



The Nexus between Green Supply Chain Management and Sustainability Performance in the Past Decade

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Abstract: Purpose: considering the resource-based view, embracing green supply chain management (GSCM) influences a firm's performance (FP). This study finds the nexus between GSCM and FP by analyzing the reporting trends among the authors, countries, and sources along with collaboration among countries and authors, the emerging topics, and different themes in this field with their impact, centrality, and density. Lastly, it probes into the different methodologies, affiliating concepts, influencers, drivers, and impacts of GSCM through content analysis. Design/methodology/approach: this paper spotted 1518 documents narrowed down to 938, pertinent to GSCM and performance, utilizing the Scopus database. It uses sources, authors, word analysis, coupling, network analysis of keywords, social structure, and conceptual structure analysis in the Biblioshiny package of Rstudio (Version 4.4.0) to identify the progress in the fields spanning through the decade (2014–2023). Moreover, content analysis has been used to study the concepts and contexts of different themes identified through thematic analysis. Findings: the study found Journal of cleaner production in sources, Sarkis in authors, and China in countries to have the highest no. of documents. Closed-loop, digital, and circular supply chains and Industry 4.0 have been identified as the trending topics. Moreover, the key themes identified are (1) Supply Chain Optimization Models for Sustainability, (2) Affiliating concepts to, and the relationship between, Sustainable Supply Chain Strategies and TBL Performance in Manufacturing Sectors of Developing Countries, (3) Life Cycle Analysis of Natural-Resource Based Supply Chains for Sustainability Assessment on TBL, and (4) Factors Influencing and Performances Impacted by GSCM. Originality/Value: this research adds to the previous literature by analyzing both the concepts of GSCM and FP collectively, and finding new themes in between their intersection. Implications: it will direct future researchers in choosing the right theme, methodology, intervening variables, affiliating concepts, and country and author collaboration for the fields related to GSCM and FP.

Keywords: green supply chain; firm performance; sustainable supply chain; bibliometrix; review; Biblioshiny; triple bottom line

1. Introduction

1.1. Emergence and Relevance of GSCM

Due to the increased sensitivity of climate change concerns on global platforms, international conventions like the UNFCCC are acting as protagonists in the war against climate change and undertaking many treaties like the Montreal Protocol and Kyoto Protocol to curb the climate change effects [1]. Talking from the viewpoint of institutional theory, the stakeholders of the companies like government organizations, customers, and investors are becoming aware of the sensitivity of the issue and are thus exerting more pressure on the companies to go green [2]. It becomes imperative for organizations to embody sustainability concerns in their workings, as they render a weighty position in leading the world



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Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). toward a sustainable future and preventing it from the wrath of climate change effects [3]. The companies' divergent SC activities, from the input acquisition/extraction stage to the eventual disposal of the goods by the consumers, are majorly responsible for various types of environmental and social degradation. The extraction process involved in the mining of various materials like lithium, iron ore, copper, aluminum, nickel, cobalt, silver, fossil fuels, etc. leads to wastage, open pits, and underground workings; water wastage, due to the high requirement for fresh water in the mining process; disturbance to biodiversity, due to construction of mining infrastructure and, transportation activities; disturbance to the social lives of people living in close proximity of the mines; and constraining the land use where residential complexes could be built or where it could be used for agriculture [4]. Moreover, unplanned purchasing of goods can lead to severe damage to the environment. Therefore, the focal company should consider the green practices followed by the suppliers of the inputs, which could otherwise lead to neglecting the embodied emissions of the finished products. The fossil-fuel-based modes of transportation used for inbound and outbound logistics lead to the discharge of various greenhouse gases (GHGs) [5]. The production process undertaken in various industries leads to the gush of GHGs, water wastage, noise pollution, and soil pollution. For instance, the calcination process involved in the manufacturing of cement leads to a lot of carbon emissions [6]. Similarly, the blast furnace-basic oxygen furnace method used to manufacture iron and steel has a high global warming potential [7]. The packaging industry radically consumes synthetic polymers that are sourced from fossil fuels. The vast majority of plastic trash damaging the environment consists of food packaging plastics. In addition, contemplating the finite nature of petroleum reserves and their impending depletion, it is essential to explore the development of other substances that may fulfill the same function as customary plastics [8]. This stimulates the pursuit of GSCM, which inculcates environmental consideration in an enterprise's operations and SC activities [2,3]. The term gained popularity in the last two decades, and is an evolving concept [3]. Various authors have provided many explanations of GSCM and green supply chain practices. There are multiple terms found affiliated with this concept, like eco-design (ED) [2], green warehousing (GW) [9], green distribution (GD) (Le, 2020), internal environmental management (IEM) [2], reverse logistics (RL) [10], green purchasing (GP) [11], investment recovery (IR) [2] and cooperation with customers [2].

There are an abundance of explorations setting forth the concept of GSCM. Beamon (1999) defined GSCM as something that leads to stretching the conventional supply chain (SC) to adopt the activities for making the product environment-friendly throughout its life cycle, which inculcates eco-design, saving cost, reducing the consumption and emission of harmful materials, recycling, and reuse of the product [12]. Khan and Qianli (2017) state that GSCM involves those practices where the focal firm works in close connection with SC partners to lessen the environmental influence of the product [13]. Handfield et al. (1997) suggest that it involves the implementation of the environmental management (EVM) principle across all the activities involved, initiating this from the order placement of the product by a customer till its final delivery, which includes the procurement, designing, producing, packaging, distribution, and logistics of the product [14]. GSCM has been articulated as a new prototype for increasing the firm's profitability via slackening environmental impacts and ameliorating ecological efficiency, simultaneously, by Zhu et al. (2005) [15]. GSCM is defined by Hervani et al. (2005) [10] as an equation that presents GSCM as a submission of the various GSCPs, viz., GP, green production, green distribution, and reverse logistics. According to Srivastava (2007), it involves integrating environmental consciousness into the activities of SCM, viz., product design, material procurement, process design, and logistics, and RL [16]. Lakhal et al. (2007) implanted GSCM into the five rings of the Olympics, which signify five zeros related to emissions, waste activities, waste resources, harmful substances, and waste generated in the product life cycle [17]. As per Lee and Klassen (2008), GSCM is the commingling of environmental activities along the SC by the buyer organization to strengthen the environmental effect of the customers and suppliers [18].

1.2. GSCM and the Firm's Performance

The allurement for adopting GSCM is the improvement in the firm's performance (FP) in terms of its environmental, economic, and social performance. Drawing upon the resource-based view, GSCM is a strategic resource of any organization that could result in the culmination of competitive advantage and improvement in FP on the triple bottom line (TBL) [19,20]. Whilst environmental performance (EVP) is weighed in scales like reduction in waste, effluents, consumption of hostile materials, and increase in energy efficiency, economic performance (ECP) is determined in terms of cost and resource savings [21]. On the other hand, social performance (SOP) pertains to improving society's healthcare facilities, providing employment, and increasing professional awareness in society [21]. Research has studied different aspects of GSCM or sustainable supply chains (SSCs) and their performance. While some studied the impact of GSCM on TBL performance by using various techniques such as structural equation modeling and interpretive structural modeling, etc. [22], others forged multi-objective optimization models of the supply chain for maintaining optimal balance among the environmental impacts, increasing profits and achieving social sustainability [23,24]. Moreover, many studies developed robust optimization models, multi-objective linear programming models, and other frameworks for building circular [25], lean [26,27], and low-carbon SCs [28], based on achieving different aspects of sustainability performance [29]. Several researchers discovered the sway of the circular economy (CE) on sustainability performance (SP) [30,31]. Moreover, there are studies related to building eco-design of products in which they probed the impact of different product designs on profit, cost, and environmental impact through life cycle analysis to find the most economically and environmentally efficient design [32,33]. Furthermore, certain studies employed the multi-criteria decision making model and DEA techniques for sustainable supplier picking, based on their SP [34,35]. Other explorations probed how lean manufacturing exerts its impression on performance [36,37]. In certain studies, researchers also integrated the impacts of green, lean, and circular supply chains on performance [38,39]. In addition, there are also studies that exploit multi-objective optimization models to optimize the performance of the logistics aspect of the SC bagging sustainability through a reduction in carbon emission and cost and the achievement of time efficiency [40,41]. Some research studied various variables in the liaison between SSCs and performance, like big data [42], industry4.0 [43], blockchain technology [44], competitive advantage [45], technological innovation [46], and Digital Technology [47]. Over and above this, several studies focused on literature reviews (LRs) of the divergent aspects of the SSCs [48,49]. Lastly, explorations also identified the barriers to the embracement of SSC practices, thus achieving SP, and also established relationships amongst identified barriers through the use of interpretive structural modeling, DEMATEL, fuzzy MICMAC, and other such techniques [50,51].

