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Green Supply Chain Management: A Comprehensive Review of Research, Applications and Future Directions

Ali Mohsin Salim Ba Awain[1], Abdullah M. Al-Ansi[2], Mohammed Jaboob[3]

[1] *University of Technology and Applied Science, College of Economics and Business Administration, Oman*
[2] *Thamar University, Faculty of Education, Yemen*
[3] *Dhofar University, Deputy Director of VC Office, Vice Chancellor's Office, Oman*

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Abstract
With continuous and rapid change in both technology and businesses due to climate change and governments regulations, Green Supply Chain Management (GSCM) is receiving increasing attentions during last two decades. GSCM refers to the abilities of businesses to enhance operations and sustain environment at the same time and efficiently. In this paper, a comprehensive review of GSCM development and applications is conducted. This review aims to explore the recent developments of GSCM and necessity of adoption GSCM applications in businesses to insure sustainable development. First, a descriptive analysis of 796 paper adopted from Scopus database was conducted to review research on GSCM. Next, a bibliometric analysis of 235 paper was conducted to determine the recent trends and areas of GSCM and related keywords by using VOSviewer software. Then, a content analysis was carried out of 53 review papers by adopting WordStat software to analyze the impact of GSCM on related subjects and trends of GSCM. Finally, a summary analysis of GSCM advantages and challenges was conducted based on fundamental GSCM's objectives. Results reveal that researches on GSCM are in upward curve with limitations in implementing GSCM applications due to high cost, and lack of sufficient experiences. Results also reveal positive moderate correlation of GSCM with environment, performance, sustainability and management practices indicating the limited implementation of GSCM applications. To further explore these limitations, this study summarized the recent challenges and future potential directions of GSCM in both businesses and environments.

Keywords
Green Supply Chain Management (GSCM); Climate change; GSCM trends; Review.

Introduction

Green Supply Chain Management (GSCM) refers to the implementation of processes and strategies that emphasize sustainability within all aspects of the supply chain. GSCM strives to reduce negative environmental impacts caused by material and energy usage in production processes, logistics, warehousing, and product delivery (Khan et al., 2022). GSCM seeks to promote business efficiency through streamlined practices such as efficient transportation (Colicchia et al., 2017), resource sharing (Antheaume et al., 2018), better emissions management, and waste reduction (Aziziankohan et al., 2017). Companies implementing GSCM benefit from increased customer appeal through improved environmental performance and cost reductions achieved through minimized resource consumption (Novitasari et al., 2021). However, these benefits can only be fully realized when companies commit to a strong Environmental Management System (EMS) that outlines goals, policies and procedures for improving their sustainability performance.

Furthermore, GSCM integrates operational, environmental and sustainability initiatives into a business's supply chain (Santos et al., 2019). GSCM drives sustainable improvements in all phases of the supply chain from product design, sourcing, production and distribution to end of life management and recycling (Mathu, 2019). By incorporating green initiatives within its supply chain, companies are able to reduce waste, lower costs (Endyanti et al., 2021)

***Corresponding author**: Abdullah M. Al-Ansi – Thamar University, Visiting Lecturer @ Universitas Muhammadiyah Yogyakarta, Indonesia, Postal Address: Thamar, 88588, phone: +62 81 252 277 534, e-mail: ebrar.ansi@yahoo.com*

through improved energy efficiency as well as improve customer relations (Haiyun et al., 2021) by demonstrating their commitment to sustainability. Furthermore, organizations invest in GSCM can build stronger relationships with suppliers and partners by helping them adopt better environmental practices thereby fulfilling legal requirements whilst increasing their market competitiveness.

The implementation of GSCM has significant positive impacts for businesses operating within today's increasingly complex and resource-limited economic environment. Prior resent researches investigated this positive impact on firm performance (Samad et al., 2021; Abbas & Hussien, 2021; Jiang et al., 2020), sustainability (Purwanto et al., 2022; Li & Yan, 2021), operational performance (Khan et al., 2022), performance improvement (Li J. et al., 2022), sustainability performance (Le, 2020) and environmental performance (Fu et al., 2023). GSCM also seeks to reduce or eliminate the environmental impact associated with the flow of resources, goods and services throughout a business's supply chain (Tarigan et al., 2021). This is accomplished through tactics such as resource reuse, close monitoring and control of energy usage, waste reduction initiatives, sensible packaging and shipping practices, management of toxic chemicals or materials, extended producer responsibility programs, and many more strategies (Ali & Shoaib, 2023; Lee & Lim, 2020; Singh et al., 2020). Implementing such practices not only leads to reduced costs in terms of packaging materials and transportation, but also offers companies competitive advantages (Al-khawaldah et al., 2022) as they are seen as sustainability leaders that take social responsibility seriously. In light of these benefits, GSCM is an essential component for any organization looking to remain competitive in the long term.

Operating in a sustainable manner is no longer merely an ethical choice but a necessary step towards long-term success. Companies should introduce green strategies into their operations to minimize negative environmental and social impacts (Kholaif & Ming, 2022) while simultaneously improving their own efficiency and cost savings. Moreover, establishing environmentally friendly practices is integral for developing consumer trust and maintaining brand loyalty; by highlighting sustainability improvements, companies can create a closer relationship with their customers, as well as differentiate themselves from competitors and remain competitive in the market. Furthermore, implementing sustainability initiatives can present various financial benefits associated with reduced energy costs, increased employee productivity and performance levels due to improved health and safety standards, improved supply chain efficiencies, as well as tax relief or incentives for green businesses (Prasetia & Imaroh, 2020).

As GSCM depends on technology development, a lot of applications continuously are adopted in different management practices and businesses enhancement. The need for introducing the most appropriate applications and identifying possible areas for development is crucial to sustain both performance and outcomes of organizations. This research focuses on identifying such areas practically and theoretically. The objectives of this review are to determine the recent developments in GSCM and its applications. In addition, this review highlights the research current focus, literature development, market drivers, leading countries and management practices. Furthermore, this review is executed to find research gaps, challenges and future directions for researchers interested in conducting more research about implementation, assessment and integration of technology in green supply chain management.

