research domain. These findings provide empirical insights on prevailing clusters and neglected areas, as well as a visual representation of the evolution of scholarly focus over time, thereby guiding future research and practical initiatives.

Results and discussion

Growth in the number of scientific articles over the years

The study applies the method of bibliographic analysis (Gümüş et al. 2020) and the calculation of the CAGR to assess the level of development of this sector. An analysis of 1724 articles from SCOPUS shows that the number of

studies on SCC-GSCM tends to increase sharply with a CAGR of 19.57% in the period 2001–2023. Initially, the studies were sporadic, but from 2011 onwards, the number of articles began to increase steadily, reflecting the growing interest in integrating sustainability principles into the supply chain. There was a surge in research from 2019 to 2023, with an emphasis on using digital technology to improve GSCM performance and maximise collaboration (Tsolakis et al. 2022).

From 2001 to 2023, the number of SCC-GSCM studies in the SCOPUS database increased significantly, as shown in Figure 2.

The influence of the expansion of supply chain collaboration-green supply chain management research on sustainable development and prospective trends

The significant increase in SCC-GSCM research reflects the growing academic and practical interest in sustainable supply chain management strategies. In the past, SCC has mainly focused on financial and operational optimisation, but recent research trends have expanded to environmental factors and sustainability responsibility, asserting that SCC not only helps to improve supply chain performance but also contributes to mitigating ecological impacts (Dubey et al. 2022). In addition to the momentum from regulations and market pressures, the development of digital technology has also promoted SCC-GSCM research, opening up flexible cooperation models, helping to improve transparency and efficiency in the supply chain. Digital technology not only optimises operations but also creates the necessary foundation to expand the strategy of cooperation and sustainable development on a global scale (El-Kassar & Singh 2019).

Although the increase in the number of studies reflects a momentary trend, it also indicates a long-term strategic shift in supply chain management. As future research continues to evolve, it should focus on the role of SCC in helping GSCM adapt to market fluctuations while also evaluating how digital technology can be harnessed more effectively to optimise the SCC-GSCM relationship and enhance supply chain resilience to global challenges.

Leading authors and countries in supply chain collaboration-green supply chain management research and global knowledge networks

The development of the supply chain collaboration-green supply chain management study and the role of the lead authors

Research on SCC-GSCM has grown tremendously over the past two decades, with the participation of many scholars across the globe.

The number of citations and the level of direct relevance to the field should be considered when evaluating the effectiveness of authors as not all studies have focused on the SCC-GSCM relationship.

The 2000–2023 data show that Joseph Sarkis (US) is the author with the highest total number of citations (TC = 2229, h-index = 5, m-index = 0.250). Prior to 2012, his research focused primarily on GSCM, but the Zhu, Sarkis and Lai study (2012) marked a turning point when it first demonstrated a causal relationship between SCC and GSCM. This work lays the foundation for the integration of SCC into GSCM strategies, creating a significant impact in the field.

Zhu (China) is the author with the highest research performance (TC = 1755, h-index = 7, m-index = 0.467), focusing on how SCC helps businesses transform environmental pressure into green action. Kee-Hung Lai (China) has also made important contributions, especially in optimising sustainable logistics through SCC. The authors, Singh (India), El-Kassar (India), and Jabbour (Brazil), are pioneers in the field of studying how digital technology may be integrated into SCC-GSCM, specifically how blockchain and artificial intelligence can be used to improve operational efficiency and transparency.

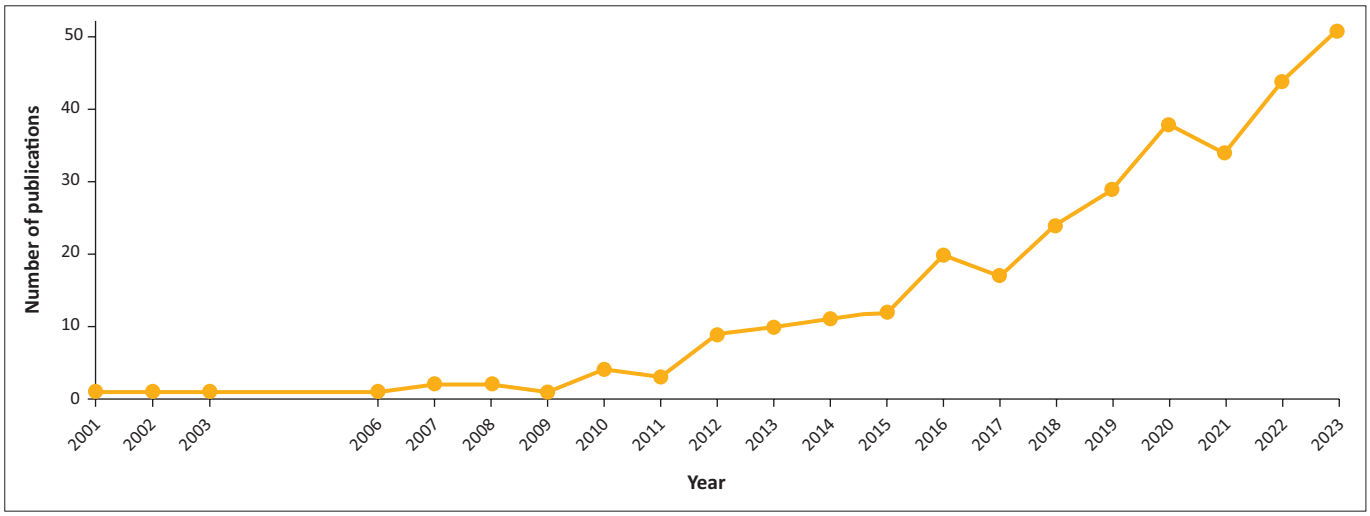


FIGURE 2: Research papers on supply chain collaboration and green supply chain management in SCOPUS.

However, the main focus of their research is on the impact of technology on GSCM, rather than the relationship between SCC and GSCM. Not all highly cited studies have a major influence on the SCC-GSCM (this will be clarified in 'The most influential documents in the supply chain collaboration-green supply chain management study' section). Table 1 summarises the research performance of leading authors in the field of SCC-GSCM.