1.3. Research Gap and Scope

Due to the existence of divergent and scattered links between the two fields, viz., GSCM and performance, in the literature that discusses the relationship between the two from different angles, there is a need to assess and garner the trending topics and different themes that arose between them through the last decade (2014–2023), along with the trends in reporting by authors, countries, and sources, and their collaboration. The previous literature solely analyzed green supply chain management, without paying much heed to its relationship with firm performance through bibliometric and content analysis. This study endeavors to systematically explore the different liaisons that exist between GSCM and FP taken together, through bibliometric and content analysis, utilizing the Biblioshiny package of Rstudio (version 4.4.0). The scope of the study covers the following objectives:

- 1. To analyze the reporting and collaboration trends in GSCM and FP among authors, countries, and sources;
- 2. To identify the trending topics and emerging themes in GSCM and FP, along with figuring out their impact, centrality, and density;

3. To find out the different methodologies, affiliating concepts, influencers, drivers, and impacts of GSCM and performance through content analysis of themes identified through thematic analysis.

The study is bifurcated into five sections, wherein Section 1 sets the backdrop of the exploration, the Literature review is cast in Section 2, Section 3 states the research methodology embraced to track down and assess the relevant documents, and Section 4 portrays the analysis' outcomes, and discusses the reporting trends, different themes, collaborations, and emerging fields. Lastly, Section 5 concludes the paper by providing insight into the research gaps that researchers could undertake to explore in future studies.

2. Literature Review

Owing to the diverse fields of studies carried out to understand the various relationships between sustainable supply chains and performance explored through multiple lenses, it becomes imperative to analyze the trending topics and different themes through bibliometric analysis in order to know the emerging themes, their impact, centrality, and density by undertaking word analysis, coupling analysis and co-occurrence of keywords while analyzing their conceptual structures, which will help researchers to identify the future work that could be done on the emerging and niche fields in the topic. Moreover, it will also be helpful for the researchers in this field to get to know the reporting trends of this field by authors, countries, and sources, together with collaboration amongst authors and countries to probe the most relevant authors, sources, and countries working in this field and to find out the research gaps in author and country collaboration. The previous literature related to the bibliometric analysis of GSCM and its affiliating concepts is presented in Table 1 below, followed by an in-depth theme-wise discussion of the literature.

 Table 1. Bibliometric Literature Review.

Themes	Author	No. of Articles Examined	Time Span of Review	Objectives	Method	Findings
GSCM and Indirect Performance Affecting Concept Analysis	Nobanee et al. (2021) [52]	1233	1990–2020	To collectively analyze sustainability practices and risk management	Bibliometric analysis through VOSviewer	Six major themes related to 1. Moral responsibilities and sustainability developments. 2. Blockchain technology and risk reduction. 3. Social sustainability and SC. 4. Environmental Impacts. 5. Safety engineering and risk identification. 6. Optimization and Sustainability practices were identified.
	Bhatt et al. (2020) [53]	343	1990–2019	To examine lean and green manufacturing principles	Bibliometric and content analysis	Most of the research focuses on the relationship of lean and Green Manufacturing with Organizational and environmental performance, with less concern given to sustainability.
	Ren et al. (2020) [54]	306	1999–2019	To undertake a collective quantitative and qualitative analysis of Green and Sustainable Logistics	Bibliometric analysis, science mapping, Literature Review	Five major research alignments related to 1. TBL research, 2. Policy, Planning and Management, 3. Practice and implementation, 4. Technology, and 5. Operation Research were identified.
	El Baz and Iddik (2021) [55]	46	2001–2020	To study the relationship b/w GSCM and Organizational Culture	Bibliometric and Content analysis	Increasing research in the time frame of 2012–2020. Research relates to studying organizational culture both as a driver and barrier to GSCM.
	Shaharudin et al. (2019) [56]	1136	2001–2021	To study the past, present, and future of Low-carbon SCM.	Content Analysis and Social Network Analysis	Six main realms under Low-carbon SCM have been explored, viz., sustainability, GSCM, SCM, innovation, environmental management, sustainable development, and climate change.
	Ferasso et al. (2020) [57]	253	2013–2019	To study the relationship between Circular Economy and Business Models	Bibliometric analysis through VOSviewer and qualitative review	Emerging topics related to the fields of CE, SCs, waste and reuse were identified in the domain of supply-side aspects, demand-side aspects, managerial implications, networking, performance and contextual considerations.

Themes	Author	No. of Articles Examined	Time Span of Review	Objectives	Method	Findings
Digital Supply Chain Management	Zekhnini et al. (2021) [58]	86	NA	To study the relationship between digital technologies, lean, green, sustainable SC, and SC performance.	Bibliometric Analysis and Literature Review	Industry 4.0 has an impact on SC performance. There exists a relationship between lean, green, and sustainable practices and digital SCs.
	Manal Benatiya Andaloussi (2024) [59]	114	2000–2023	To study the literature related to Digital Supply Chains	Bibliometric LR and content analysis through VOSviewer	Digital Technology has a significant impact on SCM. The main research trends in this field include intelligent SCM, disruptive technology to stimulate SC performance, Circular SC, information reliability in SC, and SSC.
Intervention for SSC	Chakraborty et al. (2023) [60]	477	2017–2022	To study the literature related to the application of blockchain technology in SSCs	Bibliometric Analysis and SLR	Six key themes are identified related to SC visibility, traceability, collaboration, adaptability, resilience, sustainability, performance, finance, agility, challenges to blockchain, and carbon auditing.
	Cruz and De Arruda Ignacio (2023) [61]	NA	NA	To study the literature related to the implementation of Blockchain Technology in agri-food supply chain for sustainability	Bibliometric analysis and SLR	Blockchain technology helps in improving SC performance. Environmental concerns are addressed less in this field.
	Chen et al. (2017) [62]	174	1987–2015	To analyze the link b/w SC collaboration and TBL metrics	Bibliometric Analysis and SLR	There is a growing interest in SC collaboration for sustainability, with the dominance of economic and environmental concerns over social concerns.
	Beske-Janssen et al. (2015) [63]	140	1995–2014	To measure sustainability performance for SSCM	Bibliometric Analysis and SLR	The research interest in this field grew between 2010 and 2014, whereby environmental and economic aspects dominate the field over social aspects of sustainability.
GSCM and Performance Analysis	Maditati et al. (2018) [64]	1523	1997–2016	To study structural relationships among different GSCM factors	Bibliometric citation meta-analysis and Content analysis through HistCite software	Six major research streams related to 1. Conceptual development, 2. Impact of GSCM on performance, 3. Green and Sustainable SC operations, 4. Green Supplier Development 5. Drivers to GSCM implementation, and 6. Future Scope were identified.
	Balon (2019) [65]	150	1999–2014	To review the literature related to pressures, practices and performance related to green supply chain management	Bibliometric analysis and Literature Review	Government rules and regulations, CSR, IR, and green market are identified as the key pressures. ED, IEM, waste management, GP aspect, quality, and IR have been identified as the key practices. FP, operational performance, and EVP have been identified as the key performances.
Miscellaneous analysis related to Sustainable Supply Chains	Yang et al. (2021) [66]	3656	1992–2019	To conduct a review on knowledge progress of Environmental Responsibility (ER)	Bibliometric analysis through CiteSpace software	Five research paradigms related to 1. Stakeholder participations,, 2. ER theories, 3. Management and performance 4. Sustainable SC development, and 5. Drivers to ER are identified.
	Ahi et al. (2016) [67]	445	1996–2012	To identify the metrics used for energy-related issues in GSCM and SSCM	Bibliometric Analysis	"Energy use, consumption, and efficiency" have been identified as the top three metrics used frequently. There is a lack of consensus on the measurement of energy-related performance measurement in GSCM and SSCM.
	Taticchi et al. (2014) [68]	384	2000–2013	To study the literature related to Decision Support tools and Performance measurement in SSCM	Bibliometric analysis and SLR	There is an urgent need to integrate performance models with decision-support tools inculcating TBL. Moreover, there is a need to develop industry-specific TBL metrics.
	Chopra et al. (2021) [69]	1136	2001–2021	To study the literature related to knowledge management for sustainability	Bibliometric analysis and LR	Nine foundational clusters are identified, viz., informed sustainability practices, social network, FP, knowledge-sharing culture, green innovation, sustainability models, global warming, knowledge management and innovation performance.
	Braz et al. (2018) [70]	56	2004–2018	To study the causes and mitigation factors of bullwhip effect in forward SC and CLSC.	Bibliometric and content analysis	It was found that causes are similar for both the SCs, whereas increasing product return rate can be accounted as a mitigating factor through which CLSC could reduce the bullwhip effect and thus improve performance.
	Rejeb et al. (2023) [71]	160	2020–2022	To study the literature related to CE in the COVID-19 era	Bibliometric analysis and SLR	Five key themes were identified, viz., 1. Waste management, 2. DSCM and SSCM 3. COVID-19 impacting the food system, 4. SDGs, smart cities, and bio-economy, and 5. CLSCs.