In short, the main contributions of this review are as follows:

- The recent developments in GSCM including publications, area of developments, top countries and top journals are described.
- The trending topics in GSCM during the last decade including models in sustainability, environmental performance, decision making, sustainable development and environmental economics have been illustrated.
- Impact of GSCM on sustainability, performance, environment and management practices have been discussed.
- Recent challenges and most advantages of GSCM have been discussed in addition to identifying the possible applications and further directions for future researches.

Literature review

Publications by year

Researches on GSCM begun on the beginning of 90s and became popular in 2000 with emerging of new technologies. By adopting Scopus database, 796 studies have been conducted between 2013 and 2022. The upward trends during this period are shown in Fig. 1. The number of publications has reached the peak in 2020 demonstrating that interest in GSCM is continuously growing year by year. In addition, there is slight downward during last two years, but this decreasing is reasonable due to researchers' interest, high opera-

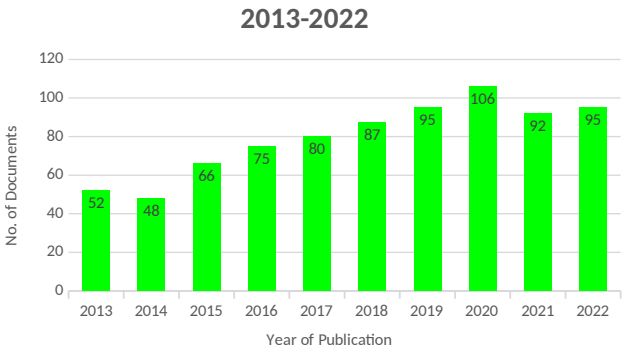

Fig. 1. Published studies by year

tional cost and complexity of adopting new technologies (Jemai et al., 2020).

Publications by subject area

To understand the new directions and development of GSCM in different areas, previous publications were classified by subject. Figure 2 illustrates the distribution of research in different fields. Business and Management (24.5% of total), Engineering (18.3% of total) and Environmental Science (12.8% of total) were the top field for Green Supply Chain Management researches respectively with more than 52% of all publications (El Baz & Iddik, 2022).

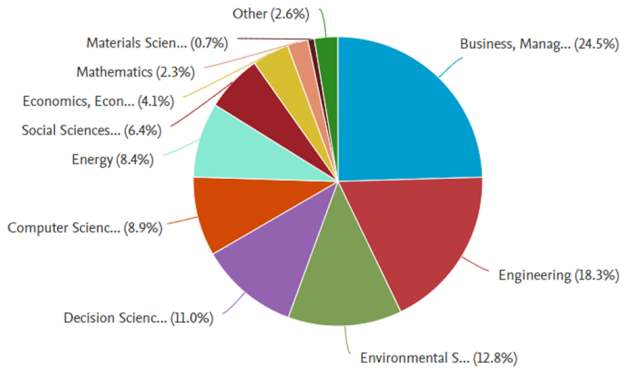

Fig. 2. Publication by subject

Publication by country

Final step in our descriptive analysis is to explore which countries have more interest in GSCM. Researches in GSCM reflects the development of these countries in adoption GSCM and the proposition of their abilities to protect environment by reducing waste and optimization of their production process (Iqbal et al., 2020). In the top 10 countries, China and India were the most countries use GSCM respectively with almost same researches as the rest 8 top countries in the list. Figure 3 shows top 10 countries in GSCM publications. It is interesting that among top 10 countries, 7 of them are located in Asia.

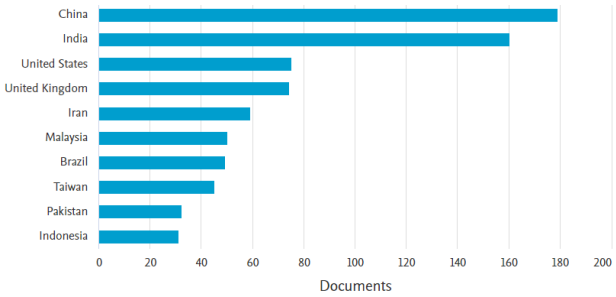

Fig. 3. Published papers by country (2013–2022)

Top journals and yearly publications

During research period (2013–2022), the top five journals of GSCM publications include around 200 published works out of 796. These journals are organized based on publication by year. Journal of Cleaner Productions comes first with 97 papers while the second is Sustainability Switzerland with 30 publications. The list includes 189 journals which reflects the increasing interest in conducting more researches as the integration of new technologies in GSCM evolves. Figure 4 shows top five journals and yearly publications.

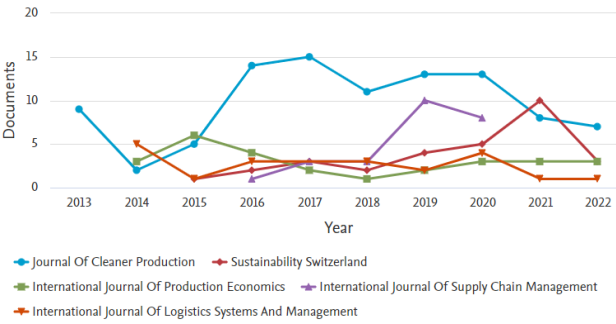

Fig. 4. Yearly distribution of top 5 journals

Materials and methods

In this review, Scopus database was adopted to conduct analysis on green supply chain management. Studies between 2013 and 2022 were selected for further analysis. The method of selections these documents are as:

TITLE-ABS-KEY (green AND supply AND chain AND management) AND (LIMIT-TO (PUBYEAR, 2013–2022)) AND (LIMIT-TO (PUBSTAGE, "final"))

AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (EXACTKEYWORD, "Green Supply Chain Management")).

In addition to our research inquires, more settings were implemented to exclude unrelated documents including: limitations to (Document type: article, review and conference paper, Source type: journal, Language: English and Publication stage: final). At the end of searching articles, 796 documents were found and have been considered for further analysis. Then, screening process was conducted to ensure all requirements were implemented and all documents are related to green supply chain management. To do bibliometric analysis, title, abstract and keywords of 235 articles were used in RIS format from Scopus database. Final step, to do content analysis 53 documents were selected from 796 where we limited our searching to review. Figure 5 illustrates the research settings and screening process of documents.

