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Green supply chain and sustainability: literature review for future directions

Cadeia de suprimentos verde e sustentabilidade: revisão da literatura para futuras direções

Cadena de suministro verde y sostenibilidad: revisión de la literatura para direcciones futuras

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Resumo: A crescente importância da Gestão Verde da Cadeia de Suprimentos (GVCS) foi potencializada pela crescente deterioração ambiental, por exemplo, diminuição da matéria-prima, inundação de locais de resíduos e aumento dos níveis de poluição (Srivastava, 2007). O gerenciamento da cadeia de suprimentos (GCS) trata-se da coordenação e gestão da complexa rede de relacionamentos empresariais que objetivam entregar um produto apropriado ao usuário final ou consumidor. Apesar da importância da temática cadeia de suprimentos verde e da sua relação com a sustentabilidade, ao examinar a literatura, percebe-se a carência de estudos revisionais, sobretudo bibliométricos que possibilitem compreender o surgimento, evolução e os estudos de fronteira destas temáticas. Diante disso, este estudo tem como objetivo identificar as principais correntes de pesquisa que deram origem à literatura de cadeias de suprimentos verde e de sustentabilidade, bem como mapear os temas fronteiriços nesta mesma temática, sistematizando assim o conhecimento dos estudos do passado, bem como das tendências do futuro. Este estudo foi elaborado por meio de técnicas bibliométricas, ou seja, trata-se de uma revisão bibliométrica. Os 599 artigos que compõem a amostra desta pesquisa foram importados para o software VOSviewer para viabilizar a elaboração do mapa de cocitação e pareamento bibliográfico. Com relação ao mapa de cocitação, foram identificados três clusters teóricos. A análise de pareamento bibliográfico possibilitou apresentar os estudos fronteiriços, ou seja, quais as tendências de pesquisas atuais e caminhos para pesquisas futuras sobre cadeia de suprimentos verde. O mapa de pareamento bibliográfico resultou na identificação. de quatro clusters.

Palavras-chave: Cadeia de Suprimentos Verde. Gestão da Sustentabilidade. Análise Bibliométrica.

Abstract: *The growing importance of Green Supply Chain Management (GVCS) has been heightened by increasing environmental deterioration, for example, decreasing raw material, flooding of waste sites and increasing pollution levels (Srivastava, 2007). Supply chain management (GCS) is about coordinating and managing the complex network of business relationships that aim to deliver an appropriate product to the end user or consumer. Despite the importance of the green supply chain theme and its relationship with sustainability, when examining the literature, there is a lack of revisionary studies, especially bibliometric studies that make it possible to understand the emergence, evolution and frontier studies of these themes. In view of this, this study aims to identify the main currents of research that gave rise to the literature on green supply chains and sustainability, as well as to map the border themes in this same theme, thus systematizing knowledge from studies of the past, as well as the future trends. This study was prepared using bibliometric techniques, that is, it is a bibliometric review. The 599 articles that make up the sample of this research were imported into the VOSviewer software to enable the creation of the co-citation map and bibliographic pairing. Regarding the co-citation map, three theoretical clusters were identified. The bibliographic matching analysis made it possible to present frontier studies, that is, current research trends and paths for future research on green supply chain. The bibliographic matching map resulted in identification. of four clusters.*

Keywords: *Green Supply Chain; Sustainability Management; bibliometric analysis.*

Resumen: *La creciente importancia de la Gestión de la Cadena de Suministro Verde (GVCS) se ha visto acentuada por el creciente deterioro ambiental, por ejemplo, la disminución de la materia prima, la inundación de los vertederos y el aumento de los niveles de contaminación (Srivastava, 2007). La gestión de la cadena de suministro (GCS) consiste en coordinar y gestionar la compleja red de relaciones comerciales que tienen como objetivo entregar un producto adecuado al usuario o consumidor final. A pesar de la importancia del tema de la cadena de suministro verde y su relación con la sostenibilidad, al examinar la literatura, faltan estudios de revisión, especialmente bibliométricos, que permitan comprender el surgimiento, la evolución y los estudios de frontera de estos temas. Ante esto, este estudio tiene como objetivo identificar las principales corrientes de investigación que dieron origen a la literatura sobre cadenas de suministro verdes y sostenibilidad, así como mapear las temáticas fronterizas en este mismo tema, sistematizando así conocimientos provenientes de estudios del pasado. así como las tendencias futuras. Este estudio fue elaborado utilizando técnicas bibliométricas, es decir, es una revisión bibliométrica. Los 599 artículos que componen la muestra de esta investigación fueron importados al software VOSviewer para permitir la creación del mapa de cocitaciones y el emparejamiento bibliográfico. En cuanto al mapa de cocitación, se identificaron tres grupos teóricos. El análisis de cotejo bibliográfico permitió presentar estudios de frontera, es decir, tendencias de investigación actuales y caminos para futuras investigaciones sobre la cadena de suministro verde. El mapa de cotejo bibliográfico resultó en la identificación. de cuatro grupos.*

Palabras clave: *Cadena de Suministro Verde; Gestión de la Sostenibilidad; Análisis bibliométrico.*

Introduction

As Companies currently face strong and continuous scrutiny from a wide range of stakeholders, including government authorities, labor organizations, and non-profit organizations. It is clear that this scrutiny exceeds the growing desire for more ecological activities by at least some customer categories (Vachon & Klassen, 2006). Over the last decade, there has been a considerable increase in pressure on industrial companies to adopt ecological methods and generate ecological products (Al-Nawafah et al., 2022). Manufacturing companies have recognized the relevance of their supply chain partners in environmental management. As a result, many industrial companies have turned to their suppliers and consumers in search of creative solutions to environmental problems (Vachon, 2007; Al-Nawafah et al., 2022).

