

A Bibliometric Analysis of Green Supply Chain Management Practices : Trends, Challenges, and Future Research

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Abstract: This study presents a bibliometric analysis of Green Supply Chain Management, focusing on key trends, emerging themes and challenges. Green Supply Chain Management (GSCM) in universities transcends conventional procurement methods to include sustainable campus operations, environmentally responsible purchasing policies, waste minimisation, and green logistics. This systematic review analyses recent studies on GSCM trends and challenges from 2002 to 2025. Articles were methodically obtained from Scopus, focusing on peer-reviewed research that examines the incorporation of environmental sustainability concepts in campus supply chains. The finding indicate that dominants contributors to sustainability research include the China, India and United States with leading and contribute to publication. The study identifies core research themes, including integration of technology, environmental and industry in Green Supply Chain Management. Research indicates an increasing inclination towards sustainable procurement strategies, zero-waste programs, circular economy frameworks, and the integration of digital technologies to improve environmental performance. However, considerable obstacles persist, such as insufficient stakeholder involvement, poor sustainable supply networks, and budgetary limitations. This analysis closes by suggesting research avenues that promote comprehensive sustainability frameworks, inter-campus collaborations, and the use of intelligent technology to enhance GSCM practices in higher education institutions. Furthermore, subsequent research ought to examine data from Web of Science, Google Scholar, dimensions and others. Combining different datasets could lead to interesting and important results.

Keywords: Bibliometric, Green Supply Chain Management, Green Supply Chain, Green Innovation, Sustainability Supply Chain, Environmental Sustainability

1. Introduction

Environmental sustainability has arisen as a crucial issue amid growing climate change impacts, pollution, and resource depletion challenges globally (United Nations, 2022). Malaysia is positioned 106th among 180 nations in the 2024 Nature Conservation Index, which evaluates worldwide conservation initiatives. In Southeast Asia, Malaysia is positioned third, following Thailand at 80 and Brunei at 103. It surpasses Indonesia at 122, Vietnam at 142, the Philippines at 148, Cambodia at 159, Singapore at 166, and Myanmar at 167 (The star, 2024). Universities, as essential



institutions of information creation and society progress, bear a significant obligation to exemplify sustainability. In addition to their educational objectives, universities operate as intricate entities with comprehensive supply chain activities that include procurement, construction, energy utilisation, logistics, and waste management. As worldwide focus on environmental sustainability escalates, universities are progressively incorporating Green Supply Chain Management (GSCM) principles into their operational frameworks to mitigate environmental effects and align with global sustainable development goals (SDGs). Its relate to SDGs 11 which is sustainable cities and communities. Green Supply Chain Management on university campuses entails the implementation of environmentally sustainable practices throughout the entire supply chain lifecycle, encompassing green procurement, sustainable vendor selection, eco-conscious campus logistics, green construction initiatives, and waste reduction strategies.

Green Supply Chain Management (GSCM) practices encompass innovations in acquisition, production, distribution, and logistics processes. Consequently, to effectively implement supply chain greening, companies must exert considerable effort to modify or adapt their products, processes, and management, frequently necessitating the adoption of new business models. Business innovation procedures are essential for reducing costs and enhancing effectiveness (Melander, 2017; Silva et al., 2019). The implementation of GSCM techniques, driven by EM pressures, necessitates modifications in the company's technical systems, demanding new processes across the supply chain. As GSCM practices advance, innovations in processes, products, organisations, and marketing will be cultivated and refined (Jabbour et al., 2014; Leifer et al., 2001). Consequently, companies will enhance their innovative capacities across all domains, not solely in environmental matters (Birkinshaw et al., 2008; Sancha et al., 2015; Wang and Sarkis, 2013; Holt, 2004).

According to Sarkis and Lai (2008), companies giving green procurement first priority have better environmental performance and competitive benefits by means of improved brand image and customer loyalty. Often linked to McKinnon's (2010) concept of a circular economy, green supply chains aim to extend product lifecycles by means of reuse, refurbishing, and recycling. Aiming to reduce waste and conserve natural resources, Guide and Van Wassenhove (2009) looked at how companies used closed loop supply chains to recover value from wasted goods and materials. GSCM has several benefits, the study points out certain difficulties related to its application. The supply chain sector is increasingly focusing on remanufacturing, incorporating it into Green Supply Chain Management (GSCM). As depicted in Figure 1, these solutions substantially advance circular economic objectives.

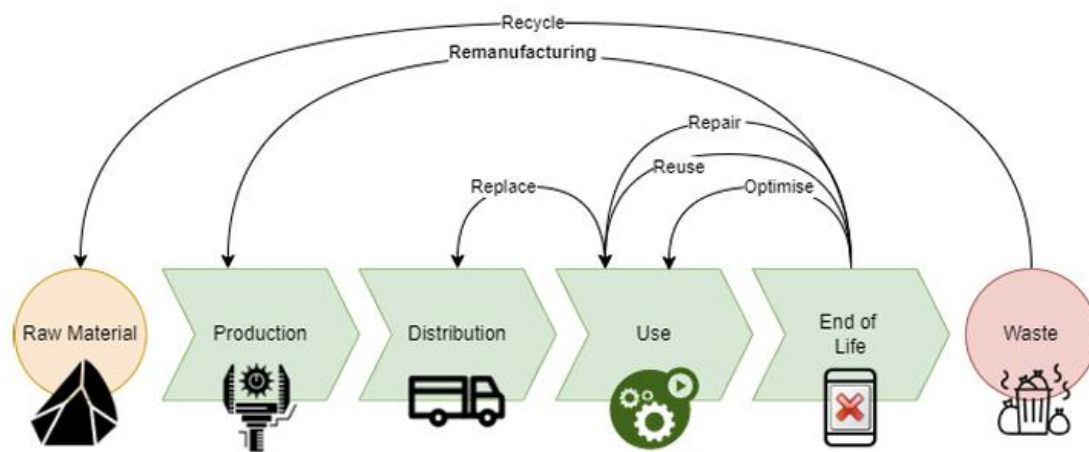


Figure 1 : Role of remanufacturing in Circular Economic Source: Shahbaz & Sadia (2022)