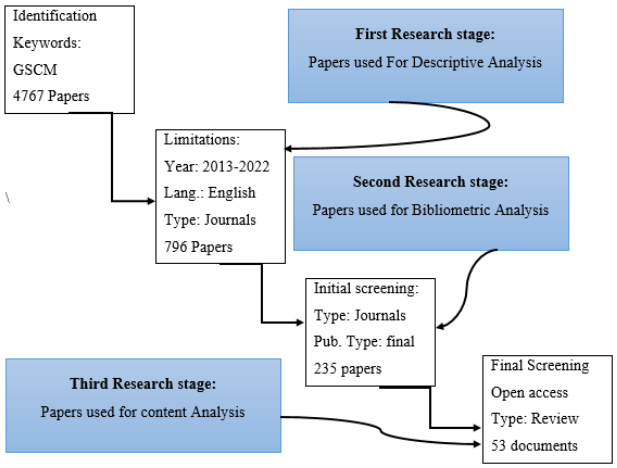

Fig. 5. Screening process of documents from Scopus database

After screening process, four review approaches were used including: descriptive analysis, bibliometric analysis, content analysis and summary analysis. We used descriptive approach to categorize research based on year of publication, subject area, country and top journals. This analysis was conducted based on algorithm of Scopus database. Then, we used bibliometric approach to analyze the development status of researches on GSCM by adopting VOSviewer. This software enables mapping of researches based on network and time illustrating the co-occurrences of keywords in every document for analysis. Furthermore, new trends of bibliometric analysis were further analyzed.

Next, we used WordStat to conduct content analysis based on data mining and topic modeling approaches. Results of this analysis includes important features such as Word Cloud, Word Frequency, Topic Analysis and Correlation among words. Three high correlated keywords including sustainability, performance and environment were further discussed and we analyzed the impact of GSCM on each of them. Final step in our process includes a summary analysis of the recent advantages and challenges of green supply chain management. Figure 6 illustrates the adopted four approaches in this research.

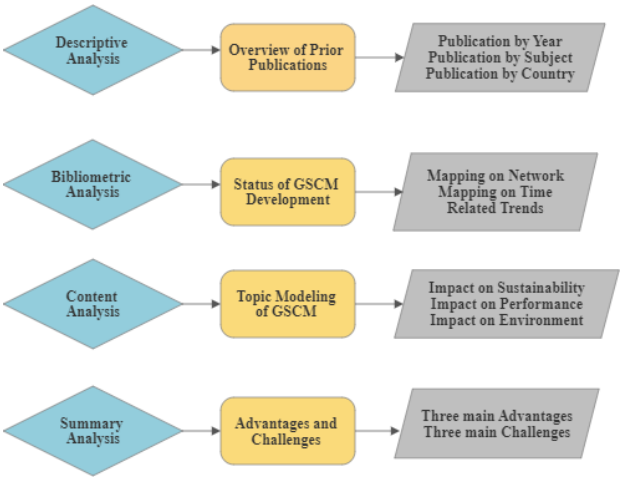

Fig. 6. Flowchart of analysis based on research approaches

Results

Status of GSCM development: A bibliometric analysis

To conduct bibliometric analysis, we used java-based software VOSviewer. We started by creating map based on bibliometric data by adopting Scopus database as references. Co-occurrence and keywords analysis and full count were chosen to conduct analysis. Then, to make analysis more accurate, minimum word of occurrence of keyword was 10. Of 3523 keywords, 135 meet the criteria. The outcome of analysis was categorized based on network and time as shown in Fig. 7 and 8.

Through analysis of Fig. 7, GSCM was correlated to four categories as shown in different colors. Researches focus on last decade were on sustainability, sustainable development, sustainable supply chain, environmental performance in addition to decision making. Figure 8 gives more details about concentration of researches by year. Research period was divided into five