The growing concerns about climate change and the environment in recent years, together with tensions arising from social inequalities and poverty issues, have shed light on sustainable

development, as it is considered one of the emerging themes that has currently awakened the attention of many academic researchers (Al-Awamleh et al., 2022). Sustainable development has been expressed as an investment of resources to satisfy the needs of the present without compromising the ability of future generations to satisfy their own needs (Al-Awamleh et al., 2022). Sustainability in this sense significantly influences decisions regarding consumer preference for product attributes when provided with calculated environmental impact values for all product design configurations (Goucher-Lambert & Cagan, 2015). A rigorous set of sustainability criteria also increases the production cost of energy crops (Smeets & Faaij, 2010).

The concept and practices of green supply chain management (GSCM) have been widely discussed in the last two decades due to the growing need for pollution reduction and resource conservation (e.g., Eltayeb & Zailani, 2009; Chin et al., 2015; Foo et al., 2018). The supply chain management approach requires coordinated efforts from upstream and downstream partners to satisfy the growing expectation of environmental awareness in the supply chain (Zhu et al., 2019). In this Industry 4.0 era, there is rapid development of digital technologies, where companies are taking advantage of emerging digital technology applications to seek innovation in green supply chains for greater cost and service efficiency.

Despite the importance of the green supply chain theme and its relationship with sustainability, when examining the literature, there is a lack of revisionary studies, especially bibliometric studies that make it possible to understand the emergence, evolution, and frontier studies of these themes. Therefore, this study aims to identify the emergence, evolution, and map the frontier themes of green supply chain and sustainability topics, thus systematizing the knowledge domain of these themes.

It is expected that the study will enable increased understanding of green supply chains and contribute to theoretical advancement on the theme, since by identifying and systematizing the knowledge stock, divergent theoretical currents are presented, and with the bibliographic coupling map, emerging themes and new insights that should be incorporated into the theoretical foundations of the theme will be presented. It is also expected to provide managerial contributions through this study, as managers can utilize green supply chain actions, practices, and policies in their operations. Such elements will naturally be discussed in the analysis of clusters from the co-citation and bibliographic coupling maps, with co-citation and bibliographic coupling analysis being the bibliometric techniques used in this research.

Theoretical Elements of the Research

This section presents the main concepts and a brief evolution of green supply chains, as well as their practices related to sustainability. In summary, it delimits which concept and which theoretical field we discuss in this bibliometric study in the following sections.

In recent years, environmental and social responsibility practices have been incorporated as major advances in the cultural foundations of the business world (Al-Quran et al., 2020). With growing interest in such responsibilities, numerous companies have determined "greening" initiatives as competitive strategic approaches (Min & Kim, 2012). Green supply chain management has gained increasing attention from academia and among operations management professionals. The growing importance of Green Supply Chain Management has been enhanced by increasing environmental deterioration, for example, decreasing raw materials, flooding of waste sites, and increasing pollution levels (Srivastava, 2007).

Supply chain management involves the coordination and management of complex networks of business relationships that aim to deliver an appropriate product to the end user or consumer (Ninlawan et al., 2010). Green Supply Chain Management also involves incorporating environmental considerations into supply chain management (Chin et al., 2015). Kumar et al. (2011) defined green supply chain management as a methodology aimed at greater optimization of material and information flows throughout the value chain. Similarly, green supply chain management has emerged as a managerial issue as it allows companies to increase profit generation while maintaining environmental efficiency for the complex processes involved in each stage of the product life cycle (Barari et al., 2012). Green supply chain management is also understood as the process of using ecological inputs and transforming these inputs into products that can be recovered and reused at the end of their life cycle, thus creating a sustainable supply chain (Dube & Gawande, 2011).

Green supply chain practices play a fundamental role in obtaining social, environmental, and economic benefits (Triple Bottom Line), thus contributing to the sustainable evolution of society (Eltayeb & Zailani, 2009). Foo et al. (2018) also highlighted sustainable supply chain management practices as a strategic issue for achieving sustainability performance, and found that the relationship between supplier selection and evaluation and sustainability performance is not significantly important. Although cooperation with customers is highly related to sustainability practices, it is negatively related to sustainability performance.

The objective of Khan et al. (2020) was to identify the relationship between green logistics operations as part of green supply chain performance and economic and environmental sustainability indicators. Their result indicated that green logistics companies had a positive relationship with foreign direct investment flows, renewable energy consumption, and energy demand. However, it demonstrated that there was a significant negative relationship with carbon dioxide emissions.

Environmental cooperation in a green supply chain environment, according to Jo and Kwon (2022), is an important driver of green innovation capacity for Korean industry-based SMEs. Furthermore, it was found that green innovation has a favorable impact on financial success through environmental performance. It provided a theoretical foundation for in-depth investigation of systematic mechanisms of green supply chains and their recommended strategic pathways for appropriate implementation of production-based green supply chain management.

Methodological elements of the research

This study was developed through a bibliometric review. Generally, bibliometrics is a type of review that provides an overview of the development of a knowledge area and enables the development of a map that systematizes the evolution of themes in this knowledge field (Zupic & Cater, 2015). In this context, bibliometrics can be understood as a technique that systematizes knowledge and identifies the growth trend of research flow in a particular discipline, as well as the dispersion and obsolescence of scientific fields, most productive authors and institutions, and journals most used in research dissemination in a particular knowledge area (Zhu et al., 2008).