Table 1. Cont.

2.1. GSCM and Indirect Performance Affecting Concept Analysis

There are research studies that relate to the bibliometric analysis of GSCM and its affiliating concepts that are not directly studying the impact of GSCM on performance but are focusing on concepts akin to GSCM that are indirectly impacting the performance. Nobanee et al. (2021) carried out a bibliometric analysis of 1233 articles from 1990 to 2020 relating to sustainability practices and risk management papers, and found six significant themes [52]. Bhatt et al. (2020) bibliometrically assessed sustainable manufacturing for 25 years. They found the dominance of lean and green proclivities interlinked with performance and a need for being more critical for sustainability [53]. Ren et al. (2020) carried out a scientific mapping of 306 green and sustainable logistics papers from 1999 to 2019. They identified five themes: triple bottom line, regulation and policy, implementation and practice, technology, and research [54]. El-Baz and Iddik (2021) bibliometrically analyzed GSCM and organization culture from 2001 to 2020 to understand the relationship between the two [55]. Shaharudin et al. (2019) analyzed knowledge management of sustainability on 1136 documents from 2001 to 2021 to identify the themes and intellectual structures [56]. Ferasso et al. (2020) retrieved 253 articles from various databases to study the relationship between CE and business models and to carry out a network analysis of keywords using VOSviewer [57]. They found the key themes related to a CE, supply chains, waste, and reuse. The studies under this theme are studying the different aspects of sustainability along the supply chain that are indirectly impacting sustainability performance, or they are studying performance as a remote and very small field, so they signal the gap in holistic studies of direct relationships between SSCs and performance, collectively, from various angles.

2.2. Digital Supply Chain Management and Blockchain Intervention for SSCs

This theme considers digital and blockchain technology as the underlying concept for supply chain sustainability and performance improvement. Zekhnini et al. (2021) carried out a bibliometric analysis of SSCs and digital supply chain (DSC) performance. They devised a roadmap for integrating the concepts of lean and green along the DSC to enhance their SP [58]. Manal Benatiya Andaloussi (2024) studied the literature related to DSC through bibliometric and content analysis of 114 articles, and found that DSC significantly impacts SCM and performance [59]. Moreover, Chakraborty et al. (2023) and Cruz and De Arruda Ignacio (2023) bibliometrically studied the implementation of blockchain technology for sustainability in the supply chain and found that it improves the performance of SCs [60,61]. Moreover, they also found the themes related to SC resilience, agility, traceability, sustainability, and collaboration. This theme studies the intervention of disruptive technologies for sustainability improvement along the SC, but does not consider GSCM or SSCM as the focal concept to be studied for its direct impact and relations with the firm's performance.

2.3. GSCM and Performance Analysis

Chen et al. (2017) carried out a bibliometric analysis on sustainable supply chain collaboration. They discovered that it is gaining momentum, with economic and environmental aspects playing the roles of protagonist and with an absence of social considerations [62]. Beske-Janssen et al. (2015) measured the sustainability performance of SSCs through a bibliometric analysis of 140 papers from 1990 to 2014, and found that economic and environmental aspects dominate over social aspects [63]. Maditati et al. (2018) used HistCite software to analyze 1523 green supply chain management papers. They discovered six significant themes relating to conceptual development of GSCM, GSCM and performance, green operations in SC, green supplier development, enablers for GSCM, and offing imperatives [64]. Balon (2019) carried out an LR and bibliometric analysis of GSCM, pressures, practices, and performance over the past two decades on 150 articles, to identify the major fields [65]. Although this theme studies the direct impact of GSCM on performance, a larger scope of the relationship between the two has been missed; this research is the one that not only depicts the impact of the former on the latter, but also deals with other detailed aspects and relations between the two, like life cycle assessment for eco-designing and performance improvement, supply chain optimization model development, and techniques for the same for TBL, logistics optimization, etc. Moreover, the period considered in the last bibliometric research in the two fields dates back to 2016, pointing toward the need to re-evaluate the two fields collectively and to probing out the new themes and their evolution.

2.4. Miscellaneous Analysis Related to Sustainable Supply Chains

This theme discusses the miscellaneous, isolated, and scattered studies and concepts related to GSCM. Yang et al. (2021) analyzed the trends and co-words in environmental responsibility (ER) through a bibliometric analysis of 3656 papers through CiteSpace software. They identified five major keyword categories encapsulating the concept of ER, viz., participation of stakeholders, theories related to ER, performance and management, SSCs, and drivers of ER [66]. Ahi et al. (2016) evaluated the employment of energy-related performance measures in SSCs to identify the energy-related complexities in GSCM [67]. Furthermore, Taticchi et al. (2014) studied the interlink between decision-support tools and performance measurement, and found an urgent need to integrate performance models with decision-support tools [68]. Chopra et al. (2021) bibliometrically analyzed 1136 papers to study knowledge management for sustainability, and found nine key areas related to climate change, sustainability, knowledge sharing, etc [69]. Braz et al. (2018) carried out a bibliometric and content analysis of 56 papers to study the causes and mitigation factors of the bullwhip effect on forward SC and CLSC, and found similar causes, while product return rate was identified as a mitigating factor for improving performance [70]. Rejeb et al. (2023) studied the literature related to CE during the COVID-19 era, and identified five key themes [71]. The scattered literature calls for a study on the broader spectrum covering all these divergent themes within one category to give a holistic idea of the concept related to GSCM and performance.

This research picks up on a bibliometric analysis of GSCM and the firm's performance collectively; this has evolved with time, and the recent updates are missing in the previous research. It utilizes the Scopus Database to find the pertinent literature on the two fields under study for the decade from 2014 to 2023. This study extends the previous research relating to GSCM by incorporating the TBL performance aspects of GSCM, to provide the descriptives of the fields, along with the emerging themes, trends in reporting, and the future avenues, by using the Biblioshiny package of Rstudio (v 4.4.0). The study analyzes the following: (1) trends in reporting by running the overview, sources, and author analysis; (2) collaboration among authors by analyzing their social structures, (3) trending topics, and emerging themes; and exploring their impact, centrality, and density by carrying out word, co-occurrence, and network analyses of keywords, along with analyzing their conceptual structures. Lastly, (4) the methodologies, affiliating concepts, influencers, drivers, and impact of GSCM on performance have been probed through content analysis facilitated by the clustering of keywords via thematic analysis.

Thus, our research questions (RQs) are outlined below:

- RQ1. What are the research trends in reporting the relationship between sustainability in the SC and performance by authors, countries, and sources?
- RQ2. What are the trending topics and different themes, and what are their impact, centrality, and density in the relationship between SSCs and performance?
- RQ3. What are the different methodologies used to develop and assess sustainability along the supply chain, based on the different themes identified through clustering?
- RQ4. What are the affiliating concepts for green and sustainable supply chains?
- RQ5. What are the drivers and influencers of green and sustainable supply chains? RQ6. What is the impact of green and sustainable SCs on performance?
- RQ7. What has been the trend in collaboration between authors and countries in SSCs and performance?

- RO1. To identify the reporting trend by authors, countries, and sources in SSCs and performance.
- RO2. To identify the trending topics and different themes, and their impact, centrality and density with regard to the relationship between SSCs and performance.
- RO3. To identify the methodologies used to develop and assess sustainability along the supply chain, based on the different themes identified through clustering.
- RO4. To identify the affiliating concepts for green and sustainable supply chains.
- RO5. To identify the drivers and influencers of green and sustainable supply chains.
- RO6. To assess the probable impact of green and sustainable SCs on performance.
- RO7. To identify the trend in collaboration of authors and countries in the realm of SSCs and performance, taken together.