Supply chain collaboration-Green supply chain management research trends and collaboration network

Analysis from VOSviewer (Figure 3) shows that Sarkis and Zhu are the two central authors connecting scholars from North America, Europe and Asia. The United States and China lead in the number of international research and collaborations, while Brazil and India are emerging with studies on digital transformation and technology applications in the SCC-GSCM. The trend of cooperation in the Asian region (especially between China, Taiwan and India) is increasing, while North America and Europe continue to play a leading role in theory and experimentation.

With a focus on SCC-GSCM optimisation and the integration of modern technologies, the years 2014–2023 mark a shift from theoretical research to practical application. The use of technology has improved the operational efficiency, traceability and transparency of SCC-GSCM. This emphasises how urgently further in-depth research is required to ascertain how digital technology could optimise SCC-GSCM. As a result, the next section will examine the most influential papers and present an overview of the SCC-GSCM knowledge network.

TABLE 1: Productivity of authors in supply chain collaboration and green supply chain management (2000–2023).

Author	Country	h-index	m-index	TC	NP	PY_start
Joseph Sarkis	United States	5	0.250	2229	5	2003
Qinghua Zhu	China	7	0.467	1755	7	2008
Kee-Hung Lai	China	6	0.400	1362	6	2008
C.J.C. Jabbour	Brazil	6	0.600	1139	6	2013
Abdul-Nasser El-Kassar	India	2	0.500	1048	2	2019
Sanjay Kumar Singh	India	2	0.500	1048	2	2019
De Sousa Jabbour A.B.L.	Brazil	2	0.286	755	2	2016
Wu G.-C.	Taiwan	2	0.182	570	2	2012
Searcy C.	Canada	1	0.100	1053	1	2013
Ahi P.	Canada	1	0.100	1053	1	2013

Note: m-index is the h-index's variation, signifying the average annual level of influence since the initial article. The total citation is the sum of all citations, which indicates the impact of science. Based on the quantity of articles with at least h citations, the h-index calculates the author's influence.

TC, total citations; NP, number of papers; PY_start, year of publication of the initial paper; h-index, hirsch index measuring author impact; m-index, h-index divided by academic career length (average annual impact).

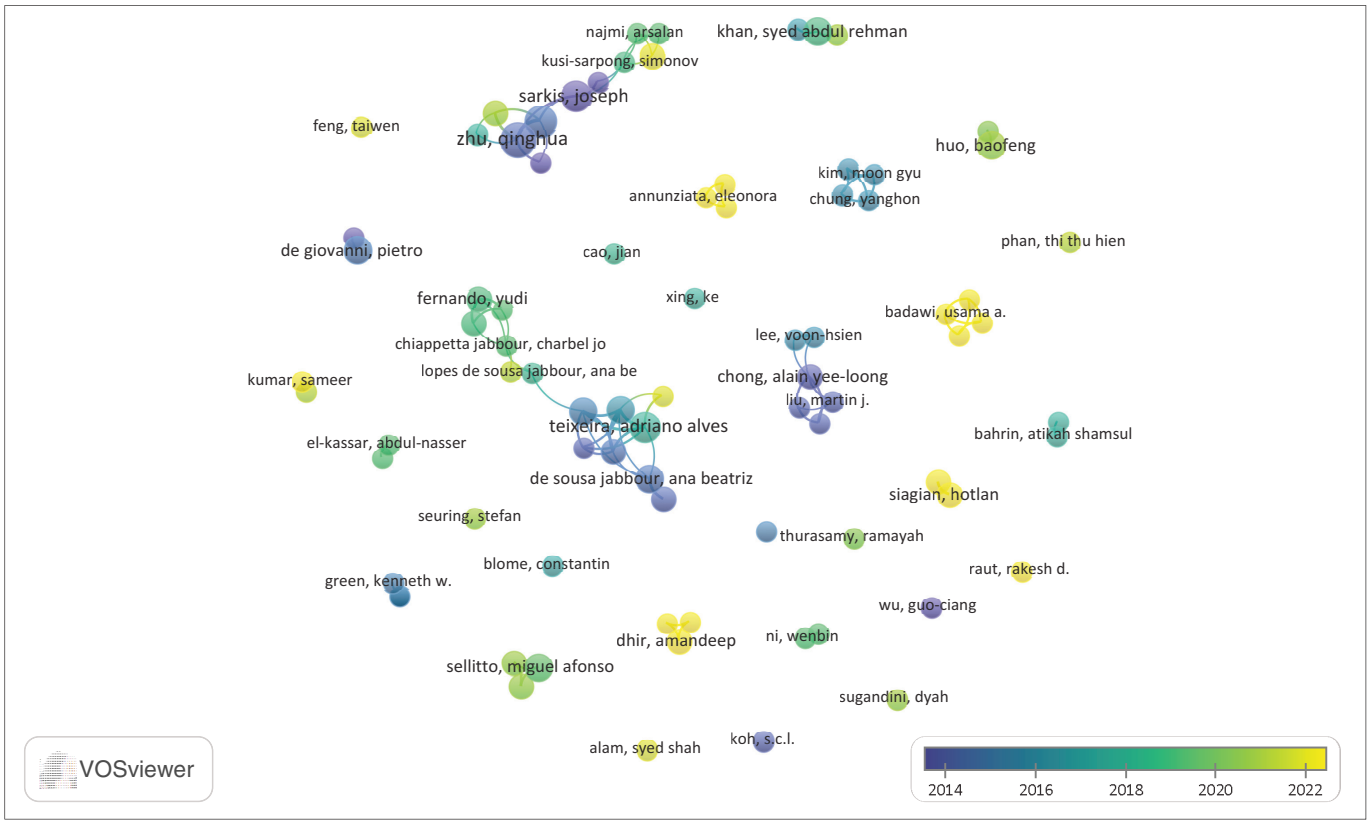


FIGURE 3: Top most authors: Affiliation.