Higher education institutions (HEIs) have a deep role and obligation in allowing the transition towards sustainable development, which balances economic success, societal justice and environmental viability (United Nations, 2022). As educators of future leaders across government, public society and industrial sectors, universities build attitudes, competences and ethics underpinning professional and personal conduct. Demonstrating commitment via formal sustainability education as well as campus greening projects further improves academia's change

stewardship, as evidenced in recent analyses of university sustainability practices (Shange et al., 2025; Mishra et al., 2022). From 2020 to 2025, the COVID-19 pandemic, technical advancements, and regulatory pressures have expedited the implementation of sustainable supply chain efforts in higher education institutions globally. The application of GSCM on university campuses encounters distinct hurdles in contrast to industrial or commercial environments. Financial limitations, varied stakeholder interests, and the educational goals of institutions require customised GSCM strategies that harmonise operational sustainability with academic aims. Within their institutional ecosystem, university campus have the benefits of demonstrating sustainability model integrated with their teaching and research missions through campus greening initiatives around energy, water, waste and mobility systems, creating living labs for wider adoption (Jain et al., 2013; Mishra et al., 2022). As sizeable residential communities, the implementation opportunities as well as visibility gains are noteworthy. Purposeful engagement via conferences, student volunteering partnerships and community green drives can further spread momentum regionally. This study uses the BiblioMagika and VOSviewer software to conduct this analysis. To curate a rich bibliometric overview of Green Supply Chain Management, this study explores three research questions (RQ) as follows:

RQ1: What is the trend of publication and citations on Green Supply Chain Management over time?

RQ2: Who are the most prolific contributors (authors, institutions, and countries) in Green Supply Chain Management research related to University?

RQ3: What are the main research themes and emerging topics in Green Supply Chain Management studies related to University?

The following sections of this work are structured as outlined below. Section 2 delineates the literature study and advancements in Green Supply Chain Management (GSCM). Section 3 outlines the technique for the bibliometric analysis of Green Supply Chain Management (GSCM). Section 4 offers a results, analysis of new discoveries and a discourse. Section 5 closes the review by discussing current issues. Section 6 is conclusion and offering directions for future research.

2. LITERATURE REVIEW

The academic literature on sustainable supply chain management has grown significantly in the last two decades and has been driven by the increased pressure on stakeholders and legal requirements that support the adoption of corporate responsibility towards the environment. The initial research in this area mainly focused on integrating environmental issues into supply chain operations, and the individuals that were given special attention included green procurement, eco-design, and reverse logistics (Srivastava 2007). One of the first and more detailed models of sustainable supply chain management has been developed by Seuring and Muller (2008), who emphasized the necessity of applying sustainability in the context of supply chain coordination and supplier relationship management. Their discussion pointed out that sustainable supply chains require partners to work together in order to reduce environmental effects without compromising the economic performance. Similarly, Carter and Rogers (2008) came up with a theory that suggests that sustainability might be used to increase the competitiveness of organizations by providing long term value through the responsible management of resources and through the involvement of stakeholders. The concept of environmental sustainability becomes a theme that is predominant in the SSCM literature. Articles on assessing environmental management practices, carbon reduction efforts and planning of efficient production systems are regularly published in journals like the Journal of Cleaner Production and Environmental Science and Pollution Research. As an example, Govindan et al. (2015) emphasized the importance of closed loop supply chains and reverse logistics as a way of decreasing waste and enhancing resource efficiency. Another important area of concern is the supply chain uncertainty and risk management. The growing nature of global supply chains presents firms with a range of disruptions such as natural disasters, geopolitical disasters, and fluctuations in the market. In turn, researchers have scaled up their analysis of approaches to enhance resilience and adaptability of supply chain. Ivanov et al. (2019) highlighted the applicability of digital technologies and advanced analytics to the improvement of resilience and to the creation of powerful decision making in the conditions of uncertainty. Another contribution to the sustainability literature is strategic management views. Empirical studies

published in such journals like the Business Strategy and the Environment, and Benchmarking, often examine the effects of sustainability efforts on corporate performance and competition. The concept of shared value was also stated by Porter and Kramer (2011), who suggested that companies can create economic advantages as well as confront social and environmental issues. This paradigm illustrates the way in which sustainability actions may be considered a part of corporate strategy and not just a mandatory requirement. Besides that, the operational aspect of the SSCM has been well discussed in articles such as the International Journal of Production Economics and the International Journal of Production Research. Such studies generally use the quantitative methods of mathematical modeling, simulation, and optimization to study sustainable production planning, transportation systems, and inventory management. Such techniques allow the researcher to evaluate the trade offs associated with environmental and economic performance, hence, offering decision supporting tools to the practitioner. In spite of the growing literature, there are still substantive issues in regard to the adoption of sustainable supply chains. Companies are often faced with the challenge of balancing the environmental goals and cost efficiency and effectiveness of operations. Additionally, sustainability principles implemented across the supply chains spread globally require alignment of an enormous number of stakeholders with a wide variety of interests and capacities. On the whole, the available literature shows that sustainable supply chain management is an increasingly popular field that is interdisciplinary in its methodologies and has a diverse analytical viewpoint. The corresponding academic research is also necessary to understand new solutions that will help organizations to realize the goals of sustainability and remain competitive in the context of more complex global markets.