3. Methodology

3.1. Data Collection and Screening

This examination drew on the Scopus database to find the essential literature on GSCM and a firm's performance. The Scopus database includes most of the articles from IEEE, Web of Science, Elsevier, etc. It contains a huge database of peer-reviewed scientific literature, comprising about twenty-two thousand titles and impactful productions from international publishers [72]. Moreover, it is a preferable database for peer-reviewed articles in SCM [55,73]. It consists of systematic details of documents, including the country, source, and no. of papers that cited the document, which makes it easier to spot the relevant articles. To fulfill the research aims, the Scopus database is utilized for the bibliometric analysis. This paper used a combination of terms to search the documents—"green" OR "environmental" OR "ecological" OR "sustainable" OR "GSCM" AND {supply chain} OR {supply-chain} AND "sustainability" OR "sustainable" OR {triple bottom line} OR "economic" OR "environmental" OR "social" OR "operational" OR "firm" OR "organizational" OR "corporate" AND "performance" OR "outcome" OR "achievement". The search strings applied are mentioned in Table 2. The initial inclusion criteria constitute documents from the last decade, i.e., from 2014 to 2024, documents that are articles or reviews in the English language, with the journal as the source type, and documents that are at the final stage of publication. The documents relate to the fields of Business, Management and Accounting, Social Sciences, Environmental Science, Energy, Decision Sciences, Earth and Planetary Sciences, Economics, Econometrics and Finance, and lastly, Arts and Humanities. The detailed methodology for data collection and screening is presented through a flow chart in Figure 1, which is prepared following the general guidelines of PRISMA review methodology [74]. After refining the initial inclusion criteria, 9324 articles were found. Thereafter, the queries were combined through the combine-query feature of Scopus, which removed the duplicates and reached a lot of the 4713 documents. 1 retracted document and 28 incomplete records were removed to get 4684 documents. Thenceforth, articles were screened based on no. of citations, wherein only those articles that had more than 30 citations were selected, to reach the bloc of highly influential studies, which resulted in the exclusion of papers for the year 2024 as they had fewer than 30 citations. This resulted in the collection of 1518 papers that were further screened for their titles, keywords, and abstracts, to select only those that established some relationship between SSCs and performance. The papers include topics related to structural equation modeling for establishing the relationship b/w GSCM and FP, the multi-objective optimization models that help in building sustainable supply chains through the optimization of TBL, the various aspects of GSCM, viz., eco-design, green warehousing, reverse logistics, green packaging, etc. and their impact on performance outcomes. Moreover, this bibliometric analysis considers the sub-topics of green supply chains, such as CE, the closed-loop supply chain (CLSC), and lean manufacturing, and their respective effects on performance. This screening finally led to the inclusion of 938 documents that were bibliometrically analyzed using the Biblioshiny package of Rstudio.

Table 2. Search Results.

S.No.	Search Strings	Initial Results	Refined Results
1	(TITLE-ABS-KEY ("green" OR "environmental" OR "ecological" OR "sustainable") AND TITLE-ABS-KEY ({supply chain} OR {supply-chain} OR {scm}) AND TITLE-ABS-KEY ("sustainability" OR "sustainable" OR {triple bottom line} AND "performance" OR "outcome" OR "achievement"))	6852	3563
2	(TITLE-ABS-KEY (gscm) AND TITLE-ABS-KEY ("environment" OR "economic" OR "financial" OR "social" OR "Operational" AND "performance" OR "outcomes" OR "achievement"))	452	284
3	(TITLE-ABS-KEY (gscm) AND TITLE-ABS-KEY ("firm" OR "organizational" OR "corporate" AND "performance" OR "outcome" OR "achievement"))	395	262
4	TITLE-ABS-KEY (gscm) AND TITLE-ABS-KEY ("sustainability" OR "sustainable" OR {triple bottom line} AND "performance" OR "outcome" OR "achievement"))	348	206
5	TITLE-ABS-KEY ("green" OR "environmental" OR "sustainable" OR "ecological") AND TITLE-ABS-KEY ({supply chain} OR {supply-chain} OR {scm}) AND TITLE-ABS-KEY ("environment" OR "economic" OR "financial" OR "social" OR "operational" AND "performance" OR "outcomes" OR "achievement"))	6349	3150
6	(TITLE-ABS-KEY ("green" OR "environmental" OR "sustainable" OR "ecological") AND TITLE-ABS-KEY ({supply chain} OR {supply-chain} OR {scm}) AND TITLE-ABS-KEY ("firm" OR "organizational" OR "corporate" AND "performance" OR "outcome" OR "achievement"))	3029	1859
TOTAL		17,425	9324



Figure 1. Data Collection Methodology.

3.2. Data Analysis

Bibliometric analysis is a highly preferred tool for the assessment of a large bulk of literary data [75]. Moreover, it is frequently used for quantitative analysis of fields related to GSCM, SSCM [76], RL [77], and sustained development [78]. Furthermore, bibliometric analysis is an efficient tool that could be used for complex scientific mapping, analyzing the relationship between different factors, exploring the emerging and niche themes providing future directions, collaboration among countries and authors, and identifying intellectual structures [75,79]. Therefore, bibliometric analysis is utilized in this research to attain the threefold objectives specified, viz., the identification of descriptives and trends in reporting among countries, authors, and sources, the identification of trending topics and different themes, with a special focus on the emerging and niche themes, and the investigation of the collaboration among authors and countries between the two factors, viz., GSCM and performance. This study uses the Biblioshiny package of Rstudio (4.4.0) to carry out a bibliometric analysis of 938 documents reached after data gathering, cleaning, and screening, because of its efficacious statistical algorithms and coalescent graphical tools. The next section provides a detailed bibliometric analysis initiated from the descriptives and trends in reporting, followed by an analysis of keywords, by analyzing the conceptual structure via a graphical tool for network analysis, and coupling by clustering. Thereafter, the social structures are analyzed to identify collaborations among authors and countries.

Content analysis is used to develop meaningful content and context out of unstructured data. It helps in drawing valid inferences and assertions from the data through existing theories and literature, and experiences through inductive, deductive, and abductive reasoning [80]. This review undertakes content analysis to identify the different methodologies used for developing sustainable supply chains, affiliating themes to GSCM, the influencers and drivers to GSCM, and the impact of GSCM on TBL performance, which is facilitated by the themes identified through clustering of keywords via thematic analysis.

4. Results and Discussion

4.1. Descriptive Statistics

There are 863 articles and 75 reviews in this analysis, totaling 938 documents that span the last decade, viz., from 2014 to 2023. The articles related to the year 2024 were removed when documents were screened for more than 30 citations. The documents are attributed to 152 sources, including journals, book chapters, etc. The annual growth rate of articles in the field of GSCM and performance tends to be decreasing, at -19.99%; because the study undertakes the analysis of only the highly cited articles, recent articles become more prone to get filtered out, because of fewer citations for such articles. Furthermore, it was found that the maximum production in these fields was between 2018 and 2020. The average citation of the documents analyzed in this study is as high as 93.31, and average citations per year are also seen to be on an increasing trend, which shows the increasing interest in the fields. The reference total also comes to a peak figure of 62,603. Moreover, 3332 keywords plus, and 2368 author's keywords are identified for the documents. There were a total of 2305 authors, with 39 authors of single-authored documents working on GSCM and performance in the last decade, indicating increased interest in sustainability concerns and their outcomes among researchers. Lastly, there are 43 single-authored documents, while the co-authors per document are 3.5, and a high 47.76% of international co-authorships are seen.

Genovese (2017a) is the top-cited article, having the maximum no. of citations, totaling 860 followed by Geissdoerfer (2018), with 659 citations, El-Kassar and Singh (2019) with 625 articles, Dubey et al. (2015), Nascimento et al. (2019), Qin et al. (2017), Kamble et al. (2020), Hong and Guo (2019), Rezaei et al. (2016), and Hashemi et al. (2015) [81–90]. The first authors of these top-cited articles prominently relate to four fields: SCM, decision making and business models, circular economy and remanufacturing, and digital technologies. While SC and operations management and their related decision-making models are common fields for all of them, Nascimento, Geissdoerfer, and Hong focus on the circular economy,

while digital transformation, machine learning, big data, and Industry 4.0 and 5.0, are key research interests of Kamble, Qin, and Nascimento. Moreover, EL-Kassar has an interest in distinctive fields of cryptography and number theory. Shedding light on the fields of these top documents shows that, while all of these documents relate to SSCM, Genovese (2017a), Geissdoerfer (2018), and Nascimento et al. (2019) have a special focus on the circular economy [81,82,85], while El-Kassar and Singh (2019), Nascimento et al. (2019), and Kamble et al. (2020) emphasize big data, Industry 4.0 and digital technologies, along with SSCM [83,85,87]. Furthermore, Geissdoerfer (2018), Qin et al. (2017), and Rezaei et al. (2016) inculcate the development of business and decision-making models for SSC [82,86,89]. This suggests that the research interests of the first authors of these top-cited documents are influencing the subject and fields of these top-cited documents. This will guide future researchers in picking up the most-cited and trending fields as per the research interest of these authors and the subject fields of these documents.

The three field plots visually depict the top authors, keywords, and countries, with their relations from left to right, respectively, through the Sankey diagram in Figure 2. It shows Zhang Y., Khan S.A.R., Tseng M-L, Bag S., Dubey R., Gunasekaran A., Govindan K., Sarkis J., Mangla S.K., and Luthra S. as the main authors in the field of GSCM and performance, working prominently on the keywords sustainability, green supply chain management, supply chain, circular economy, sustainable supply chain, and sustainable development, with contributions from China, the U.K, India, the USA, Italy, Spain, Brazil, Iran, Germany, and France, in declining order of their contributions. It could be seen that environmental performance is the key performance aspect focused on by top researchers for sustainability along the supply chain, which also suggests the need to dive into social and economic aspects.