The most influential journals in supply chain collaboration-green supply chain management research and knowledge networks

Academic journals play an important role in shaping and developing knowledge about SCC-GSCM. The assessment of the journal's impact is not only based on the total number of citations but also must consider the proportion of SCC-GSCM-focused articles, the level of knowledge diffusion and the connection in the global research network.

Data from the period 2000–2023 show that *the Journal of Cleaner Production (JCP)* is the most influential journal, with TC = 5873, h-index = 22, g-index = 26 research articles, of which 19 articles (73%) focus on SCC-GSCM. This is a leading journal on sustainable development, attracting many studies on integrating SCC into GSCM to optimise green supply chain performance. For instance, Lin's (2013) study on the *JCP* used the DEMATEL fuzzy to analyse the SCC-GSCM, which helps to identify important synergistic factors in the GSCM. The key journals contributing to SCC-GSCM research are summarised in Table 2, highlighting their citation impact and scholarly influence.

Sustainability had the highest number of articles (27 articles), with 16 articles (59%) related to SCC-GSCM. Despite the wide scope of research, this journal still has important contributions, especially the research by Liu et al. (2023), which synthesises the SCC-GSCM literature, emphasising the role of information sharing, decision synchronisation and incentive alignment in green supply chain optimisation.

Two other journals with significant impact are *the International Journal of Production Economics (IJPE)* and *the International Journal of Production Research (IJPR)*. In addition, *Technological Forecasting and Social Change (TFSC)* and *Transportation Research Part E (TRPE)* also have a great influence when researching the role of digital technology, green logistics and forecasting models in SCC-GSCM.

Supply chain collaboration-green supply chain management knowledge network and research trends

Knowledge network analysis from VOSviewer (Figure 4) shows that JCP is the centre of the SCC-GSCM knowledge system, with a high level of connectivity with *IJPR, IJPE, TFSC* and *Supply Chain Management*. The SCC-GSCM research trend is shifting strongly towards the integration of

TABLE 2: Top journals in supply chain collaboration-green supply chain management research (2000–2023).

Journal	TC	NP	h-index	g-index	m-index
Journal of Cleaner Production	5873	26	22	26	1.10
International Journal of Production Economics	1674	9	9	9	0.81
International Journal of Production Research	1059	6	6	6	0.28
Technological Forecasting and Social Change	1043	3	3	3	0.75
Industrial Marketing Management	713	5	5	5	0.45
Sustainability	695	27	15	26	1.66
Supply Chain Management	684	7	7	7	0.70
Transportation Research Part E	600	7	7	7	0.70
Business Strategy and the Environment	572	9	9	9	0.69

TC, total citations; NP, number of papers; h-index, hirsch index measuring author impact; m-index, h-index divided by academic career length (average annual impact); g-index, variant of h-index giving more weight to highly cited articles.

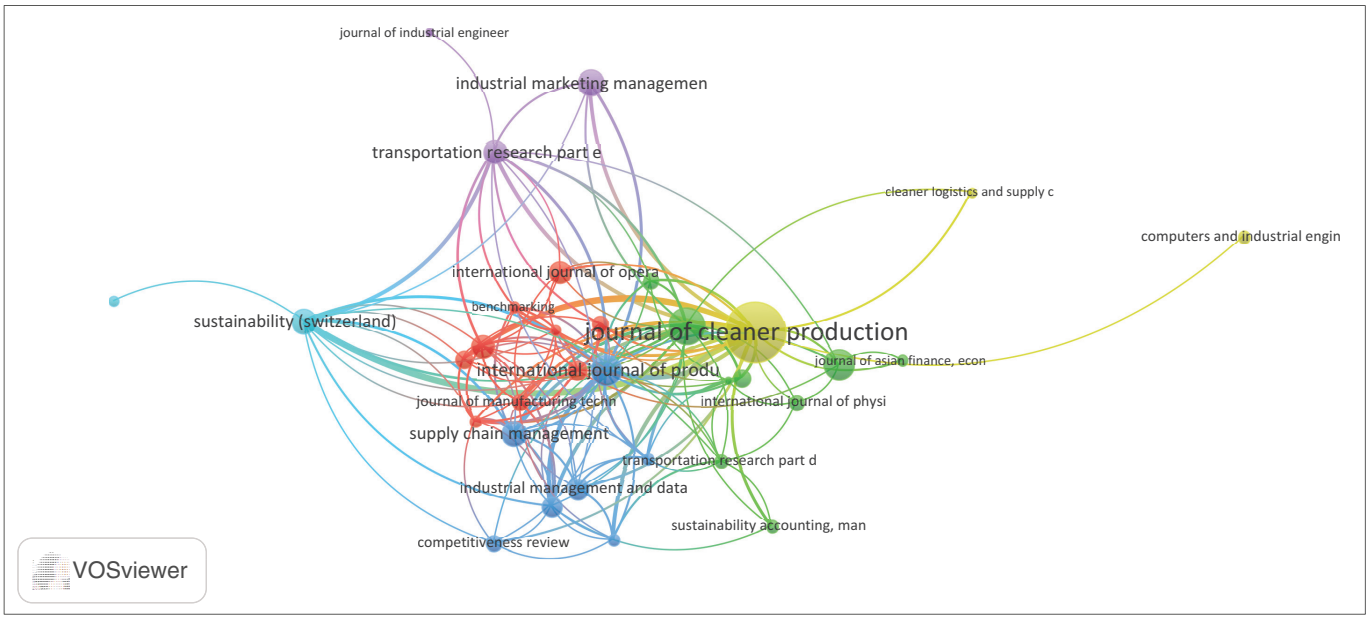


FIGURE 4: Topmost journals: Affiliation.

technology, with typical studies such as those of Holling and Backhaus (2023) helping to shape the role of digital technology in green supply chain cooperation.

The dominance of prestigious journals not only reflects the influence of science but also orients future research. Future research may focus on digital technology applications to build smart supply chain cooperation models. The most important research in the SCC-GSCM will be evaluated, which is described in 'The most influential documents in the supply chain collaboration-green supply chain management study' section.