TABLE 1
SUMMARIZE OF KEY THEORETICAL OF GREEN SUPPLY CHAIN MANAGEMENT

Category	Sub-category	Description	Citation
Green Supply Chain Management Overview	Definition and Scope	GSCM integrates environmental considerations into supply chain operations, encompassing product design, material sourcing, manufacturing processes, and end-of-life management.	Green et al. (2012); Srivastava (2007)
	Drivers and Benefits	The adoption of GSCM is driven by regulatory pressure, competitive dynamics, and stakeholder expectations, enabling organizations to improve environmental performance and operational competitiveness.	Zhu & Sarkis (2007); Seuring & Müller (2008)
	Competitive Advantages	GSCM drives competitiveness and sustainability by refocusing value-creation and embracing the triple-bottom line, which	Carter & Rogers (2008); Zhang et al. (2022)

		integrates economic, environmental, and social performance	
Green Supply Chain Practices	Green Purchasing	Organizations evaluate and screening suppliers based on environmental performance to ensure compliance with environmental regulations and sustainability standards.	Sahoo & Vijayvargy, (2020), Zhu et al. (2013)
	Stakeholder Engagement and Collaboration	Collaboration with supply chain partners, such as green suppliers, logistics and customers, is a key aspect of GSCM, fostering information sharing and shared sustainability goals.	Vachon & Klassen (2008); Seuring & Müller (2008)
Challenges and Barriers	Implementation Costs	High implementation costs, including technological upgrades and supplier development, can hinder the adoption of GSCM practices, posing a financial challenge for organizations.	Govindan et al. (2014); Srivastava (2007)
	Lack of Awareness	Limited awareness and understanding of GSCM benefits and practices among managers and employees may hinder successful implementation, emphasizing the need for training and knowledge development.	Testa & Iraldo (2010); Zhu et al. (2013)

Green supply chain management implementation is deterred by a lack of government initiatives and commitment from companies within the supply chain (Jaggernath & Khan, 2015). Table 1 lists the key theoretical dimensions of Green Supply Chain Management as outlined in the previous scholarly research. As discussed literature, GSCM transcends the concept of environmental integration in the processes of supply chains to include strategic coordination of stakeholders, and the organizational abilities necessary to overcome the obstacles to implementation.

A. Theoretical Perspectives Underpinning GSCM Studies

From the research, there are many recent studies on GSCM on university campuses. Example Chang et al. (2021) and Al-Ali et al. (2023) claim colleges use green supply chain strategies to adapt to outside limits from funding agencies, regulatory bodies, and public expectations. This institutional isomorphism drives colleges to look for legitimacy through environmental policies. The Resource-Based View (RBV), as shown by Lee and Choi (2022), holds that sustainable supply chain practices operate as strategic assets, hence increasing a university's competitive advantage in drawing students, faculty, and outside funding. GSCM enables enterprises to attain cost savings through recycling and reuse procedures (Machogu, 2014), which can assist colleges in reducing expenses. Moreover, the effective execution of GSCM techniques enables a company to reduce its environmental impact and circumvent legal expenses associated with non-compliance with environmental legislation (Gavronski, 2011).

The stakeholder theory is based on the necessity to acknowledge that the organisation has obligations to principal interest groups that may be impacted by its actions (Freeman R. E., 2015). According to Xu et al (2022), successful Green Supply Chain Management (GSCM) initiatives call for alignment with the expectations and values of both internal and external stakeholders, including students, staff, government agencies, and the local community. Due to the divergent interests of various groups, the organisation must address the incompatibility of expectations and maintain equilibrium. Managers are consequently confronted with the formidable issue of balancing the diverse expectations of all stakeholders, as each holds significance (Chan et al., 2018). Customers are essential for the corporation to generate income and may require environmentally friendly products, which investors can consider undesirable due to the high initial investment costs associated with green production. Given that customers may transition to alternative items that fulfil their demand for environmentally friendly options, managers must reevaluate their manufacturing plan accordingly. These theoretical models provide a strong foundation for understanding the enablers and barriers of GSCM adoption in academic settings. Over the last five years, research on Green Supply Chain Management (GSCM) on university campuses has grown dramatically. Emphasising theoretical foundations, methods used, and emerging patterns in scholarly debate, this part looks at notable contributions.

3. METHODOLOGY

A. Study Design

This study adopted a bibliometric research design, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, to systematically analyse Green Supply Chain Management Practises in University Campuses. Bibliometric analysis was selected because it enables the quantitative assessment of publication patterns, research impact, and collaboration networks, offering robust evidence to inform policy and research agendas. The design aligns with previous studies that have successfully used bibliometric methods to examine emerging health and technology fields.

B. Data Sources and Search Strategy

The Scopus database was chosen as the primary data source due to its comprehensive coverage of peer-reviewed scientific literature. A structured search query was developed to capture relevant documents related to Green Supply Chain Management (GSCM). Keywords such as “green supply chain management” were applied in titles. The search was conducted in December 2025, and the timespan was set from 2002 to 2025 to capture the evolution of the field.