Figure 2. Three-field plot with authors, keywords and countries.

4.2. Trends in Reporting by Sources, Authors, and Countries

Sources: the most relevant journals that have a maximum no. of documents in the field of GSCM and Performance is Journal of Cleaner Production, ranked the highest with 213 documents. Bradford's law in Figure 3 depicts that most of the research related to the fields under study is concentrated majorly around three sources, viz., Journal of cleaner production with 213 documents, Sustainability (Switzerland) with 72 documents, and International Journal of Production Economics with 66 documents, which together adds up to 351 documents, which is more than one-third of the 938 documents analyzed in this

bibliometric analysis. Furthermore, analyzing the journals' production over time shows that the production of Journal of Cleaner Production is increasing at a much faster rate than other journals. It is further observed that these top journals are emphasizing on decisionmaking models for SSC, with environmental performance as their key focus. Therefore, researchers are directed to focus on creating business and decision-making models for environmental sustainability along the SCs.



Source log(Rank)

Figure 3. Source Clustering. The Cluster includes top 3 journals viz., (1) Journal of Cleaner Production (2) Sustainability (Switzerland) (3) International Journal of Production Economics respectively shown in figure.

Authors: the top authors for the production of literature revolving around GSCM and performance are discovered to be Sarkis J., Govindan K., and Khan Sar, in descending order. A total of 23 of the papers are from Sarkis J., followed by 19 documents by Govindan K., and 13 documents by Khan S.A.R. Furthermore, from Figure 4, it could be seen that certain authors have the momentum to produce articles on GSCM and performance, even in 2023, like Khan S.A.R., Gunasekaran A., Bag S., and Zhang Y. Moreover, it also shows that Khan S.A.R. and Govindan K. have the highest no. of documents, with seven each in the years 2022 and 2017, respectively, whereas Gunasekaran A. has the highest no. of total citations in the year 2020 totaling 200.6, followed by Sarkis J., amounting to 166.2 in the same year. It is observed that the research interest of these top authors revolves around supply chain management, environment, Industry 4.0 and digital technology, circular economy, sustainability, and decision-making models. While sustainability along the supply chain is shared by all of them as an interest, Govindan K., Khan S.A.R., Mangla S.K., and Luthra S. are found to have a special interest in the circular economy. Moreover, Govindan K., Khan S.A.R., Gunasekaran A., Mangla S.K., Luthra S., Bag S., and Zhang Y. have interests in digital technologies, big data, information systems, and Industry 4.0. Furthermore, Dubey R. has a special interest in humanitarian SCs. This will drive the scholars in the field of GSCM to follow the interests and research fields of the top researchers and explore new and trending avenues in this field.

Countries: Table 3 and Figure 5 show that China has the maximum no. of documents in the field of GSCM and performance, totaling 181, wherein 81 papers relate to the source country and 100 papers relate to multiple countries' papers, followed by the U.K. and India, with 90 and 71 documents, respectively. Furthermore, it has been discovered that the production of China has been increasing at a fast rate, followed by the U.K. and India. More research in these fields is yet to be carried out in countries like Bangladesh, Botswana,



Chile, Ecuador, Egypt, and others, which guides the researchers to scrutinize the liaison between GSCM and performance in these unexplored countries.

Figure 4. Authors' production over the decade. The top authors include Sarkis J., Govindan K., Khan S.A.R., Gunasekaran A., Mangla S.K., Luthra S., Tseng M.L., Bag S., Dubey R., and Zhang Y. in decreasing order of their productions.

Country	Articles	Articles %	SCP	МСР	MCP %
China	181	19.3	81	100	55.2
U.K	90	9.6	25	65	72.2
India	71	7.6	55	16	22.5
USA	65	6.9	32	33	50.8
Italy	40	4.3	27	13	32.5
Iran	33	3.5	27	6	18.2
Australia	27	2.9	15	12	44.4
France	23	2.4	6	17	73.9
Canada	22	2.3	10	12	54.5
Spain	22	2.3	11	11	50





Table 3. Most Relevant Countries.

Figure 5. Top contributing countries.

4.3. Analysis of Trending Topics through Keyword Analysis

Figure 6 and Table 4 depict the highly recurring keywords in the documents, whereby supply chain management is the most-used keyword, with a frequency of 419, followed by sustainable development and supply chains, with a frequency of 386 and 294, respectively. Environmental impact is the most-discussed performance outcome of SSC in the literature. Moreover, life cycle assessment (LCA), sensitivity analysis, optimization models, and integer programming are the most-used research methodologies. Furthermore, the research talks about carbon footprint and emission control as the main environmental-assessment aspects. Keyword analysis also depicts a high no. of studies in China. Moreover, Figure 7 shows the trending topics in the areas where it could be seen that closed-loop supply chains, digital supply chains, Industry 4.0, the circular economy, and social performance are the emerging topics in GSCM and performance. Future research could be undertaken in these areas.



Figure 6. Word Cloud.

Table 4. Frequently Used Words.

Words	Occurrences
Supply Chain Management	419
sustainable development	386
supply chains	294
environmental management	204
decision making	152
environmental impact	125
sustainability	123
sustainable supply chains	123
environmental performance	89
green supply chain management	87



Figure 7. Most-trending topics.

4.4. Analysing Impact, Centrality, and Network of Clusters by Coupling of Authors' Keywords

With 250 units, 10 per 1000 units of minimum cluster frequency, 3 labels/cluster, and 0.3 as the label size, 3 clusters are formed based on authors' keywords, wherein global citation score is used to measure the impact, and labels are allocated using "keyword plus", by using Infomap. It can be seen from Table 5 that cluster 3, which deals with sustainability in the supply chain and performance assessment has the highest centrality, which is the interaction with other themes, but is low on impact and is also low on frequency, with only 20 documents. Cluster 2 is high on centrality and a moderate impact, which deals with the broad subject of sustainability in the supply chain; besides this, it has the highest frequency of 187 documents. Lastly, cluster 1 is high on impact but low on centrality, which deals with GSCM, focusing on EVP. Moreover, the network of various authors has also been assessed in the identified clusters, wherein Genovese et al. (2017), Mitra and Datta (2013), and Vanalle et al. (2017) are prominent documents in cluster 1 [81,91,92], discussing GSCM, SSCM, CE and their impact on performance; Kamble et al. (2020), Esmaeilian et al. (2020) and Upadhyay et al. (2021) are prominent documents in cluster 2 [87,93,94], which discussed the integration of blockchain, digital technology and Industry 4.0 in SSCM and GSCM, with the impact on performance due to such integration, and Schrettle et al. (2014), Kazancoglu et al. (2020), and Schmidt et al. (2016) are the important documents in cluster 3, which mostly focus on developing decision-making models for SSC, GSC and CE [95–97].

Table 5. Clustering by coupling of Author's Keywords.

Label	Group	Freq	Centrality	Impact
supply chain management-conf 24.8% green supply chain management-conf 70.4% environmental management-conf 45%	1	36	0.244	2.192
sustainable development-conf 84.7% supply chain management-conf 65.5% supply chains-conf 96.8%	2	187	0.43	1.872
supply chain management-conf 9.7% sustainable development-conf 5.6% performance assessment-conf 26.3%	3	20	0.457	1.771

4.5. Analyzing Different Clusters through Co-Occurrence of Keywords

By looking at Figure 8, it can be seen that three clusters are prominently formed on the grounds of the co-occurrence of keywords. Cluster 1 in red is the largest, containing various aspects and terms close to GSCM, viz., sustainability, circular economy, green manufacturing, sustainable supply chain, closed-loop supply chain, and green supply chain, which are assessed for their impacts using various methodologies like life cycle assessment [98], multi-objective optimization models [99], integer programming [100], etc., on environmental performance, profitability, economic and social performance, and carbon footprints [101,102]. Moreover, it could be extrapolated that the main research in this cluster is undertaken for the food and manufacturing industries [103]. There are various implications and directions that have been provided to the managers in this cluster [30,104]. Cluster 2 in blue mainly constitutes literature reviews [62] and articles on the impact of sustainability practices and innovation on various performances, viz., environmental and industrial [105]. The articles prominently relate to the manufacturing firms in China [106]. Cluster 3 in green contains sustainability and GSCM-related documents in logistics, for curbing carbon footprints and protecting the environment [89]. In a nutshell, cluster 1 builds up the theme of "Supply chain optimization through Multi-Objective Models and LCA", cluster 2 builds up to the "Impact of GSCM on TBL performance in the Manufacturing Industry", and cluster 3 results in "Low-carbon and Sustainable Logistics".



Figure 8. Co-occurrence of keywords.