The most influential documents in the supply chain collaboration-green supply chain management study

The identification of high-impact studies helps to systematise knowledge and orient research trends in the field of SCC-GSCM. However, not all studies with high citations have focused on the SCC-GSCM. Some of the works are broader in scope, mainly referring to sustainability management, green innovation, or supply chain performance. Meanwhile, many studies have lower citations but play an important role in clarifying the mechanism of impact of SCC-GSCM. Table 3 presents a comparative overview of the most influential studies contributing to SCC-GSCM research.

Studies that have an impact on supply chain collaboration-green supply chain management

Data from 2000–2023 show a number of typical studies that directly analyse the SCC-GSCM relationship. Zhu et al. (2012) with 490 citations is the first experimental work to demonstrate that SCC has a significant impact on GSCM practice, especially in enterprises under environmental pressure. In addition, Chen et al. (2017) with 482 citations conducted a comprehensive literature review, systematised studies on supply chain collaboration for sustainability (SCC-GSCM), analysed key factors in the SCC-GSCM, and proposed future research directions.

In contrast, Lin (2013), who cited 556 sources, evaluated GSCM methods using the DEMATEL technique, highlighting the importance of SSC in maximising green management.

A Strategic Decision Framework for Green Supply Chain Management (Sarkis 2003), which has 1085 citations and mostly discusses sustainable supply chain management, is one study that has a large number of citations but a broader focus. Alternatively, *A Comparative Literature Analysis of concepts for Green Supply Chain Management* (Ahi & Searcy's 2013) (1053-citation), which synthesises and analyses GSCM concepts, offers a useful theoretical framework but does not explicitly examine the SCC-GSCM.

The relationship between supply chain collaboration-green supply chain management and findings from studies

The study by Zhu et al. (2012) played a fundamental role in demonstrating the causal relationship between SCC and GSCM for the first time, emphasising that SCC not only helps businesses comply with environmental regulations but also promotes sustainable innovation and minimises negative environmental impacts.

Chen et al. (2017) synthesised and systematically analysed studies on SCC-GSCM, identified the key factors in this relationship, and proposed a future research programme to optimise sustainable supply chain cooperation. Meanwhile, recent studies, such as Lin (2013), have applied methods like DEMATEL and coordinated channel optimisation to determine the impact of SCC on GSCM, emphasising the role of digital technology in promoting SCC-GSCM.

Future supply chain collaboration-green supply chain management research directions

The aforementioned analysis shows that in the future, SCC-GSCM research needs to focus on the impact of technology 4.0, especially how IoT, Big Data, Blockchain and AI can drive SCC-GSCM. The development of smart collaboration models, applying digital technology to optimise sustainable performance, will be an important research direction to promote SCC-GSCM and optimise supply chains in a volatile global context. In addition to supporting the study of the most significant writers and journals in the SCC-GSCM ('Leading authors and countries in supply chain collaboration-green supply chain management research and global knowledge networks' and 'The most influential journals in supply chain collaboration-green supply chain management research and knowledge networks' sections), the results in this part also serve to guide future studies in the direction of a more intelligent and sustainable green supply chain collaboration model in the age of digital transformation.

TABLE 3: Relevance of high-impact studies to the supply chain collaboration-green supply chain management (2000–2023).

Article title	Author	Journal	Year	Rank	GC	SCC-GSCM Relevance
Examining the effects of green supply chain management practices and their mediations on performance improvements	Zhu and Sarkis	*International Journal of Production Research*	2012	Q1	436	High
Supply chain collaboration for sustainability: A literature review and future research agenda	Chen et al.	*International Journal of Production Economics*	2017	Q1	404	High
Using fuzzy DEMATEL to evaluate the green supply chain management practices	Lin R.-J.	*Journal of Cleaner Production*	2013	Q1	556	High
A strategic decision framework for green supply chain management	Sarkis	*Journal of Cleaner Production*	2003	Q1	1085	Average
A comparative literature analysis of definitions for green and sustainable supply chain management	Payman Ahi, Cory Searcy	*Journal of Cleaner Production*	2013	Q1	1053	Average

SCC, supply chain collaboration; GSCM, green supply chain management; GC, Google Scholar citations.

Thematic trends in supply chain collaboration and green supply chain management research

Keyword analysis from 315 scientific papers using co-word analysis (Van Eck & Waltman 2010) sheds light on key trends in SCC and GSCM research. The results not only define the focus of the study but also show the close relationship between SCC and GSCM, reflecting the parallel development between SCC and sustainable management strategy in a common ecosystem, which is increasingly impacted by technology.

The relationship between supply chain collaboration and green supply chain management and the thematic structure

According to the data in Figure 5, 'Supply Chain Management' is the most common keyword (160 occurrences, 751 links), followed by 'Green Supply Chain Management' (146 occurrences, 567 linkages).

This illustrates that GSCM is transitioning from a supplementary component of supply chain management to a core concept that is transforming the planning and operation of supply chains within enterprises. The phrase 'Supply Chain Collaboration' appears 18 times with 70 connections, indicating that while SCCs are less common than GSCM, they are significantly associated with sustainability concerns and provide greater flexibility in supply chains when adopting GSCM methodologies.

The keyword network in Figure 6 highlights the direct link between 'SCC' and 'GSCM', demonstrating their strong connection in 'sustainable supply chain management'. Terms like 'Environmental Performance', 'Sustainability', 'Manufacturing' and 'Decision Making' frequently appear together, emphasising 'SCC's' essential role in implementing sustainability strategies. The presence of 'Big Data' in the network shows that technology not only supports but also connects 'SCC' and 'GSCM'. It helps improve decision-making, forecasting, and real-time measurement of sustainable impacts. This confirms that combining 'SCC', 'GSCM' and 'technology' is changing supply chain operations, moving from traditional collaboration to 'intelligent data-driven platforms' for better sustainability.