C. Inclusion and Exclusion Criteria

Publications were included if they explicitly addressed the use of analyse Green Supply Chain Management Practises in University Campuses. This screening process ensured that the dataset reflected scholarly contributions directly relevant to analyse Green Supply Chain Management Practises in University Campuses.

D. Data Extraction and Analysis

The bibliographic data were exported in RIS and CSV formats for further processing. Variables extracted included year of publication, authorship, institutional affiliation, country of origin, source journals, citation counts, and keywords. Data cleaning was performed to standardize author names and affiliations, and duplicates were removed. Figure 1 depicts the structure of database and registry searches.

E. Bibliometric Tools

Three complementary bibliometric software tools were employed. VOSviewer was used for visualization of co-authorship, co-citation, and keyword co-occurrence networks. Publish or Perish was applied to calculate citation metrics such as the h-index, g-index, and average citations per year.

F. Ethical Considerations

This study utilized secondary bibliometric data extracted from Scopus, which are publicly available and do not involve human subjects. Therefore, no ethical approval was required. However, all analyses were conducted with transparency and reproducibility in mind, adhering to good research practices in bibliometrics. Figure 2 depicts the PRISMA flow diagram.

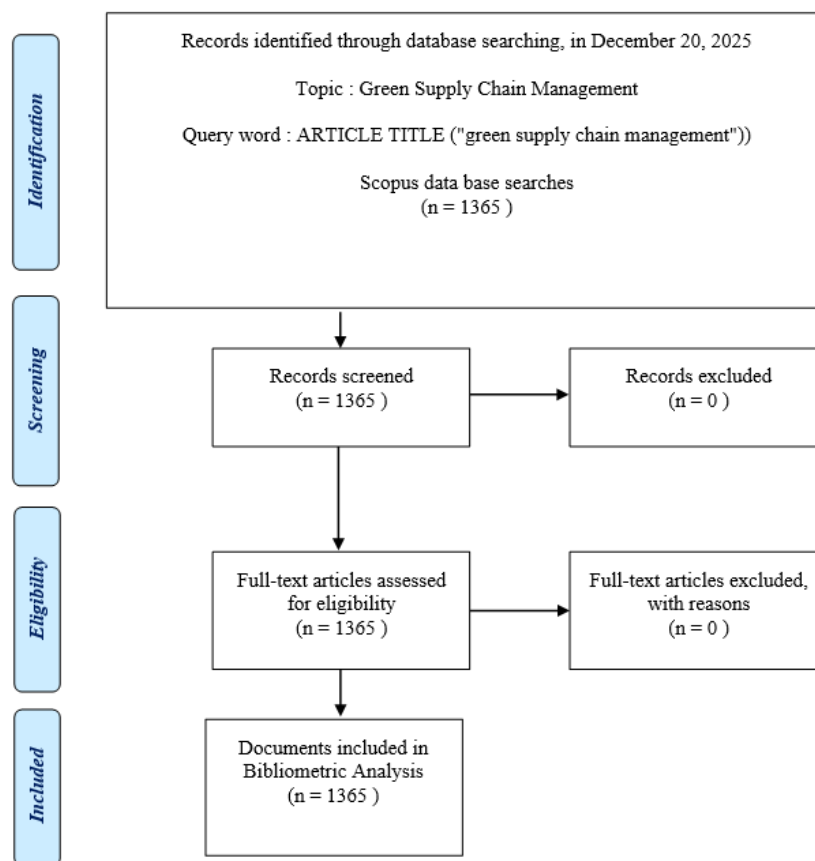


Figure 2 PRISMA Flow Diagram

Source: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 6(7): e1000097. doi:10.1371/journal.pmed1000097

4. RESULT

A. Document Profiles

A total of 1365 documents on Green Supply Chain Management were retrieved from Scopus covering the period from 2002 to 2025. Table 2 presents the distribution of document types. Articles accounted for the largest share (68.06%), followed by conference papers (17%) and book chapter (8.64%). and other forms such as reviews, erratum, retracted, book, editorial and letters. This distribution demonstrates that Green Supply Chain Management is a well established academic field with a strong balance between empirical studies and conceptual work.

TABLE 2
DOCUMENT TYPE

Document Type	TP	%
Article	929	68.06%
Conference Paper	232	17.00%
Book Chapter	118	8.64%
Review	55	4.03%
Erratum	11	0.81%
Retracted	9	0.66%
Book	5	0.37%
Editorial	4	0.29%
Letter	2	0.15%

Note : TP = total number of publications

Source type analysis (Table 3) revealed that journals were the primary publication outlets (73.92%), followed by conference proceeding (13.19%), and books (7.11%). This indicates that while journal articles dominate dissemination, conference proceedings remain an important avenue for presenting technological innovations in this field.

TABLE 3
SOURCE TYPE

Source Type	TP	%
Journal	1009	73.92%
Conference Proceeding	180	13.19%
Book	97	7.11%
Book Series	78	5.71%
Trade Journal	1	0.07%

Note : TP = total number of publications

Regarding language (Table 4), the overwhelming majority of documents were published in English (99.05%), followed by Portuguese (0.51%) and Chinese (0.22%). Publications in other languages such as Arabic, German, Indonesian, Russian and Spanish were minimal, underscoring the dominance of English as the lingua franca of Green Supply Chain Management research.