4.6. Identifying Different Themes through Thematic Analysis

The thematic analysis of keywords identified four major themes, viz., supply chain management, sustainability, environmental impact, and green supply chain management, which are portrayed in Figure 9 and Table 6. GSCM and SCM are high on centrality, whereas GSCM is lacking in density, but SCM is still high on density. Centrality here refers to the intensity of the co-occurrence of keywords within the theme, whereas density pertains to the occurrence and relation of one theme with respect to other themes. The sustainability and environmental impact themes lack centrality, whereas sustainability is high on density, and is therefore a niche theme, but the environmental impact theme is low on density, and therefore it is categorized as an emerging theme. Table 7 provides the detailed keywords used in different themes. Furthermore, Figure 10 depicts the thematic evolution of the keywords, wherein it is seen that sustainability and supply chain concepts became integrated with each other, moving from 2014 to 2018, and further new concepts emerged in SSC, like environmental management and green manufacturing, for which indicators are set through benchmarking techniques and are tested for various performance outcomes, like financial performance by using methodologies like linear integer programming while simultaneously integrating laws and regulation concerns.



Figure 9. Themes Identified.

Table 6. Themes identified.

Cluster	Callon Centrality	Callon Density	Rank Centrality	Rank Density	Cluster Frequency
supply chain management	8.185	18.935	4	3	2913
sustainability	5.244	22.854	2	4	1022
environmental impact	4.809	18.395	1	2	670
Green supply chain management	5.915	17.208	3	1	1114

Table 7. Terms used in different themes.

Clusters No.	Cluster Name	Keywords Used
1	supply chain management	supply chain management, decision making, environmental performance, commerce, economic and social effects, sensitivity analysis, environmental sustainability, sustainability performance, green supply chain, costs, environmental management, carbon, integer programming, circular economy, emission control, closed-loop supply chain, environmental technology, multiobjective optimization, profitability, product design, economic and environmental performance, benchmarking, data envelopment analysis, planning, efficiency, game theory, sustainable development, investments, social aspects, uncertainty analysis, supply chains, waste management, literature reviews, systematic literature review, carbon emissions, chains, design, stochastic systems, cost effectiveness, energy efficiency, fuzzy sets, performance measurements, stochastic models, supplier selection, cost reduction, ecodesign, network design, remanufacturing, reverse logistics, marketing, social sustainability, sustainable manufacturing, triple bottom line, blockchain, decision support systems, decision theory, environmental and economic performance, supply chain network design, sustainable supplier selections, behavioral research, closed-loop, conceptual frameworks, environmental issues, linear programming, multi criteria decision making, reverse supply chains, social and environmental, transportation, analytic network process, artificial intelligence, closed-loop supply chains (CLSC), construction industry, content analysis, customer satisfaction, environmental concerns, food industries, freight transportation, green, lean, mixed integer linear programming model, laws and legislation, environmental regulations, nonlinear programming, outsourcing, performance measure, stochastic programming, supply chain collaboration, supply chain operation, sustainability issues, agri-food supply chains, cap and trade, closed-loop supply chain networks, collaboration, consumer, consumer behavior, fuzzy logic, low carbon
2	sustainability	Sustainability, environmental economics, performance assessment, manufacturing, article, china, human, industrial performance, environmental protection, innovation, literature review, numerical model, stakeholder, management practice, strategic approach, green economy, industry, integrated approach, fuzzy mathematics, competitiveness, conceptual framework, empirical analysis, india, Pakistan, analytical hierarchy process, environmental assessment, small and medium-sized enterprise, environment, brazil, ecology, economic aspect, economic development, environmental policy, risk assessment, commercial phenomena, investment, least squares method, multicriteria analysis, corporate social responsibility, organization, business, conservation of natural resources, environmental issue, hierarchical systems, implementation process, knowledge, corporate strategy, government, industrial enterprise, manager, modeling, qualitative analysis, research work, supply chain management practices, DEMATEL, developing world, firm size, future prospect, humans, industrial development
3	environmental impact	environmental impact, life cycle, logistics, life cycle assessment (lca), optimization, food supply, carbon footprint, greenhouse gases, biomass, recycling, carbon dioxide, economics, life cycle analysis, climate change, economic analysis, global warming, carbon emission, agriculture, life cycle assessment, environmental impact assessment, gas emissions, cost benefit analysis, eutrophication, energy utilization, food industry, pollution, assessment method, biofuel, cost analysis, feedstocks, fossil fuels, priority journal, algorithm, forestry

Table 7. Cont.

Clusters No.	Cluster Name	Keywords Used	
4	Green supply chain management	green supply chain management, sustainable supply chains, manufacture, sales managers, design/methodology/approach, surveys, industrial research, structur modeling, least squares approximations, sustainable performance, developing of performance, Industry 4.0, economic performance, factor analysis, finance, integ least squares (pls), financial performance, information management, regression data, supply chain performance, sustainable operations, human resource manage manufacturing, industrial economics, operational performance, resource-based sustainability practices, electronics industry, managerial implications, manufact organizational performance, pollution control, manufacturing companies, autom emerging economies, environmental management systems, firm performance, g innovations, sustainable production, corporate social responsibilities (csr), data a and medium enterprise, social performance, competitive advantage, digital stor products, multivariant analysis, structural equation modeling, supply-chain inter business performance, knowledge management	competition, ral equation ountries, ration, partial analysis, big ement, green view, uring firms, otive industry, reen nalytics, small age, green egration,
2014–2017		2018–2020	2021–2023



Figure 10. Thematic Evolution.

4.7. Analysis of Collaborations among Authors and Countries

Authors' Collaborations: Figure 11 shows 11 clusters of collaboration among authors, wherein cluster 1 relates to collaboration among Khan S.A.R., Zhang Y., Kumar V., Wang X., Yu Z., Kumar A., Chen X. and Garza-Reyes J.A., who are working on most of the topics related to sustainability, along with SCs, viz., SSCM, CE, CLSC, reverse logistics, low-carbon SCs, GSCM, and their integration with digital technology, green innovation, machine learning, blockchain and Industry 4.0, while simultaneously considering the impact on TBL performance. They are prominently studying developing countries like India, Pakistan, and China. Cluster 2 inculcates collaboration only between two authors, viz., Agyabeng-Mensah Y, and Afum E., who are collectively studying green human resource management, along with green supply chain management, and green logistics. Cluster 3 consists of collaboration among Gunasekaran A., Bag S., Dubey R., Gupta S., and Kamble S.S., who are among the highly cited authors. They have kept the focus on digital technology, integrating it with SSCM and then studying it for the impact on TBL performance. Their fields are centered around data-driven SCs, digital twin, blockchain technology, machine learning, and Industry 4.0, along with SSCs. Further, cluster 4 relates to collaboration among Tseng M-L and Wu K-J, who pay heed to service innovations for SSCs, and who use fuzzy logic for developing GSCM models, considering the uncertainty and risk factors involved. Cluster 5 relates to Mangla K., Luthra S., Kazancoglu Y., Raut R.D., and Jabbour C.J.C., who are working on CE, reverse logistics, sustainable consumption and its barriers, and big data, with a main focus on risk assessment along the SCs, with prominent studies on food and

agriculture SCs. The two authors in cluster 6, viz., Jia F. and Gong Y., are working on SC leadership for sustainability. Govindan K., Gold S., Darbari J.D., Agarwal V., Jha P.C., and Azevedo S.G., in Cluster 7 emphasize setting up supplier selection frameworks for sustainable reverse logistics and closed-loop supply chains, predominantly for the food industry. Cluster 8, which consists of Chowdhury S. and Dey P.K., actively probes CE, lean and sustainable innovation practices in small and medium enterprises. Cluster 9, with Sarkis J., Bai C., Fahimnia B., Zhu Q., and Dou Y., predominantly relates to green and sustainable supplier selection for CE, low-carbon, and sustainable SCs. Moreover, this cluster deals in concepts like SC transparency, resilience, and flexibility. Zhang J. and Zhang Q., in cluster 10, deal with niche concepts like cap and trade regulations in 2-echelon SSCs, and the effect of cost learning and operational inefficiencies on GSCM. Lastly, Chen I.J., and Chen Y., in cluster 11, deal with compliance and commitment effects in SSCs. It is worth noting that all these clusters are very scattered, which indicates a research gap for more collaboration among authors. Moreover, there is a need for collaboration on emerging topics like the impact of cap and trade regulations on SSCs.





Countries' Collaboration: Figure 12 depicts the collaboration of countries in the domain of GSCM and performance. The thick line shows high frequency of collaboration among countries, so, it could be deduced that China and the U.K. have the highest no. of collaborations, totaling 43, followed by China and the USA, with 31 collaborations, the U.K. and India with 24 collaborations, and China and Pakistan, with 20 collaborations. The analysis also shows a single collaboration of Bangladesh and Belgium. So, this points to the research gap which needs more collaboration among these countries.