More specifically, bibliometric review refers to a method that organizes, classifies, systematizes, and allows quantitative analysis of publication patterns in a knowledge field, as well as their authorship through mathematical and statistical tests (Mukherjee et al., 2021). Bibliometrics is a tool for analyzing how themes have evolved over the years based on the intellectual structure, social

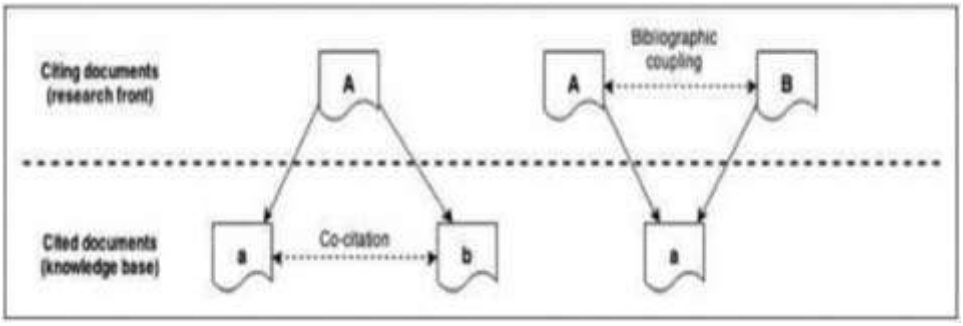
structure, and conceptual structure of the analyzed phenomena (Zupic & Cater, 2015). In summary, this technique evaluates research results, including investigated topics sought, methods used, theories employed, and samples used (Ye et al., 2012), through the basic application of advanced statistical techniques to data obtained from previously published studies, such as books, proceedings, and journals (Cobo et al., 2011).

When examining the literature, five specific techniques are identified for developing bibliometric research. These techniques are the most used: co-citation analysis, co-word analysis, co-authorship analysis, and bibliographic coupling (Koseoglu et al., 2016). Based on the scope and objectives of this research, we chose to use co-citation analysis and bibliographic coupling techniques, since these techniques allow systematizing the formation and evolution of the knowledge domain of social innovation in the field of applied social sciences, as well as allow us to trace directions regarding trends in future studies in this knowledge field. These two analysis techniques are even considered predominant in other seminal bibliometric studies (Zupic & Cater, 2015).

More clearly, the co-citation analysis technique adopts co-citation metrics to construct similarity measures between documents, authors, or journals (Mukherjee et al., 2021). Co-citation evaluates the frequency with which two units are cited together (Small, 1973). There are different types of co-citation, including author co-citation analysis and journal co-citation analysis (White & McCain, 1998). It should be noted that this study will analyze author co-citation. Co-citation analysis is employed to map the intellectual structure of different disciplines, such as marketing (Jobber & Simpson, 1988), operations management and strategy and service management (Pilkington & Chai, 2008), and tourism (Benckendorff, 2009).

On the other hand, bibliographic coupling takes into account the number of joint references in two documents as an indicator of similarity between them to analyze trends and convergences between studies in the same knowledge field (Zupic & Čater, 2015). Both techniques are indicated for analyzing relationships between study citations and are adopted in scientific studies for domain mapping, seeking to present domains of scientific communication reflected in scientific literature and in connections of researcher citations (Börner et al., 2003). Figure 1 presents a synthesis of these two techniques.

Figure 1: Co-citation and Bibliographic Coupling Analysis Search: Zupic & Cater (2015)

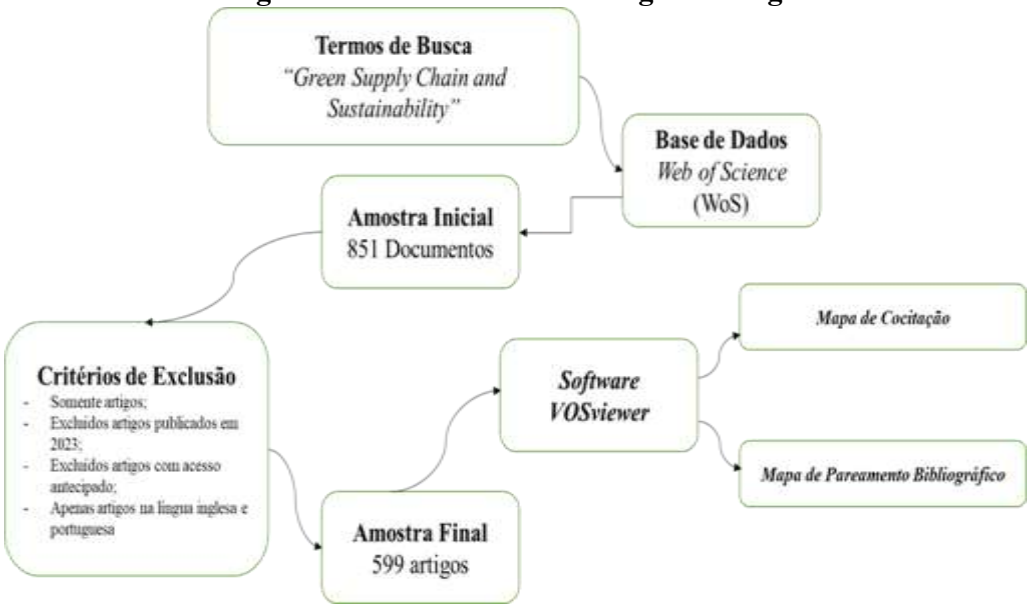


Source: Zupic e Cater (2015)

In the literature, various software can be employed to perform co-citation and bibliographic coupling analyses. Among these various tools, the VOSviewer software stands out because its graphic outputs are in high resolution, allowing greater clarity of generated clusters, and its access is free, thus

allowing its wide use in the literature (Van Eck & Waltman, 2018). The methodological design of this study is presented in Figure 2.