TABLE 4
LANGUAGES

Language	TP	%
English	1352	99.05%
Portuguese	7	0.51%
Chinese	3	0.22%
Arabic	1	0.07%
German	1	0.07%

Indonesian	1	0.07%
Russian	1	0.07%
Spanish	1	0.07%

Note : TP = total number of publications

Subject area classification (Table 5) highlighted the interdisciplinary nature of the field. Business, Management and Accounting (53.41%) and Engineering (35.75%) accounted for the highest shares, followed by Environmental Science (26.74%) and Computer Science (23.15%). These findings confirm that Green Supply Chain Management spans multiple domains, integrating business, technology, and social sciences.

TABLE 5
SUBJECT AREA

Subject Area	TP	%
Business, Management and Accounting	729	53.41%
Engineering	488	35.75%
Environmental Science	365	26.74%
Computer Science	316	23.15%
Decision Sciences	312	22.86%
Social Sciences	236	17.29%
Energy	184	13.48%
Economics, Econometrics and Finance	175	12.82%
Mathematics	70	5.13%
Materials Science	42	3.08%
Agricultural and Biological Sciences	25	1.83%
Chemical Engineering	21	1.54%
Medicine	20	1.47%
Earth and Planetary Sciences	19	1.39%
Physics and Astronomy	18	1.32%
Multidisciplinary	14	1.03%
Biochemistry, Genetics and Molecular Biology	12	0.88%
Psychology	11	0.81%
Arts and Humanities	10	0.73%
Chemistry	5	0.37%
Health Professions	2	0.15%
Pharmacology, Toxicology and Pharmaceutics	1	0.07%

Note : TP = total number of publications

B. Research Trends On GSCM

Descriptive analysis of annual publication growth, addressing trends and impacts of publications in GSCM. A detailed statistical summary of the annual publications of GSCM is presented in Table 6. Research activity was sporadic during the 2018s and early 2025s, with fewer than ten publications per year. A marked increase occurred from 2012 onwards, with the most productive years being 2024 (12.09%) and 2023 (11.06%). Publications in 2024

showed the largest compared to other years, with 165 documents. The citation trend mirrored publication growth, indicating a maturing field with increasing academic influence.

TABLE 6
YEAR PUBLICATIONS

Year	TP	%
2025	117	8.57%
2024	165	12.09%
2023	151	11.06%
2022	117	8.57%
2021	87	6.37%
2020	119	8.72%
2019	103	7.55%
2018	95	6.96%
2017	63	4.62%
2016	64	4.69%
2015	44	3.22%
2014	60	4.40%
2013	49	3.59%
2012	33	2.42%
2011	29	2.12%
2010	19	1.39%
2009	15	1.10%
2008	15	1.10%
2007	6	0.44%
2006	5	0.37%
2005	3	0.22%
2004	3	0.22%
2003	1	0.07%
2002	2	0.15%

Note : TP = total number of publications

C. Publication By Countries

From the Scopus database that has been collected, there are researchers from 88 countries who have published documents on Green Supply Chain Management research. Table 7 and Figure 3 illustrate the global contributions to Green Supply Chain Management research. The China ranked first with 329 publications (24.10%), followed by the

India (16.19%), United States (8.21%). Other active contributors included Indonesia, United Kingdom, Pakistan, Taiwan, Brazil, and Iran. Malaysia contributed 106 publications (7.77%), placing it within the top 10 most productive countries. Although modest compared to Western nations, Malaysia's contributions indicate a growing recognition of the importance of Green Supply Chain Management for addressing demographic aging.

TABLE 7
TOP 10 COUNTRIES CONTRIBUTED TO THE PUBLICATIONS

Country	TP	%	Continent
China	329	24.10%	Asia
India	221	16.19%	Asia
United States	112	8.21%	North America
Malaysia	106	7.77%	Asia
Indonesia	100	7.33%	Asia
United Kingdom	89	6.52%	Europe
Pakistan	75	5.49%	Asia
Taiwan	75	5.49%	Asia
Brazil	54	3.96%	South America
Iran	52	3.81%	Asia

Note : TP = total number of publications

Figure 3 Geographical Distribution of Publication

D. Institutional Contributions

Institutional analysis (Table 8) revealed that Dalian University of Technology (China) was the most productive with 29 publications (2.05%). Other leading institutions included Universiti Sains Malaysia and School of Management at Clark University (20 each), Universidade Estadual Paulista Júlio de Mesquita Filho and Suan Sunandha Rajabhat University (19 each). In Malaysia, Universiti Sains Malaysia and Universiti Teknologi Malaysia were among the top contributors, reflecting emerging regional leadership in this research domain.

TABLE 8
TOP 10 MOST INFLUENTIAL INSTITUTIONS

Institution	TP	%
Dalian University of Technology	29	2.05%
Universiti Sains Malaysia	20	1.47%
School of Management at Clark University	20	1.47%
Universidade Estadual Paulista Júlio de Mesquita Filho	19	1.39%
Suan Sunandha Rajabhat University	19	1.39%
Syddansk Universitet	16	1.17%
The Hong Kong Polytechnic University	15	1.10%
University of Science and Technology Beijing	13	0.95%
Universiti Teknologi Malaysia	13	0.95%

E. Most Productive Authors

Table 9 summarizes the most productive authors. Zhu, Q. led with 28 publications (2.05%), followed by Sarkis, J. with 26 publications (1.90%) each. Govindan, K. (1.17%) were also among the most influential contributors. These scholars represent leading voices in shaping the global discourse on Green Supply Chain Management.