Latitude

Figure 12. Countries' Collaboration.

4.8. Content Analysis of Identified Themes

Content Analysis: This review examines the existing literature, the developments in the literature, the prospects of sustainability along the supply chain, and the performance outcomes of the organizations. The concepts, their categorization, and contexts in this domain have been identified in the literature through content analysis; this is facilitated by the keywords identified in the different themes, through thematic analysis, which led to the identification of four prominent themes pivoting around the central concept of sustainable supply chain management. Each theme is explained through the keywords identified in the thematic analysis, viz., "Theme-1: supply chain management", "Theme 2: sustainability", "Theme 3: environmental impact", and "Theme 4: green supply chain management", citing the references of the keywords as per the focal concept of the theme. Moreover, the themes are renamed, considering the central concept of the theme discovered. The content analysis helped in spotting the different methodologies, drivers, influencers, affiliating themes and concepts, and the impact of GSCM on performance.

Theme 1 (Supply-Chain-Optimization Models for Sustainability on TBL). This theme relates to the optimization models developed for sustainable supply chains. Consumer awareness of environmental concerns, stricter environmental laws and legislations, and increasing competition have been identified as key drivers for adopting such Sustainability practices in Supply Chain [107]. This surging institutional pressures to adopt sustainability led to the development of sustainability in the supply chain, as a momentous topic in commerce [99,108], and to achieve the sustainability objective in SCs these optimization models have been developedBy applying decision theory [90], various decision-making models and support systems have come into view, like Multi-Objective Optimization Models [99], Mixed Integer linear Programming Models [100], and Nonlinear Programming models [109], using Artificial Intelligence tools [110] to attain optimal balance and tradeoff among the threefold goals of sustainability, viz., environmental, economic and social sustainability [111], popularly known as the triple bottom line [101]. Furthermore, stochastic models that incorporate uncertainties relating to different parameters have also been used [112]. These models are often tested through uncertainty and sensitivity analysis for changes in various parameters like consumer demand, risks, supply, returns, emission, etc. [113,114]. In these models, environmental sustainability is generally measured in terms of reduced emissions and wastes [115,116], economic sustainability is measured in terms of reduction in cost and increase in profitability [25,117], and social sustainability is measured in terms of the welfare of the society [118]. Besides these performances, customer satisfaction is also viewed as an important attribute for developing sustainable supply chains, through these models [119]. These models are developed to design *closed-loop* [120], *low-carbon* [102], *reverse* [113], *lean* [121], *energy-efficient* [122], *circular* [123], green [124], and resilient supply chains [125] and networks [126], ultimately leading to sustainable supply chains by optimizing divergent sustainability aspects simultaneously relating to the following: reduction in transportation cost [100], logistics optimization [89], and reduction in carbon emissions [127] through optimized freight transport [128] and route planning [117], reduction in procurement cost [129], sustainable manufacturing [101], sustainable outsourcing [130], optimal waste management [131], eco-efficient product designs [132], and improved profitability [117]. The literature focuses on building lean, green, resilient, closed-loop, and circular supply chains, for which various Multi-Criteria Decision-Making techniques like the Analytic Network Process [133], the Analytical Hierarchy Process [134], DEMATEL [135], Data Envelopment Analysis [35], etc., with or without fuzzy set theory and fuzzy logic to interpret the linguistic and qualitative data obtained from experts [136], have been used to determine the weights and indicators that are proposed as benchmarking tools for assessing the supply chains' sustainability [137]. Sustainable supplier selection is one of the key and frequently referred-to aspects of SSC, for which, together with AHP, ANP, DEA, and DEMATEL, TOPSIS is quite often used for ranking the suppliers, based on their sustainability performance [134]. Apart from that, various game theory models, like the Stackelberg model [138], the Nash model, Non-cooperative game [139], Cooperative game [140], etc., have been used among different SC members, viz., manufacturers, distributors, retailers, customers, collectors of goods, and governments, for different scenarios [138,141]. They have also been used for the

following: strategies relating to remanufacturing [141], cap and trade, and channel structures, viz. e-commerce and physical distribution channels [66], pricing strategy, delivery, marketing strategies, the technology adopted [138], R & D investment [142], degree of Corporate Social Responsibility, contracting structures [139], the extent of low-carbon behaviors of different supply chain members, including the customers [143], consumer green awareness [88], consumer green product demand [144], reverse logistics systems [145], product designing strategy [146], payment and credit policies [147], product quality [148], centralized and decentralized decision-making strategies, supply chain coordination [149], integration, collaboration [150] and power [151], government subsidies, policies and regulations, etc., to achieve the objective of sustainable supply chains and the circular economy [144]. Lastly, links among blockchain, operations management, sustainability issues, and SCM have been identified [125,152]. Many of the studies in these fields are undertaken in construction, food, and agri-food supply chains [103,133].

Proposition 1. The application of Multi-Objective Optimization models can enhance the sustainability of Supply Chains by developing optimal SC frameworks and trade-offs among the TBL Performances.

Theme 2 (Affiliating concepts to and relationship between Sustainable Supply Chain Strategies and TBL Performance in Manufacturing Sectors of Developing Countries). This theme studies the environmental economics in the supply chain, whereby various management practices and strategic approaches could be applied to fulfill the twin goals of environmental protection and economic development, thus conserving the natural resources exploited by human activities [54,153]. To evaluate this premise, empirical analysis of the impact of various corporate strategies, like environmental orientation [154], environmental dynamism, low-carbon and digital SCs [155], Industry 4.0 [43], knowledge sharing [156], the circular economy [157], green supply chain management [13], green practices [158], corporate social responsibility [159], green innovation [160], SSC risk management [161], SSC integration [162], etc. are carried out on firm industrial performance [163], with intervening variables like investment recovery [164], firm size [165], competitiveness [166] etc., predominantly in developing countries like China [106], India [167], Pakistan [153], and Brazil, in the manufacturing industry [168] in the small and medium-sized enterprise cadre [154]. Government rules, regulations, policies, and legislation have often been quoted as key factors influencing the adoption of circular supply chains [157], green supplier development programs [169], green development behaviors [170], and sustainable consumption and production [171]. Weights for these concepts are determined by integrating fuzzy mathematics with AHP [157]. The partial least squares structural equation modeling has often been used to evaluate numerical and conceptual models for environmental, economic, and social impact assessment under these concepts [172]. Much of the research shows a positive impact and influence of these environment-related practices in the supply chain on firms' performance [154,155]. Product innovation, process innovation [168], technological innovation [46], investment recovery [164], and supply chain integration [162] are found as the key mediators between SSCM and firms' performance. Moreover, GSCM and SSCM are found to be mediating the relationship between environmental management orientations, and sustainability performance [154]. Furthermore, institutional pressures and firm size are observed to moderate the relationship between SSCM and performance [165,173]. These models will help the managers and stakeholders of the organizations to assess the future prospects of these green management practices and environmental policies on business performance and development, ultimately leading to green industrial development [174]. There are also suggestions for the policymakers to formulate guidelines for overall green development and support to transport and logistics industrial enterprises, to solve environmental issues and lead toward a green economy [170].

Proposition 2. Sustainable Supply Chain and its affiliated practices positively influence firms' TBL performance.

Proposition 3. Green innovation (product, process, and technology), investment recovery, and supply chain integration mediate the relationship between sustainable supply chain management and TBL performance.

Proposition 4. The relationship between environmental orientation and TBL performance is mediated by green/sustainable supply chain management.

Theme 3 (Life Cycle Analysis of Natural Resource-Based Supply Chains for Sustain**ability Assessment).** This studies the environmental and economic impact of various product supply chains, like biomass supply chains [98], bioenergy supply chains [175], food supply chains [176], biofuel supply chains [177], fossil fuel supply chains, like petroleum supply chains [178], forestry-based supply chains, like wood supply chains for furniture, and firewood supply chains [179], minerals [180], and agriculture supply chains like mushroom farms [181], palm oil supply chains [182], coffee supply chains [183], etc., through life cycle analysis [32], cost-benefit Analysis (CBA) [184], multi-regional input-output analysis (MRIO) [98], economic analysis, and energy assessment, to evaluate their greenhouse gas emissions, carbon emission [185], energy utilization [181], eutrophication, costs, profitability, global warming, and the pollution they cause [186], 2014). It also covers the eco-designing aspect of the supply chain, whereby different product designs are assessed through LCA for choosing the designs with lesser environmental impacts [179]. In several instances, LCA has shown a positive impact for recycling materials on curbing environmental burdens [187]. Based on the LCA and LCCA (life-cycle cost analysis), optimization models like stochastic optimization models have also been developed by using genetic algorithms for supply chains like biomass, bioethanol, etc., inculcating the uncertainty aspect affiliated with them to optimize the collection, logistics, feedstock consumption, land use, and product design, in terms of their cost and ecological impact [188,189].