Figure 2: Research Methodological Design



Source: Authors (2023*)*

It should also be noted that the database from which the sample was extracted is the Web of Science (WoS). The choice of this database took into account the high concentration of studies on the theme compared to the Scopus database, in addition to its global coverage, which encompasses the proposed subjects and is also recognized for presenting a structure for information analysis on indicator production, without the need for major prior data manipulations (Pinto et al., 2016).

For sample article selection, the term "Green Supply Chain and Sustainability" was searched in the topic field (title, abstract, and keywords) in the main search interface of the Web of Science database. Initially, 851 documents on the theme were found. After the first stage of filter application, we excluded documents with early access. We also excluded articles published in the current year of 2023. This procedure was necessary to ensure research validity and replicability, leaving 746 documents. Aiming to select documents with methodological rigor and high-quality criteria, we selected only articles, reducing the sample to 603 articles. Subsequently, we selected only articles developed in English, leaving 599 scientific articles as the final sample.

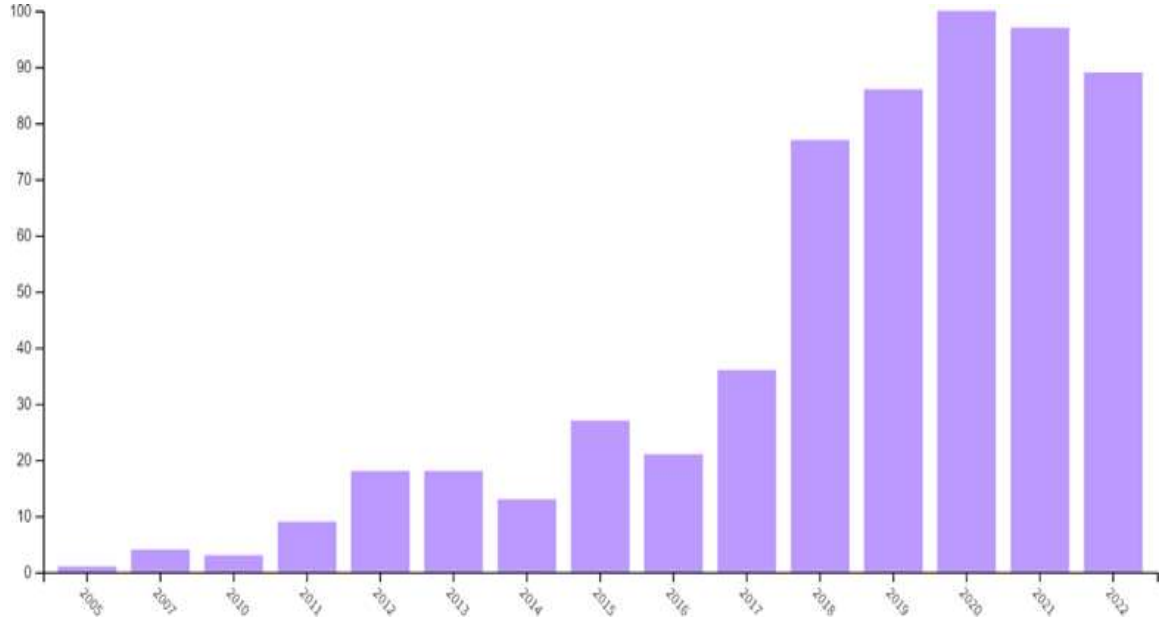
Descriptive Results

When analyzing the evolution of studies in relation to publication years, it is clearly perceived that in the last five years the volume of publications has grown exponentially, growing from approximately 40 in 2017 to almost 100 publications on green supply chain and sustainability in 2022. In part, this notable growth can be explained by the increasing pressure that organizations are suffering

from their different stakeholders (customers, government, and society in general) to go beyond generating profit, but also to generate social and environmental impact. This concern was reinforced by countries at the UN (United Nations) meeting that occurred in 2015 and defined 17 sustainable development goals as the 2030 agenda. Thus, governments increased the demand for sustainable environmental practices that must be implemented by organizations, especially in supply chains, affecting suppliers, intermediaries, focal companies, and distributors. Figure 3 presents the yearly evolution of the themes investigated in this research.

The author with the highest number of publications is Joseph Sarkis with 18 publications. The author has 85,213 citations on Google Scholar and an H-index of 134, meaning his works have many citations by other studies. He is a professor of management at the Worcester Polytechnic Institute School of Business. Previously, he served as a faculty member at Clark University and the University of Texas at Arlington. His teaching and research interests are in the areas of environmental sustainability, operations, and supply chain management. He is the author or co-author of more than 500 publications. His research is widely cited and has earned the designation of highly cited researcher for seven years, from 2016 to 2022, from Thomson-Reuters/Clarivate Analytics (Web-of-Science). He was also identified as the most productive researcher in the supply chain management area between 1995-2015.

Figure 3 - **Evolution of Research on Green Supply Chain and Sustainability**



Source: Web of Science (2023)

In Figure 4, the volume of publications by author was analyzed, which made it possible to identify the most influential authors in green supply chain and sustainability research. The three researchers with the highest volume of publications will be presented in greater depth.