Key topic clusters from keyword analysis in the supply chain collaboration-green supply chain management study (2000–2023)

The examination of the keyword phrase in Figure 7 revealed four primary research clusters, reflecting the fundamental tendencies in the evolution of SCC-GSCM.

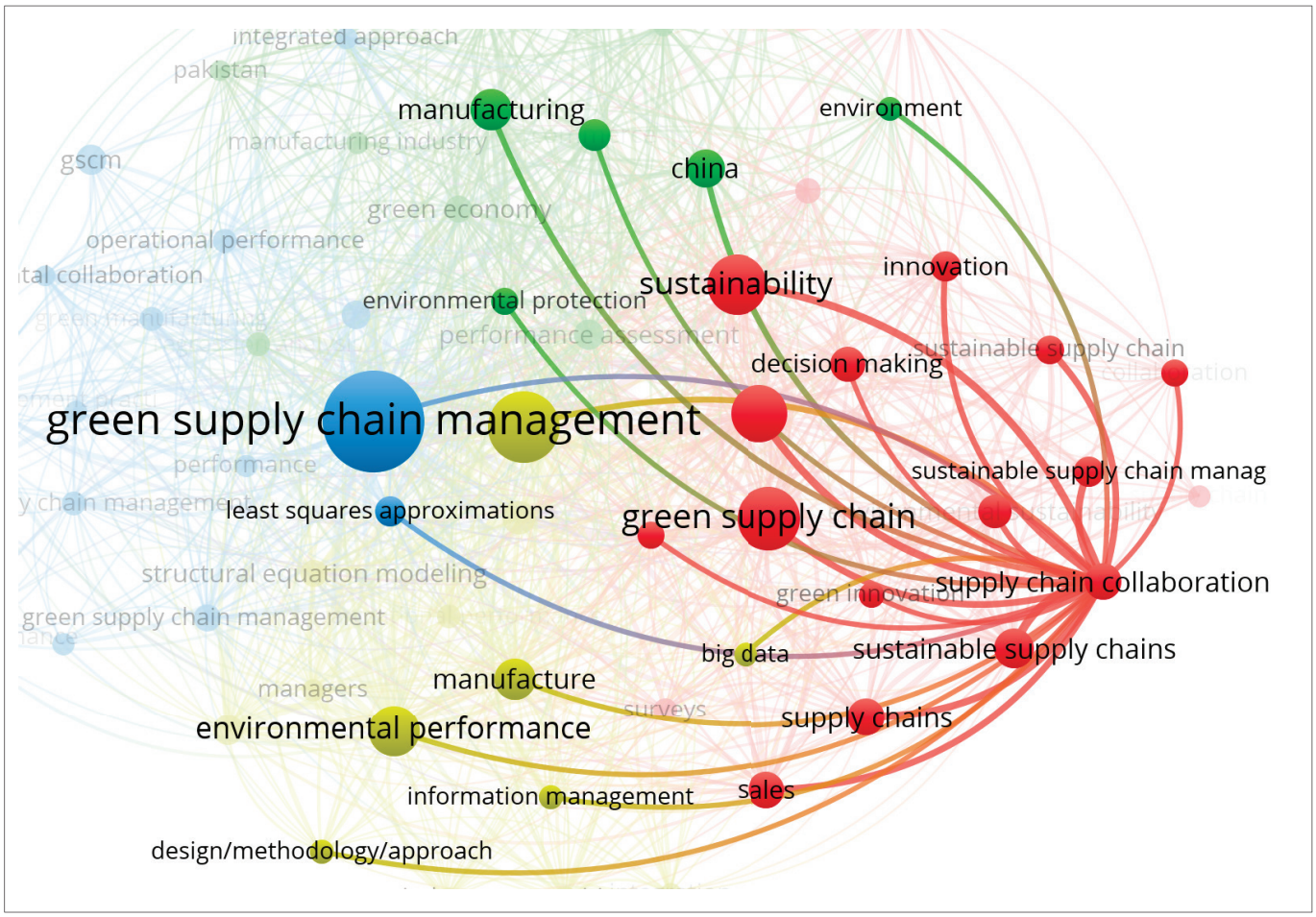
Cluster 1: Strategic collaboration in sustainable supply chains

The cluster includes terms such as 'Sustainability', 'Decision Making', 'Collaboration' and 'Sustainable Supply Chains', indicating that the SCC serves as both an operational framework and a vital strategy for achieving sustainability goals. The emergence of the keyword 'Brazil' indicates that emerging economies are significantly contributing to the testing and application of the SCC-GSCM model by demonstrating that the scalability of these initiatives transcends developed economies and can adapt to different economic and policy contexts.

Verify selected keywords

Selected	Keyword	Occurrences	Total link strength
☑	supply chain management	160	751
☑	green supply chain management	146	567
☑	environmental management	72	389
☑	green supply chain	55	176
☑	sustainability	50	215
☑	sustainable development	46	284
☑	environmental performance	36	212
☑	manufacture	22	150
☑	manufacturing	22	123
☑	sustainable supply chains	21	128
☑	china	19	91
☑	supply chains	18	109
☑	supply chain collaboration	18	70
☑	sales	17	109
☑	environmental impact	17	97
☑	decision making	16	74
☑	performance assessment	15	93

FIGURE 5: Keywords analysis.



SCC, supply chain collaboration; GSCM, green supply chain management.

FIGURE 6: Keyword co-analysis supply chain collaboration and green supply chain management.

Cluster 2: Application of green supply chain management in the industrial sector

This cluster focuses on how 'GSCM' is used in manufacturing and how it affects business profits. The main keywords are 'China', 'Manufacturing', 'Green Economy' and 'Firm Performance'. The frequent mention of 'China' shows that the country plays a big role in global manufacturing and is also leading in green industry policies.

Cluster 3: Environmental collaboration and supply chain performance

This cluster looks at how businesses work together to make their supply chains more environmentally friendly. Important keywords include 'Green Supply Chain Management', 'Environmental Performance', 'Green Buying' and 'Environmental Collaboration'. This shows that companies are not just trying to reduce pollution on their own but are working with suppliers and partners to do it together. By choosing greener materials, improving production processes and following sustainable policies, businesses can both protect the environment and improve their profits.