Proposition 5. *Effective implementation of LCA and LCCA analysis could lead to eco-product design and reduction in manufacturing cost, thus steering towards sustainable manufacturing.*

Theme 4 (Factors Influencing, and Performance Impacted by, Green Supply-Chain Man**agement).** This theme revolves around the specific sustainability concept of green supply-chain management. The studies relate to the field of industrial economics [190] where some studies talk about the enablers [191], drivers [192], or influencers of GSCM [193], while others talk about the different performances impacted due to the adoption of GSCM [194]. The studies on this theme mostly relate to industrial research in small and medium enterprises [195], in manufacturing sectors like electronics, automotives, in emerging and developing economies [196,197]. Various relationship models have been created among knowledge management [198], green human resource management [199], Industry 4.0 [200], sustainable operations [201], supply chain integration [194], Information Management technologies like Big Data analytics [202], quality control practices and quality information management like total quality management [84], competitive advantage [203], green innovation [204], corporate social responsibility [205], etc. with green supply chain management as the focal aspect [199]. These models have been tested for consistency, validity, and reliability, using multivariate analysis like Confirmatory Factor Analysis [206], Exploratory Factor Analysis [207], etc. Supply chain collaboration [208], big data [202], and Industry 4.0 have been found to be key influencers on green supply-chain practices [209]. Furthermore, drawing upon the resource-based view [210], green supply-chain management practices and the affiliating concepts have been checked for their impact on performance in similar aspects, with differences in nomenclature, viz., firm performance [211], economic performance, operational performance [212], organizational performance [213], business performance [214], social performance, financial performance [203], and sustainable performance [215]. The studies are prominently conducted by designing survey questionnaires for managers, while the relationship among the different concepts has been established using the partial least squares structural equation modeling method and regression analysis [212,215]. The prominent sustainability practices highlighted in the studies are green manufacturing, also referred to as sustainable production [200], green products [205], and the maintenance of an environmental management system [77]. Many studies portray a positive

impact of GSCM practices on competitive advantage and TBL performance in terms of increased sales, improved returns, pollution control, reduction in emissions and waste, and the welfare of society at large [204,216]. Operational and environmental performance are seen to be mediating the relationship between GSCM and performance [217,218], whereas several firm-specific characteristics, like industry type, firm size, export orientation, and ISO certification moderate the relationship between the two [210,219]. Moreover, it is also seen that innovation acts both as a mediator and moderator in the relationship [220,221]. These relationship studies provide managerial implications for the government, manufacturers, and company managers, regarding the steps and interventions required to be taken for fostering the adoption of GSCM or its affiliated practices [222,223].

Proposition 6. There is a positive impact of GSCM practices on competitive advantage, environmental performance, and economic performance.

Proposition 7. *Operational and environmental performance mediates the relationship between GSCM and economic performance.*

Proposition 8. *Innovation acts both as a mediator and moderator in the relationship between GSCM and performance.*

Proposition 9. *Industry type, export orientation, ISO certification, and firm size moderate the relationship b/w GSCM practices and firms' performance.*

Proposition 10. *Supply chain collaboration, green innovation, big data, and Industry 4.0 influence green supply-chain practices and improve sustainability performance.*

5. Conclusions

This study espoused a bibliometric analysis of 938 reviews and articles identified through the Scopus database in the collective domain of GSCM and performance, by utilizing the Biblioshiny Package of Rstudio (4.4.0). Firstly, it threw light on the descriptives of the literature and analyzed the trends in reporting among authors, countries, and sources. Secondly, it undertook to analyze the trending topics, the different themes concerning the fields, and the thematic evolution of the themes in the last decade. Moreover, it analyzed the collaboration in the field among countries and authors. The study highlighted the top sources, authors, and countries that could be used for consideration in future research. There are emerging and niche themes identified in the analysis that can be taken into consideration for future research that inculcates environmental analysis through life cycle assessment and performance assessment of sustainability practices. Moreover, the study analyzed the thematic evolution of the themes through time slice analysis, wherein it was found that from 2014 to 2018, sustainability concerns have been integrated along the supply chain, and from 2018 to 2022 new concepts like green manufacturing and environmental management have emerged, which are checked for the financial performance and cost reduction capabilities by using methodologies like the multi-objective optimization model, integer programming, etc. Research gaps in author and country collaborations have been found, wherein author collaborations are found to be too scattered, and collaborations of countries like Bangladesh and Belgium are too meager. Lastly, a content analysis of the identified themes based on thematic analysis has been undertaken to probe the methodologies, affiliating concepts, influencers, drivers, and the impact of GSCM practices on TBL performance. The findings of this bibliometric and content analysis relevant to the seven RQs are noted below:

F1 to RQ1: Sarkis J., Govindan K., and Khan S.A.R. are the top-three authors for these two fields. Journal of Cleaner Production, Sustainability (Switzerland), and International Journal of Production Economics are the top-three sources. China, followed by the U.K. and India, are the top three countries contributing to these fields.

F2 to RQ2: closed-loop supply chains, digital supply chains, Industry 4.0, the circular economy, and social performance are the trending topics in GSCM and performance. More-

over, three clusters are identified, based on the coupling of authors' keywords viz., Cluster 1: "supply chain management-Green Supply Chain Management-Environmental Management", Cluster 2: "sustainable development-Supply Chain Management-Supply Chains", and Cluster 3: "supply chain management-Sustainable Development-Performance Assessment", wherein cluster 3 has highest centrality and cluster 1 has the highest impact. In addition, four clusters are identified, based on thematic analysis, viz., "supply chain management", "sustainability", "environmental impact", and "green supply chain management", wherein the "supply chain management" cluster is highest on centrality, dealing in supply chain optimization models, and "sustainability" is highest on density, dealing with SSCM and its affiliating concepts. The four key themes identified on the basis of thematic analysis are renamed on the basis of the content and context of these themes, which are discussed in detail in the content analysis section. These are the following: 1. Supply-Chain-Optimization Models for Sustainability on TBL, 2. Affiliating concepts to, and relationship between, Sustainable Supply Chain Strategies and TBL Performance in Manufacturing Sectors of Developing Countries, 3. Life Cycle Analysis of Natural-Resource-Based Supply Chains for Sustainability Assessment, and 4. Factors Influencing, and Performance Impacted by, Green Supply-Chain Management.

F3 to RQ3: multi-objective optimization models, mixed-integer linear programming models, nonlinear programming models, stochastic models with sensitivity analysis, and game theoretical models are used to develop and foster SSCs. Further, multi-criteria decision-making techniques like ANP, AHP, DEMATEL, DEA, etc., with and without fuzzy set theory have been used to determine the weights and indicators for sustainability. Moreover, LCA, LCCA, CBA, MRIO analysis, economic analysis, and energy assessment analysis have been used to assess and compare the different natural-resource-based supply chains, to spot the efficient ones. Lastly, regression analysis, and structural equation modeling have been used to establish relationships between various aspects of sustainable supply chains and performance.

F4 to RQ4: environmental orientation, environmental dynamism, low-carbon, and digital SCs, Industry 4.0 integration with SSC, knowledge sharing for sustainability, the circular economy, green supply-chain management, green practices, CLSC, RL, corporate social responsibility, green innovation, SSC risk management, and SSC integration and collaboration, are found to be affiliating concepts to sustainable supply chains.

F5 to RQ5: consumer awareness of environmental concerns, stricter environmental laws and legislations, and increasing competition have been identified as key drivers for adopting green practices, while supply chain collaboration, green innovation, big data, and Industry 4.0 are key influencers for SSCM.

F6 to RQ6: Much of the research supports a positive impact of green and sustainable supply chain management on firms' performance.

F7 to RQ7: China and the U.K. have the highest no. of collaborations, followed by China and the USA, the U.K. and India, and China and Pakistan. Bangladesh and Belgium have the least collaborations. Moreover, it has been observed that authors are collaborating in the fields of SSCM, CE, CLSC, reverse logistics, low-carbon SCs, GSCM, digital technology, green innovation, machine learning, blockchain and Industry 4.0, TBL performance, green human resource management, green logistics, digital twin, uncertainty and risk factors associated with GSCM, sustainable consumption and its barriers, big data, lean and sustainable innovation practices, SC transparency, resilience, and flexibility, cap and trade regulations for emissions, and compliance and commitment effects in SSCs.

This research will facilitate future research in picking up the right theme, author, country collaboration, intervening variables, and methodologies in the realm of GSCM and performance. Moreover, researchers are guided to explore the propositions developed, based on the content analysis of the themes identified. The study lacks in taking documents with fewer than 30 citations, taking only the most influential documents, which limits the no. of documents of recent years. Future research could carry out a holistic examination of all the studies, irrespective of the no. of citations, to have a clearer picture.

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