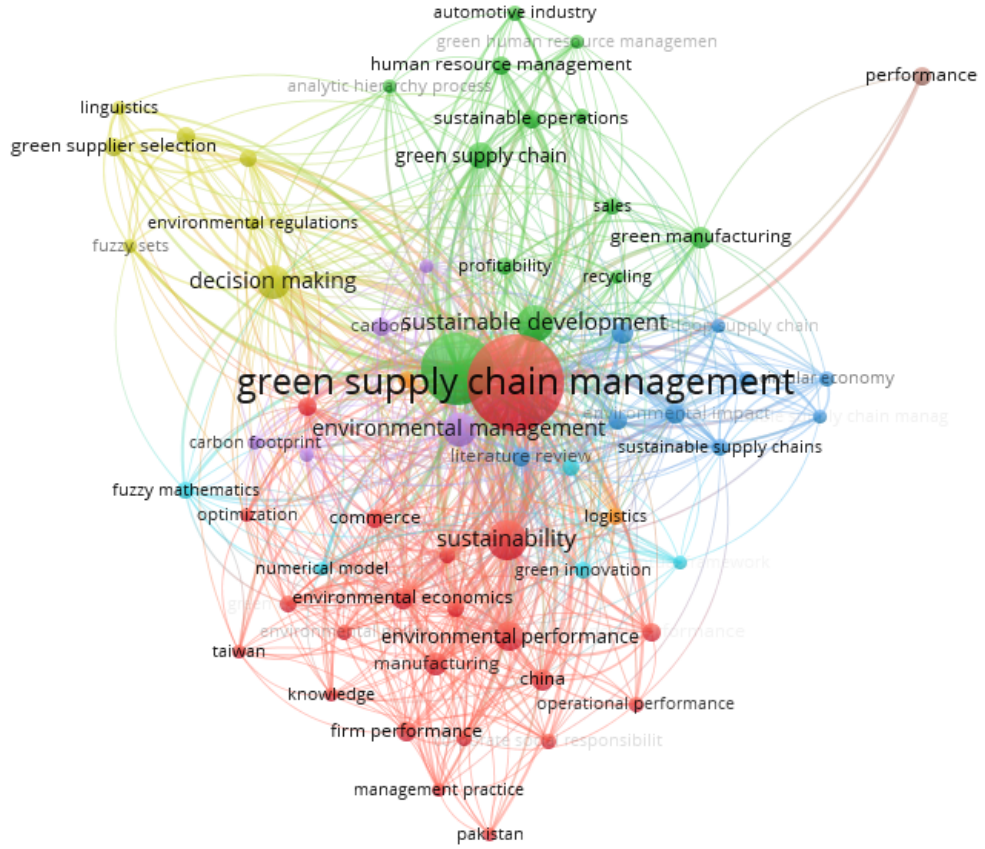

Fig. 7. Mapping on network visualization of co-occurrence Keywords of GSCM

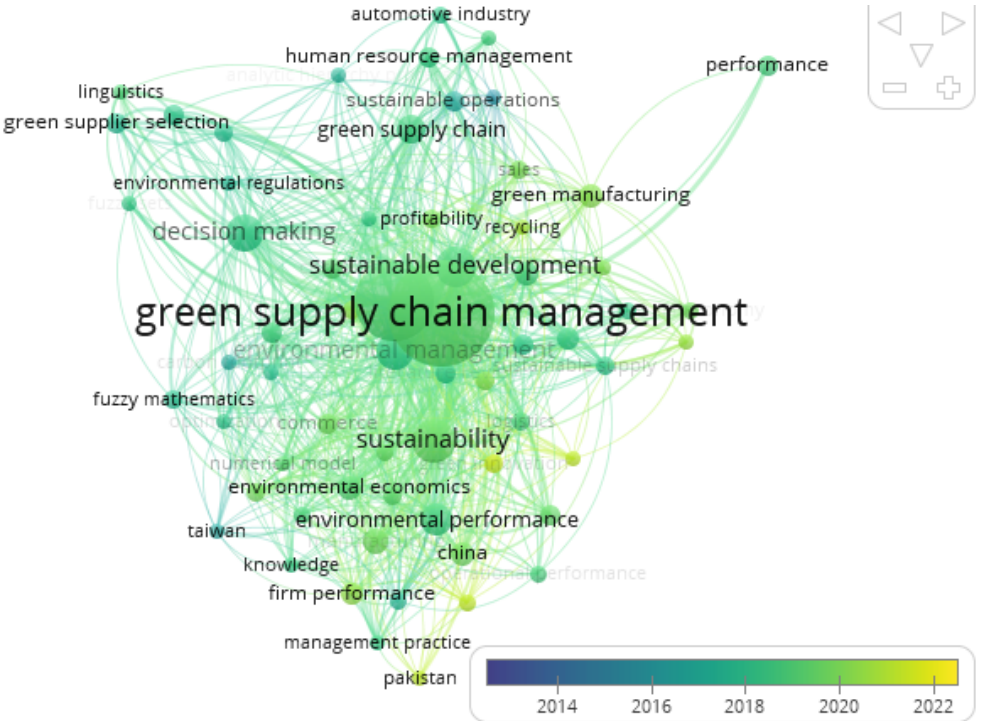

Fig. 8. Mapping overly time visualization of Keywords co-occurrence of GSCM

parts, every period 2 years in different color. Results reveal that during (2013–2015) researches were more conducted in management practices and sustainable operations [blue color]. In 2016 to 2019, more researchers were conduct about GSCM and sustainability [green color]. While the third period includes years 2020–2022 where the focus on environment performance and sustainability [yellow color].

According to Figs. 7 and 8, we conclude that environmental, performance, sustainability, sustainable development, environmental economic and decision making were the focus of researches and development in GSCM during 2013 to 2022. The purpose of these developments is to sustain both environment and business at the same time. Based on these conclusions, there is need for further analysis about these trends and how GSCM impact them to sustain environment and businesses. So, we took further step to do more analysis by investigating these trends in next section and apply content analysis by WordStat to reveal GSCM impact on these trends.

Investigation of related trends

Environmental performance: Recent research on GSCM have been conducted to investigate positive and negative impact on environment (Al-Sheyadi et al., 2019; Khan et al., 2022; Roh et al., 2022). Environmental performance is an important consideration when it comes to green supply chain management. Utilizing the principles of environmental sustainability, organizations should strive to reduce their environmental footprint through initiatives such as emission responsibility programs, waste reduction approaches, and renewable energy strategies (Fianko et al., 2021; Al-Ansi et al., 2023). Furthermore, green supply chain management seeks to promote a greater level of efficiency in terms of resource utilization by driving process optimization throughout the entire supply chain. Additionally, organizations may look at opportunities for honing supplier relationships through providing incentives and rewards for best practices or performance levels that adhere to strict criteria within the realms of sustainable development. Ultimately, the goal of taking a more environmentally friendly approach to managing a supply chain is to lessen negative externalities on the environment while improving overall business operations.

Sustainability: With the continuous growth of global population and increased demand for resources, sustainability in Green Supply Chain Management (GSCM) have become crucial elements to ensure long-term economic viability. GSCM promotes the circular economy and rethinking traditional linear patterns of production and consumption to support a more efficient flow (Li X. et al., 2022, Al-Ansi et al., 2023). Strategies to support green efforts include implementing principles such as waste reduction, resource efficiency, renewable energy systems, and shift to green packaging materials (Hans et al., 2022). In addition, an upstream approach with better management of raw materials sourcing is important for realization of sustainability goals in SCM. Investing in renewable energy generation can save considerable costs in utilities when appropriately managed by harnessing groundbreaking technologies to predict supply chain activities (Gawusu et al., 2022). Moreover, utilizing low emission vehicles along with supporting digital tools that track fuel consumption and driver performance towards improved operations require investment from organizations wanting to achieve efficiency objectives while reducing their carbon footprints.

Decision making: Effective decision making is a prerequisite for successful green supply chain management. GSCM requires organizations to analyze the context of their decisions and measure the potential impacts over all phases of the supply chain to help ensure compliance with environmental regulations. Moreover, by minimizing negative impacts on the environment, an organization can potentially realize economic gains through reduced energy costs or improved public image (Ghosh et al., 2022). In order to effectively make green SCM decisions, organizations collect and analyze data from their suppliers at each point in time to identify areas where improvements can be made. It is also essential that leadership carefully weigh the costs of implementing sustainable initiatives against the potential benefits in terms of sustainability goals, so that decision makers understand both sides of the equation. Furthermore, organizations continually evaluate how their decisions are impacting both short- and long-term results, so as to identify trends and modify decision making accordingly.