Figure 4 - **Main Authors in Green Supply Chain and Sustainability Research**

Source: Web of Science (2023)

Finally, the third most influential author indicated in this research refers to Sachin Kumar Mangla, with 10 publications. His works have been cited 14,238 times and his H-index is 69 on Google Scholar. He is currently working at the Faculty of Business Knowledge and Decision Making, University of Plymouth, United Kingdom. His research is in the area of Green and Sustainable Supply Chain and Operations; Industry 4.0; Circular Economy; Decision making and modeling. He has over five years of teaching experience in Supply Chain and Operations Management and Decision Making, and is currently associated with teaching at various universities in the UK, Turkey, India, China, France, etc. He has published/presented several papers in renowned international/national journals (International Journal of Production Economics; International Journal of Production Research; Production Planning and Control; Business Strategy and the Environment; Journal of Cleaner Production; Annals of Operations Research; Transportation Research Part-D). He is involved in editing some special issues as Guest Editor in Production Planning and Control, Annals of Operations Research, Journal of Resource Policy, Journal of Cleaner Production.

Figure 5 presents the most important journals with research on green supply chain and sustainability. It should be remembered that the map was constructed based on the sample of 599 articles selected in this research and was organized based on the number of publications per journal.

The most important journal is the Journal of Cleaner Production, with 79 publications, with an impact factor of 11.1 and CiteScore of 18.5, meaning it is extremely rigorous in the acceptance criteria of articles that are published and undergo double-blind checking to ensure impersonality in the article acceptance analysis process. It is an international and transdisciplinary journal focused on Cleaner Production, Environmental and Sustainability research and practices. Through published articles, they intend to help societies become more sustainable and consequently organizations.

Figure 5 - **Journals with the Highest Volume of Publications on Green Supply Chain and Sustainability**

Source: Web of Science (2023)

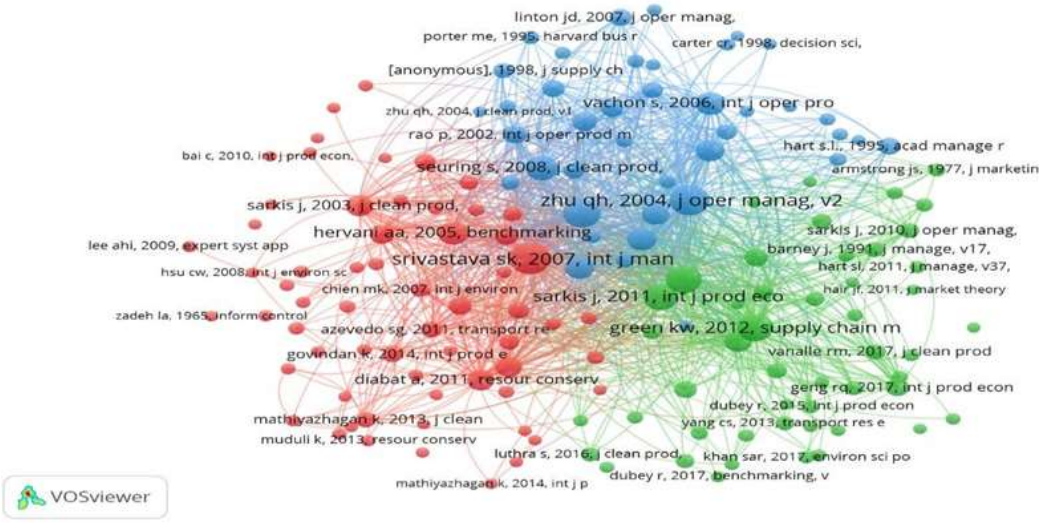
The second most important journal in terms of volume of publications on the themes refers to Sustainability, with 63 publications. Its indicators related to impact factor are 3.9 and CiteScore of 5.8. Sustainability is an international, interdisciplinary, academic, peer-reviewed, and open-access journal about environmental, cultural, economic, and social sustainability of human beings. It provides an advanced forum for studies related to sustainability and sustainable development and is published online biannually by MDPI. The Canadian Urban Transit Research and Innovation Consortium (CUTRIC) and the International Council for Research and Innovation in Building and Construction (CIB) are affiliated with Sustainability and their members receive discounts on article processing fees.

Finally, the third main journal in terms of number of publications refers to the International Journal of Production Economics, with 27 publications. The journal has an impact factor of 12 and CiteScore of 18.3, meaning it is extremely rigorous regarding article acceptance criteria for publication. It focuses on topics that address the interface between engineering and management. All aspects of the subject related to manufacturing and process industries, as well as production in general, are addressed. The journal has an interdisciplinary character, considering complete activity cycles, such as the product life cycle - research, design, development, testing, launch, disposal - and the material flow cycle - supply, production, distribution. The journal's ultimate goal is to disseminate knowledge to improve industrial practice and strengthen the theoretical foundation needed to support sound decision-making.

Graphic Mapping Results

The 599 articles that comprise the sample of this research were imported into VOSviewer software to enable the creation of co-citation and bibliographic coupling maps. Regarding the co-citation map, three theoretical clusters were identified, which are addressed in depth in the sequence of this research and are highlighted in Figure 6.

Figure 6 - **Green Supply Chain Co-citation Map**



Source: Authors via VOSviewer (2023)

Co-citation Map Analysis

Seminal Studies on Green Supply Chain and Attributes for its Implementation (Red Cluster): The most important cluster of the co-citation map is the red one according to the VOSviewer software manual (Van Eck & Waltman, 2018). This cluster is composed of 62 studies. The main theme analyzed by studies in this group refers to seminal studies on green supply chain and attributes for its implementation.