Cluster 4: Digital transformation and expansion of supply chain collaboration-green supply chain management

This cluster includes keywords such as 'Big Data', 'Information Management' and 'Integration', emphasising that digital technology is not only supporting but also reshaping the way SCC and GSCM are implemented.

The appearance of the keyword 'Big Data' shows that big data is now an important tool for making strategic decisions. It helps improve forecasts, use resources better and make supply chains more flexible. These technologies support the growth of SCCs and make GSCM work more efficiently, especially when companies face high costs and challenges in going green.

Figure 7 also reveals dense links between *decision making*, *sustainability* and *environmental performance*, confirming that policy frameworks and organisational culture remain decisive enablers beyond digital tools. By contrast, only sparse ties connect 'big data' to practice-oriented nodes such as *manufacturing* and *firm performance*, signalling capability gaps and investment barriers in data-driven adoption. Recent empirical work points to three remedies: (1) targeted government incentives that lower the cost of green-supplier integration (Li & Zhong 2024); (2) supplier development programmes that embed joint environmental goals and build process capabilities (Vachon & Klassen 2008) and (3) phased pilots of IoT, CPS and blockchain that let firms scale Industry 4.0 solutions progressively (Ghadge et al. 2022).

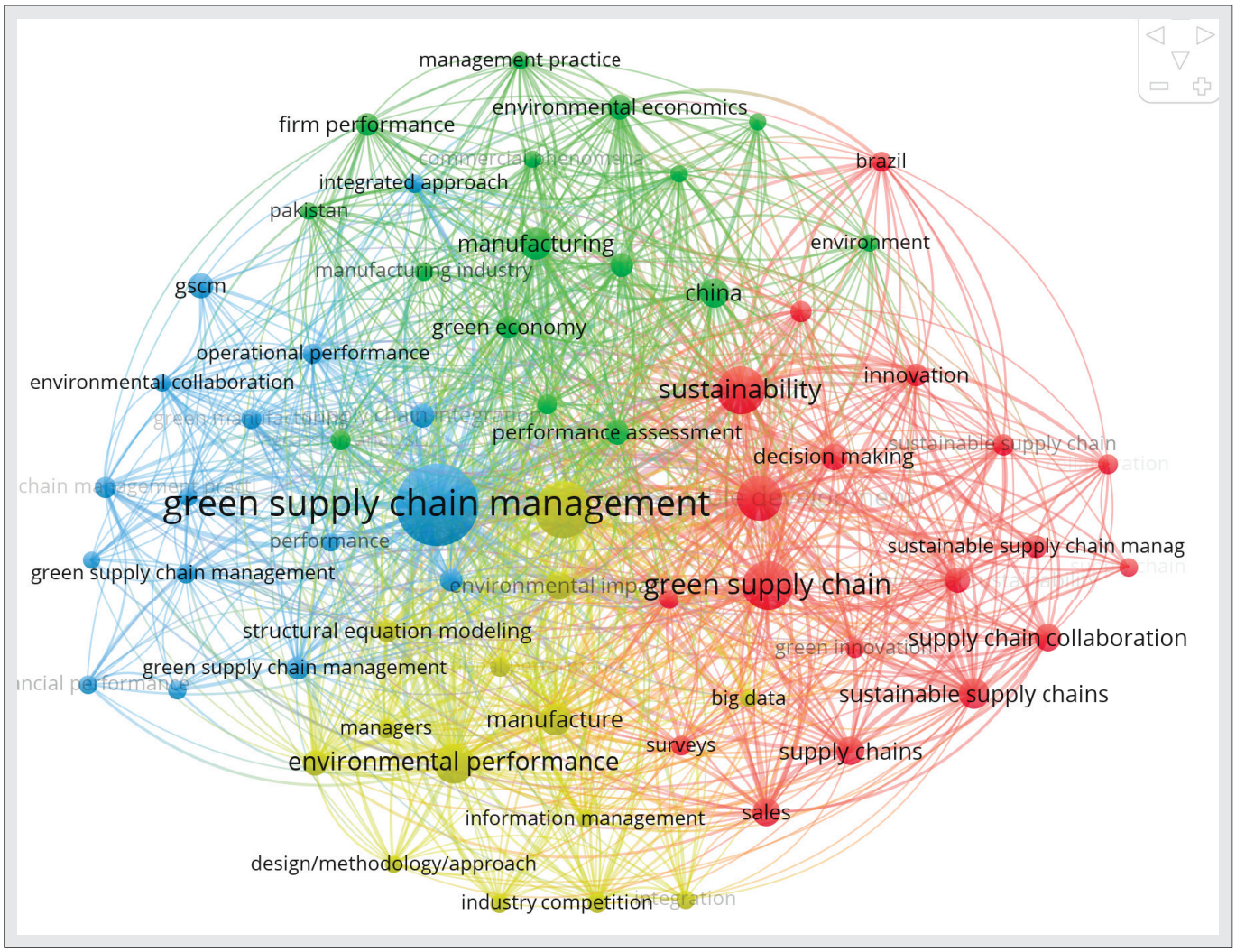


FIGURE 7: Keyword co-analysis.

Empirical reflections of keyword clusters: The four theme clusters listed above correspond closely with recent large-sample research. Cluster 1 (strategic collaboration) is supported by Zhu, Sarkis and Lai (2008), whose study of 341 Chinese manufacturers substantiates a multi-dimensional measurement model for GSCM implementation, affirming information-sharing and decision synchronisation as performance drivers. Cluster 2 (industrial GSCM) reflects the findings of Li and Zhong (2024), which demonstrate that green supplier integration enhances environmental performance more significantly than supplier selection, particularly when bolstered by government backing, across 391 manufacturing enterprises. Cluster 3 (environmental collaboration) aligns with Vachon and Klassen (2008), demonstrating an empirical connection between collaboration with upstream suppliers and process-oriented manufacturing improvements. Cluster 4 (digital transformation) is corroborated by Ghadge et al. (2022), who, utilising a sample of 243 European automotive specialists, illustrate that Industry 4.0 technologies (IoT, CPS, blockchain) indirectly improve GSC performance via green practices. These convergences offer indirect empirical corroboration for the bibliometric results.