Sustainable development: Sustainable development and Green Supply Chain Management (GSCM) are interdependent as they focus on the triple bottom line of economic, environmental, and social sustainability. The goal of sustainable GSCM is to reduce overall ecological footprints through innovative supply chain designs, products, services, and processes (Kalpande & Toke, 2021). This involves designing environmentally conscious strategies that consider source reduction of materials used in production processes leading to improved efficiency. In addition,

GSCM aims to sustain the use of renewable energy sources (Gawusu et al., 2022) such as solar power and wind energy instead of traditional fossil fuels. As a result, companies are not only improving their financial performance but also their ethical corporate behavior while upholding social values. It is important to note that sustainable SCM relates closely to corporate social responsibility as companies that engage in SCM practices can achieve both social and environmental goals in harmony with economic objectives.

Environmental economic: Environmental economic and green supply chain management (GSCM) combine the principles of eco-efficiency and triple bottom-line sustainability with the tools and activities traditionally used in the field of operations to reduce costs, add value, and improve performance throughout a company's entire supply chain (Banik et al., 2022). In particular, GSCM focuses on reducing upstream resource use, waste disposal, transportation costs, and improving product life cycles; all which result in significant reductions of a company's environmental impact (Behera, 2022). Furthermore, green supply chain management helps companies gain competitive margins through increased customer loyalty through focus on "greenness" while meeting corporate environmental objectives especially during Covid-19 (Garad et al., 2021; Al-Ansi & Fatmawati, 2023). Green practices historically focus on recycling materials or reallocating them to new uses rather than wasteful disposal practices that ultimately lead to a loss of resources. Implementations of this strategy in an increasingly larger spectrum also demonstrate how organizations use their influence to affect broader changes outside their boundaries as it stands today.

Topic odeling of GSCM in market: a content analysis

For further analysis, we used WordStat software to give deep understanding of GSCM content. This analysis includes word cloud, word frequencies and topic modeling in every documents. The number of documents used in this analysis has been decreased to 53 documents including prior reviews by limiting our research scope in Scopus database to reviews. Then, we adopt text mining and topic modeling by approach used by (Moro et al., 2017; Nave et al., 2018) to summarize our results.

By adopting WordStat software, further analysis for 53 reviews was conducted to give deep understand of content related to GSCM. The first step is to draw the word cloud for document content and highlight the main words in these documents. Figure 9 illustrates the Word Cloud for green supply chain management of our research period (2013–2022). In addition to keywords of GSCM, other keywords have been emerged such as environment, performance and production.

Fig. 9. Word cloud of GSCM (2013–2022)

Due to its effectiveness in analyzing content, WordStat was adopted as in prior study by [x]Lewis (1999). Settings have been implemented to reveal word frequency of each review document. Table 1 shows the results based on word frequencies. In addition, number of papers which included every word, total processed and showing percentages are included. Research main keywords including supply, management, chain and green were the top words respectively and counted more than two thousand times. These results reveal the increasing importance of GSCM in today market and management. In addition, results also reveal the trend keywords correlated with GSCM including environment, performance, management practices and production respectively as among the top ten keywords in this analysis. These trends will be investigated more in the end of this section.

Digging deeper in our analysis, we adjust setting to selected top 20 topics related to GSCM Table 2. The main topics in the top of the table based on coherence and order show that researches on GSCM have investigated different aspects including, green effectiveness, life cycle, energy efficiency and other subjected concerning green supply chain management. Top 13 topics are located in Table 2 while 7 topics were unrelated and eliminated from table.

After identifying the main keywords, we did final step analysis to indicate correlation among these keywords and GSCM. Figure 10 illustrates this relation. These co-occurrence keyword analyses were conducted by wordStat where analysis limited to top correlations to avoid complexity.

Table 1
Frequency distribution of words in GSCM reviews

Word	Freq.	% Shown	% Processed	% Total	No. of Papers
Supply	2639	3.32%	2.26%	1.32%	53
Management	2338	2.94%	2.00%	1.17%	53
Chain	2323	2.92%	1.99%	1.16%	53
Green	2073	2.61%	1.77%	1.04%	53
Environment	1617	2.03%	1.38%	0.81%	53
GSCM	1274	1.60%	1.09%	0.64%	49
Performance	974	1.22%	0.83%	0.49%	53
Practices	936	1.18%	0.80%	0.47%	53
Research	851	1.07%	0.73%	0.43%	53
Production	621	0.78%	0.53%	0.31%	53
Literature	561	0.71%	0.48%	0.28%	53
Study	541	0.68%	0.46%	0.27%	53
Analysis	528	0.66%	0.45%	0.26%	53
Energy	527	0.66%	0.45%	0.26%	42
Logistics	487	0.61%	0.42%	0.24%	53
Review	472	0.59%	0.40%	0.24%	53
Industry	420	0.53%	0.36%	0.21%	50
Barriers	404	0.51%	0.35%	0.20%	46
Sustainable	393	0.49%	0.34%	0.20%	53
Model	333	0.42%	0.29%	0.17%	53
Implementation	331	0.42%	0.28%	0.17%	50
Suppliers	331	0.42%	0.28%	0.17%	50
Manufacturing	328	0.41%	0.28%	0.16%	53
Product	321	0.40%	0.27%	0.16%	49
Business	312	0.39%	0.27%	0.16%	53
Sustainability	299	0.38%	0.26%	0.15%	53

Based on content analysis by WordStat, four topics are considered as new developments in prior research and market drivers including sustainability, performance, environmental and management practices. In this part, we further investigate the impact of GSCM on these four research areas based on the results of content analysis.