The most influential study in this grouping was developed by Srivastava (2007), has a link strength of 2,713, was cited 173 times by other studies in the sample, and has 153 links with other studies. The literature analysis of this article shows that a comprehensive reference framework for green supply chain management was not adequately developed. Regulatory bodies that formulate regulations to address social and ecological concerns to facilitate business and economic growth also suffer from its absence. A succinct classification to help academics, researchers, and professionals understand integrated green supply chain management from a broader perspective is needed. Furthermore, there is sufficient literature to justify such classification. This article takes an integrated and current look at the green supply chain management area.

The second most important study in this cluster was developed by Diabat and Govindan (2011). The study has a link strength of 1,701, was cited 80 times by other studies, and has 150 links with other studies. The authors developed a model of drivers that affect green supply chain management implementation using an Interpretive Structural Modeling framework. The various drivers of green supply chain management are identified based on GSM literature and consultations with industry experts. The developed model is validated in a case study involving a manufacturing company in

southern India.

Implementation Practices and Effects of Green Supply Chain on Company Performance (Green Cluster): The green cluster is understood as the second in terms of importance of the co-citation map. This cluster is composed of 49 studies. The predominant theme analyzed by studies in this group deals with the analysis of implementation practices and effects of green supply chain on company performance.

The main study in this cluster is an article written by Zhu et al. (2008). The research aimed to empirically investigate the construct and evaluation scale of green supply chain management practices implementation among manufacturers. With data collected from 341 Chinese manufacturers, two measurement models of green supply chain management practices implementation were tested and compared by confirmatory factor analysis. Our empirical results suggest that both first-order and second-order models for supply chain management implementation are reliable and valid. The study has a link strength of 2,617, was cited 134 times by other studies in the sample, and has 150 links with other studies.

The second study in terms of importance in this cluster was developed by Green et al. (2012). This study has a link strength of 2,599, was cited 137 times, and has 150 links with other studies. In the research, the objective is to contribute significantly to the first wave of empirical investigations related to the impact of green supply chain management practices on performance. The article also aims to theorize and empirically evaluate a comprehensive model of green supply chain management practices and performance. The model incorporates green supply chain practices that connect manufacturers with supply chain partners (suppliers and customers) to support environmental sustainability throughout the supply chain.

The Relationship between Green Supply Chains and Improvement in Financial Performance and Competitiveness of Asian Companies (Blue Cluster): The blue cluster is the third most influential cluster of the co-citation map. This cluster is formed by 40 studies. The predominant analysis theme of this group refers to finding improvement in financial performance and competitiveness of Asian companies that implement green supply chain practices.

The most influential study in this cluster was developed by Zhu and Sarkis (2004). This study has a link strength of 2,917, was cited 162 times by other studies that comprise the sample of this research, and has 150 links with other studies. The study states that green supply chain management is emerging as an important approach for Chinese companies to improve performance, possibly in both dimensions. Using empirical results from 186 respondents on green supply chain management practice in Chinese manufacturing companies, we examined the relationships between green supply chain management practice and environmental and economic performance. Using moderated hierarchical regression analysis, they evaluated the general relationships between specific green supply chain management practices and performance. Then, they investigated how two main types of operations management philosophies, quality management and just-in-time (or lean) manufacturing principles, influence the relationship between green supply chain management practices and performance.

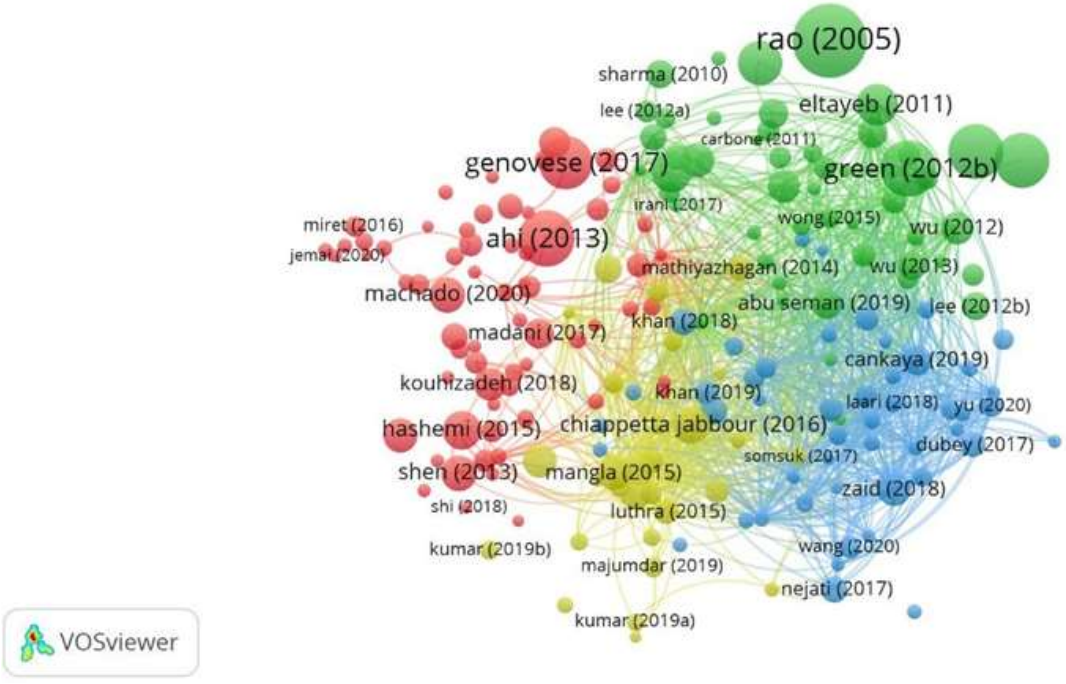
The second most important study in the blue cluster was developed by Zhu et al. (2005). The study has a link strength of 2,093, was cited 94 times by other studies, and has 150 links with other studies. The authors stated in the research that green supply chain management has emerged as a fundamental approach for companies seeking to become environmentally sustainable. This article aims to evaluate and describe the drivers, practices, and performance of green supply chain management

among various Chinese manufacturing organizations. The results presented by the authors found that Chinese companies increased their environmental awareness due to regulatory, competitive, and marketing pressures and motivators. However, this awareness did not translate into strong adoption of green supply chain management practice, much less improvements in some performance areas where it was expected.