TABLE 9
MOST PRODUCTIVE AUTHORS

Author Name	TP	%
Zhu, Q.	28	2.05%
Sarkis, J.	26	1.90%
Govindan, K.	16	1.17%
Jabbour, C.J.C.	14	1.03%
Mathiyazhagan, K.	13	0.95%
Tseng, M.L.	11	0.81%
Geng, Y.	10	0.73%
Kant, R.	10	0.73%
Luthra, S.	9	0.66%
Malviya, R.K.	9	0.66%

F. Publication By Source Titles

Analysis of source titles revealed that Sustainability Switzerland was the most active publication outlet with 65 documents (4.76%), underscoring its role as the leading specialist journal in the field (Table 10). Other prominent sources included the Green Supply Chain Management, which contributed 63 documents (4.62%), reflecting the strong involvement of computer science in technological innovation for aging populations. Additional important outlets were the International Journal of Supply Chain Management 41 papers (3.00%). Together, these sources highlight the interdisciplinary nature of Green Supply Chain Management, spanning medical informatics, engineering, public health, and applied computer science.

TABLE 10
MOST ACTIVE SOURCE TITLE

Source Title	TP	%
Sustainability Switzerland	65	4.76%
Journal of Cleaner Production	63	4.62%
International Journal of Supply Chain Management	41	3.00%
Uncertain Supply Chain Management	34	2.49%
Environmental Science and Pollution Research	31	2.27%
Benchmarking	23	1.68%
International Journal of Logistics Systems and Management	22	1.61%
Business Strategy and the Environment	21	1.54%
International Journal of Production Economics	14	1.03%
International Journal of Production Research	14	1.03%

G. Citation Analysis

The retrieved dataset of 1365 papers accumulated a total of 75,208 citations over a 23-year period (2002–2025), averaging 3269.91 citations per year (Table 11). Each paper received an average of 55.10 citations, while the dataset achieved an h-index of 137 and a g-index of 250, indicating both breadth and depth of scholarly impact.

TABLE 11
CITATIONS METRICS

Metrics	Data
Publication years	2002-2025
Citation years	23 (2002-2025)
Papers	1365
Citations	75208
Citations/year	3269.91
Citations/paper	55.10
Citations/author	29905.23
Papers/author	543.90
Authors/paper	3.22
h-index	137
g-index	250

Table 12 lists the ten most highly cited articles based on the Scopus database depending on the total number of citations for each document. The most cited work was by S.K. Srivastava (2007), Green supply-chain management: A state-of-the-art literature review, with 3088 citations and an average of 171.56 citations per year. This was followed by Q. Zhu, and J. Sarkis (2004) for article entitled “Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises” (2221 citations) and J. Sarkis, Q. Zhu, K.H. Lai, (2011), for article entitled “An organizational theoretic review of green supply chain management literature” (1759 citations). Other influential works included B. Fahimnia, J. Sarkis, H. Davarzani (2015) for article entitled “Green supply chain management: A review and bibliometric analysis” (1594 citations), Q. Zhu, J. Sarkis, K.H. Lai (2008) for article entitled “Confirmation of a measurement model for green supply chain management practices implementation” (1249 citations). Collectively, these studies emphasize the green supply chain management in shaping the field.

TABLE 12
HIGHLY CITED ARTICLES

Authors	Title	Year	Source	ECC	Cites Per Year	Cites Per Author
S.K. Srivastava	Green supply-chain management: A state-of-the-art literature review	2007	International Journal of Management Reviews, Vol. 9 (1), 53-80	3088	171.56	3088
Q. ZHU, J. Sarkis	Relationships between operational practices and performance among early	2004	Journal of Operations Management, Vol. 22 (3), 265-289	2221	105.76	1111

	adopters of green supply chain management practices in Chinese manufacturing enterprises					
J. Sarkis, Q. ZHU, K.-H. Lai	An organizational theoretic review of green supply chain management literature	2011	International Journal of Production Economics, Vol. 130 (1), 1-15	1759	125.64	586
B. Fahimnia, J. Sarkis, H. Davarzani	Green supply chain management: A review and bibliometric analysis	2015	International Journal of Production Economics, Vol. 162, 101-114	1594	159.4	531
Q. ZHU, J. Sarkis, K.-H. Lai	Confirmation of a measurement model for green supply chain management practices implementation	2008	International Journal of Production Economics, Vol. 111 (2), 261-273	1249	73.47	416
Q. ZHU, J. Sarkis, Y. Geng	Green supply chain management in China: Pressures, practices and performance	2005	International Journal of Operations and Production Management, Vol. 25 (5), 449-468	1223	61.15	408
A.A. Hervani, M.M. Helms, J. Sarkis	Performance measurement for green supply chain management	2005	Benchmarking, Vol. 12 (4), 330-353	1162	58.1	387
J. Sarkis	A strategic decision framework for green supply chain management	2003	Journal of Cleaner Production, Vol. 11 (4), 397-409	1129	51.32	1129

Q. ZHU, J. Sarkis, K.-h. Lai	Green supply chain management: pressures, practices and performance within the Chinese automobile industry	2007	Journal of Cleaner Production, Vol. 15 (11), 1041-1052	957	53.17	319
Q. ZHU, J. Sarkis, K.-H. Lai	Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices	2013	Journal of Purchasing and Supply Management, Vol. 19 (2), 106-117	929	77.42	310

H. Keyword Analysis

The keyword frequency analysis (Table 13) indicates that Green Supply Chain Management is the dominant theme in the field, appearing in 930 records (68.13%). This confirms its position as the central organizing concept around which the literature has evolved. Other frequently used terms include Supply Chain Management (47.69%), Green Supply Chain (13.99%), and Environmental Management (13.41%), which reflect the broad demographic scope of the research. More specific descriptors such as older Sustainable Development (13.33%), Sustainability (10.62%), point to the emphasis on both Green Supply Chain Management and sustainability.