Table 2
Topic Analysis by WordStat

No.	Topic	Order	Coherence (NPMI)	Eigenvalue	Freq.
4	Greening Effectiveness Retailer	20	0.602	3.43	589
5	Life Cycle	18	0.472	3.30	473
13	Energy Efficiency	17	0.443	2.49	625
19	Reverse Logistics Network Design	12	0.384	2.26	826
11	Dependence Power	11	0.376	2.62	198
8	Sized Suppliers Medium	10	0.369	2.83	193
12	Automotive	9	0.360	2.52	415
1	Upstream Downstream	8	0.359	5.93	47
17	Intangible Performance Practices	7	0.359	2.31	672
18	Mutual Trust Employee Empowerment	6	0.359	2.27	299
6	Supplier Selection Criteria	5	0.358	3.16	829
7	Supply Chain	4	0.357	3.03	8594
20	Benefits Barrier Category	3	0.342	2.22	579

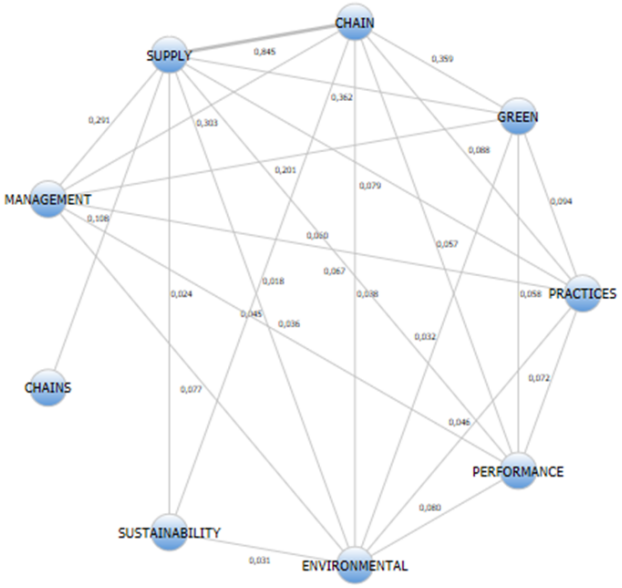

Fig. 10. Agglomeration order: Association Strength (Occurrence)

Advantages and challenges of GSCM: a summary analysis

Green Supply Chain Management (GSCM) is an important, growing practice that has numerous advantages for companies. GSCM involves reducing waste and maximizing efficiency throughout the entire supply chain. The benefits of implementing Green Supply Chain Management include enhancing long-term sustainability efforts; improving organizational practices (Jabbour et al., 2020). In addition, GSCM involves in changing processes to reduce environmental damage and energy consumption; creating opportunities to use resources more efficiently; generating cost savings by cutting transportation costs and increasing supplier collaboration (Tseng et al., 2022). Furthermore, prior research on GSCM revealed many benefits for GSCM in different fields including raising employee productivity due to improved morale and better working conditions; strengthening customer relationships through increased consumer trust in the company's commitment to environmental responsibility; enabling or reinforcing corporate social responsibility (CSR) standards across suppliers, partners, and customers; provoking innovation through competition in green practices among business entities within similar industries (Zaid et al., 2018). In this summary, we focus on benefits of GSCM based on its objectives in improving efficiency, quality and stability.

On the other hand, green supply chain management could be an incredibly challenging undertaking for companies and organizations. For starters, managing the complexities of sustainable procurement, such as tracking suppliers' environmental performance and certifications, requires oversight from multiple departments within a company's operation (Etse et al., 2022). In addition, additional costs associated with GSCM implementation must be taken into account, as products and services with sustainability attributes often come at a premium to their non-sustainable counterparts. Further challenges lie in innovating green processes to reduce waste proper disposal practices that adhere to stringent regulations (Iqbal et al., 2020). Finally, effective communication between stakeholders is essential to ensure visibility of sustainable initiatives across multiple layers of operations. Companies who master GSCM can enjoy enduring benefits such as increased brand equity, improved employee loyalty and decreased operational costs over the long term.

Advantages based on GSCM objectives

Green supply chain management is a strategic approach that encompasses all activities in the supply chain with the aim of minimizing environmental impact and promoting sustainability. By implementing green practices, companies can improve the quality and efficiency of their supply chains. Firstly, by reducing energy consumption, companies can lower their operational costs while also contributing towards reducing carbon emissions and combating climate change. Moreover, green supply chain management encourages recycling, waste reduction, and responsible sourcing practices, which in turn lead to higher-quality products that meet customer expectations. Furthermore, by collaborating with suppliers who prioritize sustainability, companies can ensure reliable and ethical sources of materials and reduce the risk of disruptions in the supply chain. Overall, integrating green practices into supply chain management not only enhances efficiency but also improves product quality, promotes environmental responsibility, and creates a competitive advantage for organizations in today's increasingly environmentally conscious market.

Improving efficiency: Green Supply Chain Management could be a powerful tool for organizations looking to improve efficiency and maintain a competitive edge. By involving the consolidation and optimization of processes within the supply chain to reduce energy consumption, pollution, emissions and waste and strategically tracking and monitoring activities of suppliers, in addition to analyzing business processes, companies can identify areas for improvement that are not just cost-effective but also reduce their environmental impact (Somjai & Jermsittiparsert, 2019). Additionally, green supply chain management encourages improved collaboration between stakeholders built on commitments to sustainability initiatives. This exchange of expertise accelerates knowledge sharing throughout the industry by making more data available as well as helping foster more eco-friendly methods of manufacturing products. Ultimately, implementation of green supply chain management helps businesses achieve their sustainability goals while also positively impacting their bottom line.

Improving quality: Green supply chain management is an effective way to reduce environmental impact and improve overall quality in business operations. This involves the use of sustainable practices throughout the entire production, handling and distribution process in addition to reducing waste, promoting energy efficiency, reducing hazardous materials, ensuring ethical sourcing and increasing recycling efforts (Lin, 2022). Furthermore, green sup-

ply chain management also requires collaboration between stakeholders such as suppliers, manufacturers, distributors and end-users so that everyone shares responsibility in creating a more environmentally responsible industry. More efficient systems for tracking material shipments can help to reduce human error and redundancy throughout the entire system. Having proper incentives for participating in green initiatives will ensure commitment from companies which produces better results for customers by improving the quality of goods and services offered.