Bibliographic Coupling Map Analysis

The bibliographic coupling analysis made it possible to present frontier studies, that is, current research trends and paths for future research on green supply chain. The bibliographic coupling map resulted in the identification of four clusters that will be discussed in depth in this research and are represented in Figure 7.

Figure 7 - **Green Supply Chain Bibliographic Coupling Map**



Source: Authors via VOSviewer (2023)

Sustainable Supply Chain Management, Circular Economy and Differences between Supply Chain and Green Supply Chain (Red Cluster): The main cluster of the bibliographic coupling map according to the software manual is the red cluster. This cluster is formed by 66 studies. The central theme of articles in this cluster was the differentiation of the green supply chain concept, and generally, studies emphasized sustainable management and circular economy as drivers that enhance green

supply chain implementation.

The most influential study in this cluster was developed by Genovese et al. (2017). This study has a link strength of 552 and was cited 644 times by other studies in the sample. The study emphasizes that circular economy goes beyond environmental sustainability boundaries, emphasizing the idea of transforming products in such a way that there are viable relationships between ecological systems and economic growth. Therefore, circular economy is not only concerned with reducing the use of the environment as a waste sink, but with creating self-sustaining production systems where materials are used repeatedly. Through two case studies from different process industries (chemical and food), this article compares the performance of traditional and circular production systems across a series of indicators. Direct, indirect, and total life cycle emissions, recovered waste, virgin resource use, as well as carbon maps (which provide holistic visibility of the entire supply chain) are presented.

The second most influential study in this cluster was developed by Ahi and Searcy (2013). The objective of this article is to identify and analyze published definitions of green supply chain management and sustainable supply chain management. Twenty-two definitions for green supply chain management and 12 definitions for sustainable supply chain management were identified. To analyze the identified definitions, two different sets of key characteristics were proposed for business sustainability (i.e., economic, environmental, social, stakeholder, voluntary, resilience, and long-term focus) and supply chain management (i.e., flow, coordination, stakeholder, relationship, value, efficiency, and performance focuses). The identified definitions were analyzed among themselves and the two proposed sets of key characteristics. The analysis shows that definitions for green supply chain management were generally more restricted than those for sustainable supply chain management and had emphasis on environmental, flow, and coordination focus characteristics. The study has a link strength of 567 and was cited 745 times by other studies.

The Positive Effects of Green Supply Chain on Corporate Financial Performance of Companies (Green Cluster): The second cluster in terms of importance of the bibliographic coupling map is the green cluster. This cluster is formed by 50 studies. The theme analyzed by studies in this cluster concerns the emphasis on positive effects of green supply chain on corporate financial performance of companies.

The most influential study in this cluster was developed by Rao and Holt (2005). This study has a link strength of 158 and was cited 1,253 times by other studies. This article seeks to identify potential links between green supply chain management, as an initiative for environmental improvement, economic performance, and competitiveness among a sample of Southeast Asian companies. The analysis identified that greening different phases of the supply chain leads to an integrated green supply chain, which ultimately leads to competitiveness and economic performance. Future research should empirically test the relationships suggested in this article in different countries, to enable comparative studies.

The second most important study in this cluster was developed by Green et al. (2012). The study has a link strength of 709 and was cited 741 times by other studies in our sample. The objective is to contribute significantly to the first wave of empirical investigations related to the impact of green supply chain management practices on performance. The article also aims to theorize and empirically evaluate a comprehensive model of Supply Chain Management practices and performance. The model incorporates green supply chain practices that connect manufacturers with supply chain partners (suppliers and customers) to support environmental sustainability throughout the supply chain.

Effects of Green Supply Chain on Environmental, Social and Economic Performance (sustainability tripod) and Environmental Sustainability Management of Companies (Blue Cluster): The third cluster of the bibliographic coupling map based on importance. This cluster is composed of 48 studies. The theme investigated in this cluster refers to analyzing the effects of green supply chain on environmental, social, and economic performance and environmental sustainability management of companies.

The most influential study in this cluster was written by Zaid et al. (2018). The study has a link strength of 1,173 and was cited 273 times by other studies in our sample. This study aims to investigate the link between green human resource management package practices and green supply chain management (i.e., external and internal practices), as well as their impact on Triple Bottom Lines of sustainability performance (i.e., environmental, social, and economic performance). A quantitative method is applied in which data are collected from a customized survey with 121 companies operating in the most polluting manufacturing sectors (i.e., food, chemicals, and pharmaceuticals) in Palestine. Data analysis was performed through partial least squares structural equation modeling. The results of data analysis show that both green human resource management and green supply chain management practices have a positive effect on sustainable performance jointly.

The second most important study in the blue cluster was developed by Çankaya and Sezen (2018). The study has a link strength of 1,493 and was cited 199 times by other studies. The authors explored in the research the impact of eight dimensions of green supply chain management on economic, environmental, and social performance, which are the three dimensions of corporate sustainability. The eight dimensions addressed in this study are: green purchasing, green manufacturing, green distribution, green packaging, green marketing, environmental education, internal environmental management, and investment recovery. With the exception of green purchasing, all dimensions of green supply chain management are related to at least one of the performance dimensions.