Trends over time: Shifting to digital collaboration for faster sustainability: Figure 8 shows a clear change in SCC-GSCM research over time. Before 2017, most studies focused on 'green supply chain management', 'sustainability' and 'environmental performance'. This means earlier research mainly explored how businesses could reduce pollution and support long-term environmental protection. The focus was on finding ways to lower pollution, improve waste management and make production more eco-friendly. Over time, the research has shifted towards using digital tools and technology to improve collaboration, making sustainability efforts faster and more effective.

However, the increase of the buzzwords 'Big Data', 'Collaboration' and 'Supply Chain Integration' since 2019 indicates a new trend: technology and cooperation are becoming the primary drivers of sustainable supply chains. This shift not only reflects the growing interest in optimising data-driven decision-making and sustainable management but also underscores that digital technology is closely linking SCC and GSCM, promoting coordination between supply chain parties to meet sustainability standards more effectively. This confirms that SCC-GSCM in the new era is

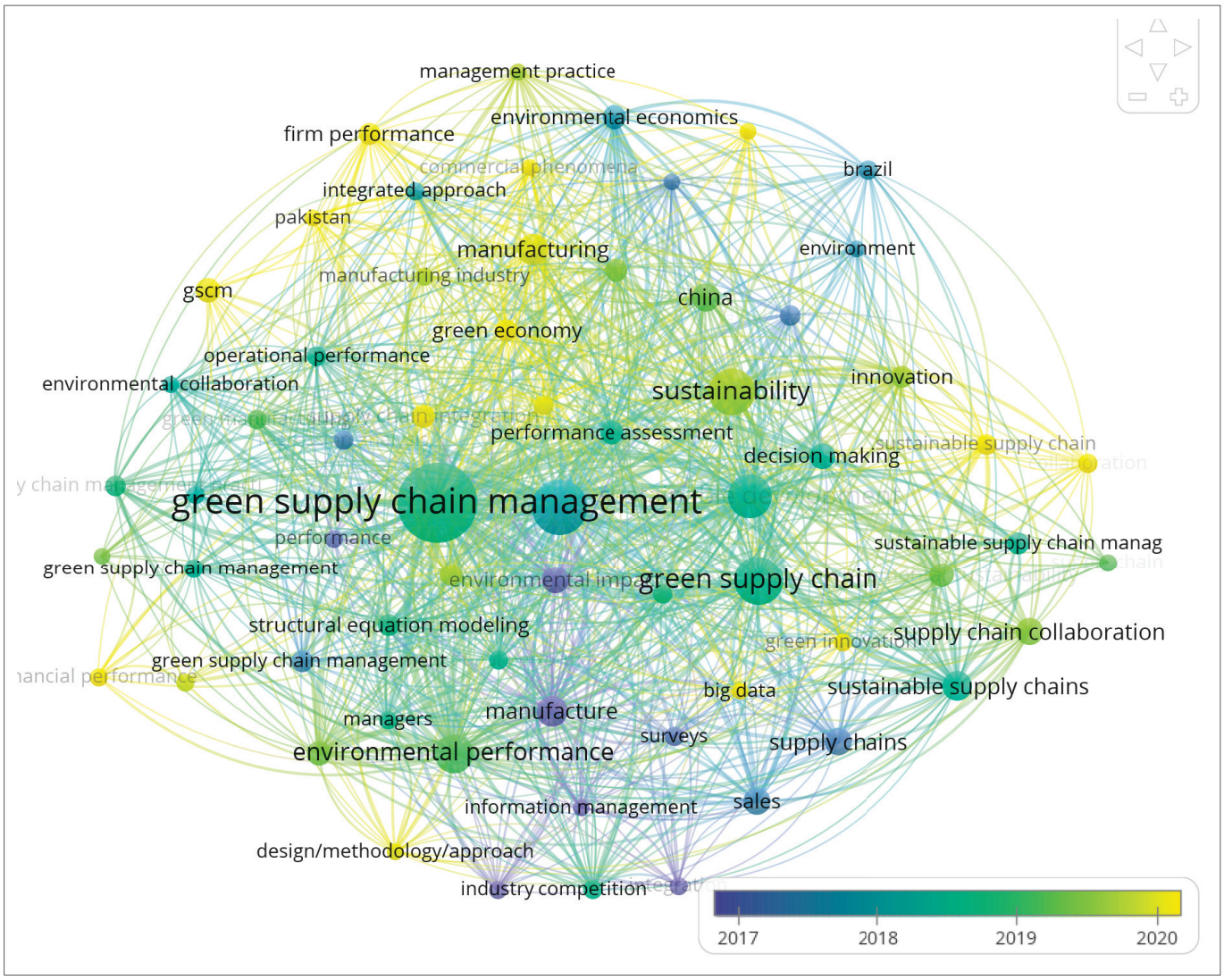


FIGURE 8: Overlay network of keyword co-occurrence.

not just an operational strategy, but an intelligent data-based collaboration system, helping the supply chain to both achieve high performance and meet increasingly stringent sustainability requirements.

Future research direction

Digital transformation and the development of supply chain collaboration-green supply chain management

The results of the study show the close relationship between SCC and GSCM, emphasising the important role of SCC in improving sustainable performance. The convergence of these two fields does not take place naturally but is driven by many factors, especially the development of technology 4.0. Modern technologies not only change the way we collaborate but also help optimise operational processes and increase long-term performance. Therefore, the future research direction needs to clarify how SCCs can support and enhance GSCM and consider the intermediary role of technology in promoting this integration to help supply chains adapt more effectively to global challenges.