Improving stability: The implementation of green supply chain management can effectively improve the stability of supply chains to ensure a level of environmental sustainability across organizations (Wang & Zhang, 2022). In order to do so, organizations should first identify the opportunities and threats posed by their current operations and use data analytics systems to better understand and monitor their processes.in addition, companies should strive to embody green practices within their operations such as waste reduction, ensuring ethical practices throughout their supply chains, as well as conserving resources through efficient use of materials. Moreover, companies innovate by building strategies around sustainability that not only reduce their impacts but also create positive ripple effects throughout the entire operation. It is important for organizations to foster long-term relationships with suppliers who share similar values and goals in order to increase trust and build strong partnerships based on shared objectives.

Recent challenges in GSCM

The invisible supply chain: In today's increasingly digitally driven world, the global supply chain is becoming more and more invisible. The challenges of globalization, such as varying levels of regulations and compliance, ever-shifting customer demands, increasing cost pressures, complex logistics networks, and financial instability put immense strain on the Green Supply Chain Management (Gandhi & Vasudevan, 2019). To maintain an efficient GSCM system that can meet customer needs in a cost-effective manner requires substantial time and resources devoted to finding adequate solutions. Additionally, businesses need to invest in new technologies to keep up with the speed of current operations while still preserving a secure chain. With the lack of visibility comes increased risk for potential disruption due to miscommunication between stakeholders or unforeseen external forces. Therefore, organizations must have strong communication strategies when managing their GSCM systems if they want to remain competitive and successful in today's market.

Lower suppliers struggling to meet growing demands: As the global economy shifts and changes at an increasingly rapid pace, businesses are often left struggling with meeting the ever-increasing demand. A key challenge facing many companies is that their lower-tier suppliers may not be able to keep up with this demand (Jo & Kwon, 2021). This strain on their production capabilities can lead to difficulties in securing materials and resources in a timely manner, resulting in increased costs and delays for customers, as well as mounting pressure for those companies that are reliant on these lower-tier suppliers. To ensure success and mitigate any potential disruption caused by this situation, it is essential for businesses to engage with their suppliers early and frequently to effectively manage supply chain expectations. With proper communication and extensive planning, it's possible for companies of any size to source needed supplies from vendors that are capable of meeting changing needs.

Lack of knowledge and expertise: A lack of knowledge and expertise in Green Supply Chain Management is a significant challenge facing organizations today. Without an understanding of the complexities and interrelationships between the many operations of GSCM, companies are unable to develop an adequate approach to managing their global supply chains (Peiris et al., 2022). This can lead to costly mistakes resulting from incorrect decisions, delays caused by a lack of actions in response to shifting customer demands, and overall decreased efficiencies compared to competitors who have mastered GSCM principles. Organizations must invest in the appropriate staff training and supplemental resources and learning (Al-Ansi, 2021) required to develop a robust supply chain strategy if they hope to remain competitive in today's global marketplace.

Discussion

Goods and services of green supply chain management (GSCM) have been identified as playing a key role in promoting sustainability. As an essential element of GSCM, proper lifecycle management can be critical in the effort to reduce waste and enhance the use of resources. By analyzing the entire supply chain and assessing areas where resources may be overused, perhaps due to inefficient processes or outdated technologies, organizations are able to identify opportunities to leverage their GSCM capabilities while also reducing their environmental impact.

Recent prior researches confirmed the positive impact of GSCM on sustainability. These results include improving sustainability performance [65, 66]Yildiz Çankaya & Sezen, 2019; Zaid et al., 2018), implementation of GSCM practices can improve both environmental and financial performance (Choi & Hwang, 2015) while Rupa and Saif (2022) revealed difficulties of implementing environmental sustainability through profit. In addition, use of lean manufacturing processes such as just-in-time delivery or improving reverse logistics help to reduce resource consumption, resulting in greater organizational sustainability. Furthermore, advancements in technology can enable organizations to better plan for future disruptions in the supply chain so that if something does occur or prices rise suddenly, they are better prepared and more resilient than ever before. Finally, cloud computing systems can help automate tasks within the GSCM process streamlining operations thus providing tangible reductions in costs and wasted resources which drives up sustainable gains even further. All these elements contribute towards making a significant contribution towards achieving organizational sustainability goals.

The implementation of Global Supply Chain Management (GSCM) strategies has been shown to substantially improve organizational performance in both the short and long term. GSCM enables companies to better manage their global risk exposures, resulting in increased cost savings while also facilitating improvements in quality and delivery reliability. When instituted properly, GSCM can increase customer satisfaction by reducing wait times and enhancing internal resilience, allowing companies to remain competitive within the global marketplace (Garad et al., 2022). Furthermore, GSCM allows for optimized decision-making, providing greater insights into potential impacts on production levels and resource utilization.

Previous recent researches highlighted the significant impact of GSCM on performance in different business. Seman et al. (2019) proved that GSCM has positive significant on environmental performance, GSCM dimensions are found to be related with at least one of the performance dimensions (Yildiz Çankaya & Sezen, 2019) and positive influence of green supply chain management capability on performance (Daddi et al., 2021). By taking a holistic view of their supply chains and utilizing cutting-edge analytics tools, organizations can anticipate variables that may have a negative effect on operational performance, thus avoiding any costly mistakes or delays. In conclusion, the successful implementation of GSCM is a highly beneficial system that can improve overall organizational performance in a range of areas.

With large-scale production comes the potential for significant environmental damage, matter of transportation of goods remains a fundamental issue for environment. Through implementation of green supply chain management (GSCM), there is a chance to reduce this harm by focusing on sustainable practices and reduction of waste. GSCM initiatives typically focus on different concepts such as reducing emissions, maximizing energy efficiency and delivering a positive environmental impact. Such approaches have enabled organizations to become more competitive by optimizing operations across their value chains, whilst conforming to customer expectations (Al-Ansi, 2022) and addressing global issues related to climate change (Sahoo & Vijayvargy, 2021). By use of strategies such as green logistics, renewable energy sources and technology advancements, GSCM has been effective at reducing the carbon foot print and other kinds of pollution over time (Badi & Murtagh, 2019; Behera, 2022; Gawusu et al., 2022). In short, through effective management of supply chains adopting principles of GSCM firms have access to a range of techniques that allow them to create an environment where protection takes first place above all else.