Critical Success Factors in Green Supply Chain Implementation (Emphasis on Green Human Resource Management) (Yellow Cluster): The yellow cluster is the last in terms of influence and importance that was identified in the bibliographic coupling map. The cluster is composed of 30 studies. The theme analyzed by studies in this cluster refers to analyzing the proposition of critical success factors in green supply chain implementation, especially the attention of these studies is on the relationship between green human resource management and green supply chain.

The most influential study in this cluster was developed by Jabbour and Jabbour (2016). This study has a link strength of 1,001 and was cited 328 times by other studies. Green Human Resource Management (GHRM) and Green Supply Chain Management (GSCM) are popular topics in the areas of human resource management (HRM) and operations management (OM), respectively. Although scholars in each of these areas are advancing in the roles of GSCM and GHRM in building more sustainable organizations, there has been a significant delay in integrating these two contemporary themes, based on a larger gap in integrating HRM and supply chain management. Thus, the objectives of this study are to propose a synergistic and integrative framework for the GHRM-GSCM relationship and propose a research agenda for this integration.

The second most important study in the yellow cluster was developed by Luthra et al. (2016), has a link strength of 1,266, and was cited 152 times by other studies in the sample. The article explores the importance of Critical Success Factors (CSFs) for implementing green supply chain management

toward sustainability, taking into consideration the Indian automotive industry. The hypothetical relationships of the proposed framework were tested through analysis of data collected from 123 Indian automotive organizations. This study examined the impacts of CSFs for implementing supply chain management toward sustainability on current green practices implemented by the Indian automotive industry and expected organizational performance results using multiple regression analysis. The results indicate that the "regulatory" CSF was identified as playing the most important role in promoting green practices.

Final Considerations

Literature Review and Evolution

The bibliometric review proposed in this research enabled identification through the co-citation map of the intellectual structure and evolution of studies on green supply chain. This technique allowed identification of four clusters, with the most important cluster of the co-citation map dealing with seminal studies on green supply chain and attributes for its implementation. Studies in this cluster are referenced in other research on the theme, that is, they are considered the most important studies on the emergence, theoretical developments, conceptual models, and frameworks on green supply chain.

The second main cluster of the co-citation map concentrated on analyzing implementation practices and effects of green supply chain on company performance. Generally, articles belonging to this cluster addressed the main practices that can benefit companies seeking to make a transition from conventional supply chain to a supply chain with emphasis on sustainability, through a green supply chain. The third cluster identified in the co-citation map was the blue one. Generally, the focus of this study was on the Asian continent, more specifically China, which makes sense when we relate it to the growth of the Chinese economy in recent years. Thus, the focus of this group of articles was to analyze the relationship between green supply chains and improvement in financial performance and competitiveness of Asian companies.

The bibliographic coupling performed identified four clusters of studies on green supply chain in the literature. The most important cluster, which is red, analyzed sustainable supply chain management, circular economy, and differences between supply chain and green supply chain. More specifically, these studies sought to differentiate the concepts of traditional supply chain from the concept of green supply chain and how circular economy can positively impact sustainable supply chain management. The second cluster of the bibliographic coupling map is green. Articles in this grouping concentrated on analyzing the positive effects of green supply chain on corporate financial performance of companies, relating green supply chain practices to improvement in company market value, revenue, and return on assets (ROA).

The third cluster mapped in the bibliographic coupling analysis investigates the effects of green supply chain on environmental, social, and economic performance (sustainability tripod) and environmental sustainability management of companies. That is, these articles extrapolate the assertion that green supply chain only positively affects financial performance, but also positively influences environmental and social performance of companies, leading to better stakeholder reciprocity and company brand valorization. Finally, the fourth cluster, which is yellow, concentrated on analyzing critical success factors in green supply chain implementation. Despite various critical

factors that are proposed, the emphasis was on relating implementation success to companies' ability to perform green human resource management, that is, focus on employees.

Future Directions

The present study presented the theoretical-conceptual evolution of the green supply chain theme and identified, through bibliographic coupling, the boundaries of study areas on the addressed theme, as well as research trends and insights for future studies. The main contribution of this study is exploratory in nature and goes beyond mapping the theoretical-conceptual evolution, its main theoretical influences, existing theoretical currents, and current theoretical fronts on green supply chain, as it allows for increased understanding of the formation and evolution of the scientific field and presents the current boundaries of studies, thus marking a starting point for future descriptive and causal studies, especially in the clusters formed in the bibliographic coupling map.

The study has some limitations. The first consists of choosing only the Web of Science (WoS) database, because despite the high overlap index in relation to the Scopus database, it is recommended that future studies use studies from both databases for a more robust analysis. Another limitation refers to the method, bibliometric analysis, since although a bibliometric review is a technique to identify the theoretical evolution of the green supply chain theme, it does not allow for in-depth analysis of how divergences occur between studies in each cluster, which would enable new insights. Therefore, it is recommended that future studies conduct systematic literature reviews, especially in areas identified in bibliographic coupling, as the clusters identified in this map address study trends and knowledge frontiers of the theme. A model that can be used as a reference for systematic literature reviews is ACMM (antecedents, consequents, mediations, and moderation) (Ribeiro et al., 2023). It is the synthesis and analysis of articles based on antecedent, consequent, mediation, and moderation variables of the studied construct. Another important research agenda is the relationship between green supply chain and ESG (Environmental, Social and Governance). An important work that maps ESG research in applied social sciences can be found in Ribeiro and Lima (2022). New researchers can seek to understand the intersection of these theoretical fields.

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