Application of technology 4.0 and smart collaboration model in supply chain collaboration-green supply chain management

Technology 4.0 not only plays a supporting role but also is a decisive factor in promoting the integration between SCC and GSCM. Artificial intelligence and Big Data help improve forecasting and decision-making capabilities, supporting supply chain partners to synchronise sustainable strategies. Blockchain helps make supply chains more transparent and trustworthy, while 'IoT' provides real-time data to track environmental impact and use resources more efficiently in 'GSCM'. However, differences in technology between partners, especially small businesses, can make 'SCC-GSCM' integration difficult. Relying too much on data can also reduce flexibility when the economy changes. To solve this, businesses need strategies that balance performance and flexibility. Besides technology, success also depends on strong partnerships, fair benefit-sharing and supportive policies. Future research should focus on building a smart cooperation model where technology improves teamwork and keeps green supply chains stable and sustainable.

Future study should investigate a combination of institutional and strategic strategies to address the technology differences, high implementation costs, and potential rigidity associated with digital transformation in SCC-GSCM integration. According to Kannan and Gambetta (2025), SMEs may overcome adoption barriers and participate in green collaboration by implementing capacity-building efforts like digital upskilling, technical consultancy and subsidised training programmes. In parallel, policy instruments, including tax incentives, green financing and targeted subsidies, can lower the financial burden of advanced technology deployment (Wu, Rahman & Lee 2024). Furthermore, promoting modular and cloud-based technology architectures allows for phased investment, while establishing interoperable and flexible data-sharing frameworks can preserve supply chain agility in volatile environments (Wang, Zhang & Lin 2025). Lastly, public–private partnerships (PPPs) offer an effective mechanism for resource sharing and co-development of sustainable innovations across sectors. These approaches provide a viable roadmap to mitigate implementation challenges and ensure the long-term success of SCC-GSCM integration.

Strategic direction for supply chain collaboration-green supply chain management in the future

The digital transformation landscape is blurring the boundaries between SCC and GSCM, making these two sectors no longer operate separately but are gradually converging into a more sustainable and flexible supply chain system. However, in order for this process not to be hindered by external factors, future research should focus on identifying the necessary conditions to ensure that the SCC-GSCM integration takes place effectively, delivering economic benefits while maintaining a commitment to sustainability.

One of the key priorities is to develop a flexible SCC-GSCM model, leveraging technology to optimise coordination without creating barriers between businesses with different capabilities. At the same time, empirical studies are needed to evaluate how intermediary technology factors can regulate the SCC-GSCM relationship, thereby proposing a cooperation model suitable for green logistics and the circular economy.

Finally, in the face of increasing volatility in global supply chains, future research needs to clarify the role of digital technology in promoting or coordinating the integration between SCC and GSCM. This is to ensure that this convergence is not just a temporary trend but actually becomes a sustainable driving force, helping the supply chain achieve optimal performance in the long term.

Although the present study is bibliometric, the alignment between its clusters and established empirical findings strengthens construct validity. Future longitudinal surveys and embedded case studies should examine how these digitally enabled collaboration mechanisms causally translate into environmental and economic gains across diverse supply chain contexts.

Conclusion

This study provided a comprehensive and systematic view of the relationship between SCC and GSCM. These are two important pillars that have promoted sustainability in modern supply chains over the past two decades. Through a bibliographic analysis of 1724 articles from the Scopus database (2000–2023), the study clarified the development of the field, identifying influential authors, important journals, as well as core themes and key trends in SCC-GSCM research.

The fact that our science-mapping results echo the well-cited empirical studies further reinforces their practical relevance and provides a robust foundation for subsequent hypothesis-driven research.

The results show that SCC and GSCM do not exist as two separate fields but are increasingly converging. This is reflected in the three stages of development and boom in the recent period (2019–2023) with a CAGR of 19.57%. The study identified four main research clusters: strategic collaboration in sustainable supply chains, application of GSCM in industry, environmental cooperation and supply chain performance, as well as the expansion of SCC-GSCM under the impact of digital technology. In particular, the number of research related to technology and global knowledge networks has increased significantly, reflecting the shift of supply chains from traditional environmental issues to technology-driven collaborative solutions to promote SCC-GSCM. The fact that emerging economies like Brazil and India are also placing a high priority on digitalisation and green supply chain transformation, in addition to countries with long history of research like the United States and China, demonstrates the globality of SCC-GSCM. The increasing diversity and integration of the research collaboration network is laying a crucial foundation for the development of successful and sustainable cooperation models.

These results support the study's conclusion that combining SCC and GSCM is a long-term approach to creating a more robust and sustainable supply chain, not merely a passing fad. However, this convergence process does not occur naturally but depends on many intermediate factors, in which technology acts as an important catalyst, promoting collaboration and optimising sustainable performance. Therefore, future studies should focus on clarifying how SCC can support and improve the effectiveness of GSCM, and evaluate the influence of mediating factors, especially the role of technology 4.0 in promoting the SCC-GSCM relationship. These orientations not only make an important contribution to the SCC-GSCM theory but also bring high practical value in the context of increasingly complex and interconnected global supply chains. They help businesses leverage technology to maximise collaboration, improve performance, and achieve sustainability goals.

Although this study maps the intellectual structure of SCC-GSCM, causal links remain to be tested. Future work should combine longitudinal case studies with large-sample surveys to verify the mechanisms identified here and to integrate non-technological enablers such as policy incentives, organisational culture and capability-building schemes into technology-driven models. Such triangulation will clarify theoretical tensions and offer actionable guidance to managers and policymakers.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

D-N.N., T-T.M. and H-H.H. contributed to conceptualisation, writing, review and editing, validation and supervision. D-N.N. and T-T.M. contributed to formal analysis. T-T.M. contributed to investigation, writing of the original draft and rewriting, visualisation, data curation, resources and software. H-H.H. contributed to data curation and D-N.N. contributed to funding acquisition.

Ethical considerations

Ethical approval was not required for this study, as it did not involve human participants, animals, or any sensitive data. All data used are from publicly available sources and appropriately cited.

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Data availability

The data that support the findings of this study are available on request from the corresponding author, T-T.M.

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