TABLE 13
TOP KEYWORDS

Keywords	TP	%
Green Supply Chain Management	930	68.13%
Supply Chain Management	651	47.69%
Green Supply Chain	191	13.99%
Environmental Management	183	13.41%
Sustainable Development	182	13.33%
Sustainability	145	10.62%
Environmental Performance	127	9.30%
GSCM	103	7.55%
Decision Making	88	6.45%
Green Supply Chain Management (GSCM)	83	6.08%

I. Keyword Co-Occurrence Network

The keyword co-occurrence analysis generated a network visualization in which each node represents a keyword and the size of the node reflects its frequency of occurrence (Figure 4). The thickness of the connecting lines

indicates the strength of co-occurrence between terms. The visualization revealed Green Supply Chain Management as the dominant keyword, centrally positioned with the largest node size, reflecting its centrality to the research domain.

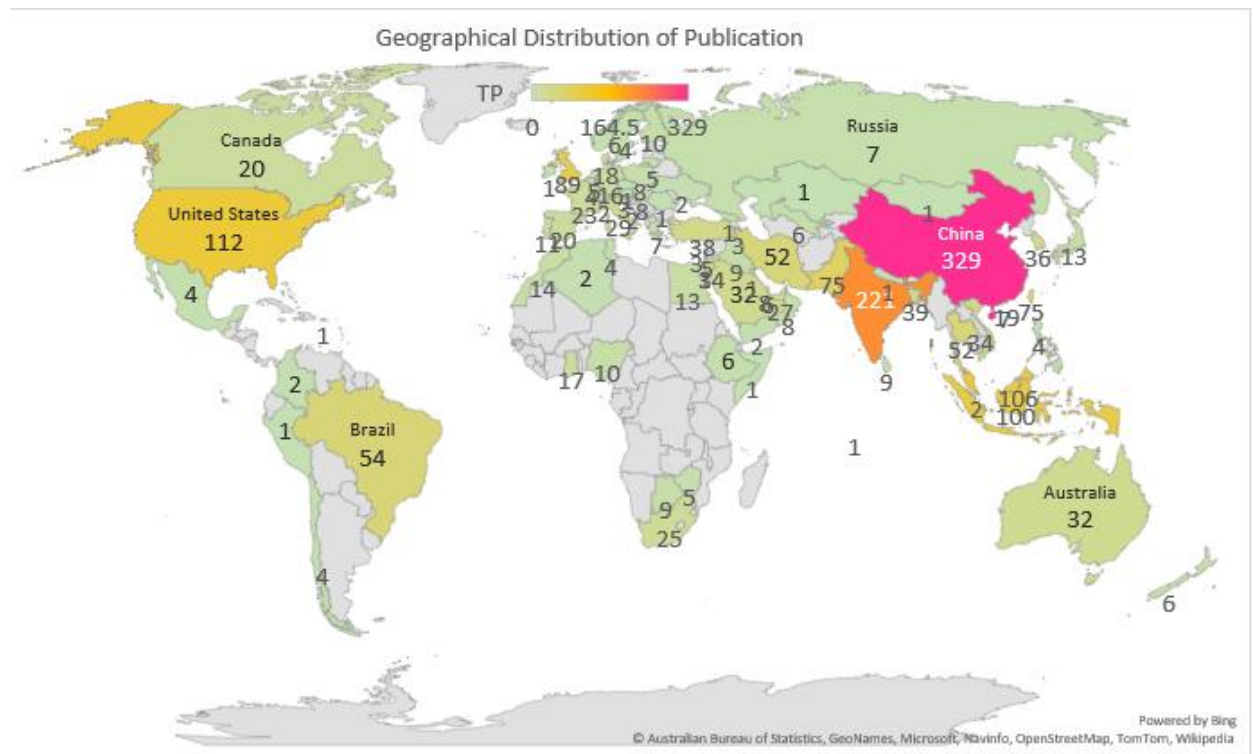


Figure 4 Network visualisation map of the author keywords

Several thematic clusters were identified, each represented by different colors. The purple cluster focused on green supply chain management, including keywords such as GSCM, and green manufacturing environmental. This suggests a strong research orientation toward the integration of technology in green supply chain management. The blue cluster highlighted terms associated with decision making, including environmental impact, industry. These keywords reflect the environmental and industry. The red cluster represented supply chain management. The green cluster reflected green supply chain. Also, the yellow cluster that links the key keywords demonstrates strategic management and integration perspectives, including the topics of green practices, environmental management, and supply chain integration. This cluster highlights the strategic value of green supply chain management to connect both the environmental goals and the operations of the organization. All in all, the illustration shows that green supply chain management is a very complex topic of research that binds various viewpoints, such as environmental sustainability, strategic management, and analytical decision making processes. The network architecture also demonstrates that the modern tendencies in research are moving towards the spheres of digital transformation, sustainable innovation, and performance monitoring inside the supply chains. Overall, the keyword co-occurrence map allows identifying the most dominant themes, developing topics, and transdisciplinary nature of the research on green supply chain management and provides excellent understanding of the way the field has been developing and which directions still attract the interest of scholars.

J. Document Citation Network

The document level citation network is presented in Figure 5. Each node represents a document, with node size indicating the number of citations and links reflecting the co-citation relationships between papers. The visualization reveals several clusters of highly influential works that have shaped the field of green supply chain management.