The implementation of Green Supply Chain Management (GSCM) practices in professional operations has had a significant impact on management practices (Samad et al., 2021; Habib et al., 2021; Huma et al., 2022). GSCM encourages organizations to shift away from traditional methods of sourcing, manufacturing, and distributing goods with the objective of reducing environmental waste and improving efficiency. This has demanded an increased focus on streamlining the supply chain process while actively looking for ways to reduce energy consumption and maximize product lifecycles. The emergence of new technology solutions such as cloud computing and analytics have provided access to meaningful data when measuring progress against established objectives. GSCM also promotes innovation in process optimization, delivery route planning, sustainability considerations throughout the life cycle of a product, as well as collaboration with suppliers at every stage. By recognizing that management practices need to evolve ahead of industry trends such as green SCM initiatives, organizations can remain competitive in today's marketplace.

Conclusions

In this review, we started by describing and reviewing of research on Green Supply Chain Management (GSCM) classifying them by year, research area, country and top journals. Results of this descriptive

analysis reveal that researches on GSCM are in upward curve, management and business, engineering and environments were the top research areas and China was the top of leading countries on GSCM. Then, bibliometric analysis by adopting VOSviewer software was conducted to determine the man trends and areas of GSCM and related keywords. Results of bibliometric analysis reveal that Environmental performance, sustainability, environmental economic, sustainable development and decision making. Further analysis was conducted for 53 reviews by using WordStat revealing word frequencies and topic analysis. The results reveal the correlation among keywords which was somewhat moderate. In addition, the impact of GSCM on main keywords including: environment, performance, sustainability and management practices was positive but still low due to lack of implementation of GSCM features, high cost, and lack of sufficient experiences.

In the final step of our review, we conducted a summary analysis for the main advantages and challenges in green supply chain management. These advantages were analyzed based on fundamental objectives of GSCM including improving efficiency, quality and stability. Invisible supply chain, lower suppliers struggling to meet growing demands and lack of knowledge and human expertise were the most challenges facing GSCM at the current time. This research highlighted the recent trends of GSCM in different areas and recommended adoption of new technologies including industry 4.0 applications. Furthermore, this work adds to the prior literature by determining the recent areas of development and what need to be done in coming years. The impact of GSCM on environment, performance, sustainability and management practices was discussed.

Further research directions

The potential for future green supply chain management is tremendous and can drastically reduce company's' carbon footprint and overall environmental impact. As companies become increasingly conscious of the need to reduce their environmental footprint, green supply chain management is rapidly becoming an important part of the business strategy. This practice involves continually tracking the entire supply chain from supplier through customer, as well as developing a strategy for eliminating or reducing negative impacts on the environment wherever possible. Here we introduce potential research areas in GSCM:

Digital Supply Chain Twins (DSCT): Digital Supply Chain Twins refer to the emergence of new technologies that enable a better twinning of physical supply chains and digital supply chains. By using predictive analysis, machine learning and automation, Digital Supply Chains are able to provide improved visibility into the supply chain and create actionable insights. This improved insight enables business to be proactive in decision making from procurement through to delivery with flexible planning, accurate forecasting and optimized operations. Furthermore, Digital Supply Chain Twins can reduce costs associated with freighting inventory back and forth across long distances due to its ability for network optimization. With its capability for more efficient communication across partners and faster response times when responding to shifts in demand or other changes within the supply chain, Digital Supply Chain Twins offer an integrated model that can bring multiple benefits such as increased efficiencies, improved cost control, increased profitability and customer satisfaction.

Blockchain: The incorporation of blockchain technology into green supply chain management (GSCM) can help to create a sustainable business model. By using distributed ledgers and certain smart contract protocols, companies can improve the traceability of their products from source to end-consumer, allowing for greater transparency and assurance that the business is following sustainable practices. In addition, due to its decentralized nature, blockchain technology can facilitate green trading more securely and cost-effectively by eliminating many potential points of failure and fraud while also preventing unauthorized access to data. As such, coupling GSCM with blockchain is a powerful mechanism which provides an opportunity for businesses operating in today's global marketplace to increase efficiency, minimize waste, reduce costs, and promote sustainability.

Circular Supply Chains (CSC): Circular supply chains are the new model for sustainable and efficient production. By utilizing existing resources and utilizing technologies such as 3D printing, companies can reduce waste and create a closed loop system. This process can save businesses time and money by manufacturing on demand, reducing the need to ship products across distances or purchase raw materials separately. Furthermore, these supply chains provide traceability enabling businesses to better monitor their product's origin while providing transparency throughout the production process to customers. In order to create a circular economy, organizations must rethink current practices such as packaging choices, product design with repairability in mind, extend

product lifecycles, and inform customers of their options for responsibly disposing products at end of life.

Cloud-based products: Cloud-based products offer several advantages to the modern professional, providing an opportunity to access the necessary data and cloud services from anywhere with a compatible internet connection. Cloud-based software solutions allow teams to securely share files and collaborate on projects in real time, eliminating the need for physical storage hardware and cutting down on operating costs associated with purchasing, upgrading, storing, and accessing software packages. Furthermore, cloud computing supports increased scalability for businesses of any size; it also ensures that all users have access to the most up-to-date versions of their applications without having separate download processes for each instance. Finally, cloud architecture allows professionals to take advantage of enhanced security features such as encryption, two-factor authentication, identity and access management procedures.

Robots and automation: Robots and automation increasingly play a major role in the management of global supply chains. Utilizing autonomous machines and systems helps to reduce costs, increase accuracy and undertake more complex operations. Automation also helps to improve response time due to the elimination of manual intervention, which is especially important for operations that require quick decisions. Moreover, robots and automated systems amplify quality assurance by reducing the possibility of errors related to human labor. Tasks such as sorting, stacking, packaging and transportation are completed with greater speed since robots and automation move materials quickly from one place to another instead of relying on people or manual processes. On the whole, robots and automation provide cost savings as well as increased quality assurance, response time, accuracy and efficiency that are essential components for success in any GSCM operation.

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