Figure 5 Network visualisation map of the citation by documents

Minimum number of citations of a document = 5

5. DISCUSSION

Table 12 displays the most prominent and widely cited papers in the subject of Green Supply Chain Management (GSCM), revealing the intellectual foundations and growth trajectory of the domain. The most cited study is Srivastava (2007), a comprehensive literature review that greatly affected early conceptual understanding of GSCM. The table also reveals the strong scholarly influence of Zhu and Sarkis, whose collaborative studies between 2004 and 2013 contributed extensively to empirical validation, institutional perspectives, and performance based analyses of green practices, particularly within Chinese manufacturing contexts. Most of the highly cited articles were published in leading operations and production management journals, such as the *Journal of Operations Management*, *International Journal of Production Economics*, and *Journal of Cleaner Production*, indicating that GSCM research is deeply rooted in operations management and strategic performance discourse. Overall, the table demonstrates that the area has developed from strategic framework building and performance assessment toward stronger theoretical integration and empirical substantiation, with performance implications maintaining a primary research priority.

The figure 5 represents a visualization of citation network created by using VOSviewer, thus highlighting the most significant publications in the field of the Green Supply Chain Management (GSCM) research using minimum number of citation of a document is five. From this figure, Srivastava (2007), which offers some of the main theoretical perspectives on the green supply chain practices. The other influential authors are Zhu and Sarkis, which are also noted and demonstrate their significant contribution to the environmental strategies of the supply chain, and supply chain sustainability. The high level of inter node relationships indicates the presence of an intellectual connections between researchers and overall the network defines the main literature that influences the formation and further evolution of GSCM scholarship.

6. CONCLUSIONS

The first research question is about identifying current trends in the field of Green Supply Chain Management (GSCM). Therefore, to meet the main objective of exploring research trends on Green Supply Chain Management (GSCM), a bibliometric analysis has been conducted. Using bibliometric analysis can assess research productivity and publications in a particular research field (Moed et al., 2001). According to Gu's (2004), information obtained from bibliometric data can evaluate the performance of a field of study, and help related research institutions to set some policies related to fund allocation, and to compare scientific input and output. In addition, bibliometric research findings can further explain the factors that support the contribution of research in a field of study and guide researchers to conduct influential research (Akhavan et al., 2016).

Therefore, the focus of this study is on Green Supply Chain Management publications collected from the Scopus database. This study uses a specified search query to find 1365 documents from the specified database. The main keywords used to search for relevant documents are "green supply chain management" and its equivalents. The research on Green Supply Chain Management (according to documents collected from the Scopus database) was initiated by J. Sarkis (2003) with the title "A strategic decision framework for green supply chain management". Since then until 2008, the number of publications has increased slightly. Starting from 2016 until now, the number of publications on Green Supply Chain Management has increased. The trend of Green Supply Chain Management publications has increased linearly, meaning that the topic of Green Supply Chain Management is still interesting to researchers. Regarding the second research question, which is to find the most prolific in the field of Green Supply Chain Management, a citation matrix has been used. The importance of Green Supply Chain Management publications can be explained from the citation metrics discussed in this study. As a consequence of 23 years of publications in the field of Green Supply Chain Management (2002-2025), 1365 articles have been published and more than 75,208 citations. In general, Green Supply Chain Management documents collected from the Scopus database are cited 3269.91 times each year, 55.10 citations per paper and 3.22 authors per paper, and have also

achieved an h-index of 137, and a g-index of 250. As for the author who published the most research is Zhu, Q. and the most affiliated with Dalian University of Technology.

This study only focuses on the type of document article, source document journal, and articles that use English only. China, India and the United States have been ranked as the top countries with the largest contribution to the publication of Green Supply Chain Management. Research on Green Supply Chain Management is usually published in publications in the fields of "Environmental Performance", "Green Supply Chain", and "Environmental Impact". Research on Green Supply Chain Management is concentrated in the field of social sciences. While the source of documents that often publish studies on Green Supply Chain Management is Sustainability (Switzerland). As for answering the third research question regarding the main research themes and emerging topics in Green Supply Chain Management publications, we analyzed 1365 document sources. The results of the analysis found that "Green supply-chain management: A state-of-the-art literature review by (S.K. Srivastava, 2007) is the most cited article.

K. Limitation of the Study

Although bibliometric analysis has special characteristics, this study also has some limitations, which should be limited so that readers can understand this article clearly and strengthen future research. The findings pertain exclusively to specific keywords, specifically Green Supply Chain Management, as indicated by document titles. The analysis excludes search query results for other fields, such as author and source. The main point is that most academic studies use titles as search queries for relevant documents. Some researchers may also focus on search words on authors or sources, as a result, their research may not be directly related to their objectives. Therefore, data filtering (filtering and cleaning) is needed before data analysis. Future research can extend to it.

L. Future Research

It should also be noted that no search query is 100% ideal; therefore, false positives and false negatives should be considered (Sweileh et al., 2017). The current study exclusively relied on the Scopus database as the primary source for documents. Although Scopus is one of the most comprehensive databases that archives all academic research, it does not cover all published sources (Ahmi & Mohamad, 2019). Further databases, for example, Web of Science, Google Scholar, Dimensions and others, can be used in future studies. Integrating all these databases can help add interesting and valuable results. Despite these limitations, the current study adds to the knowledge by providing current research trends on Green Supply Chain Management. This study also contributes by applying bibliometric methods to expand the knowledge of Green Supply Chain Management literature.

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