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ISSN: 2328-8272 (print)
ISSN: 2328-8280 (online)

Journal of Eastern European and Central Asian Research

International Affairs * Economics * Finance * Management * Marketing

Vol 9, No 5 (2022) - Special Issue



The Institute of Eastern Europe and Central Asia



Special issue dedicated to the 5th International Conference on Business, Economics, Social Sciences, and Humanities (ICOBEST) held on May 30-31, 2022, in Bandung, Indonesia.

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BIBLIOMETRIC ANALYSIS OF GREEN SUPPLY CHAIN RESEARCH USING VOSVIEWER

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ABSTRACT

A green supply chain is used to consider the environmental effects of all products, including environmental influences originating from goods/products and the product manufacturing process from raw materials to finished products. This study aims to perform a bibliometric analysis on the green supply chain topic by combining mapping analysis using VOSviewer software. In collecting the data, we used a quantitative bibliometric approach. Meanwhile, a descriptive method is used to obtain the results from the data collected. The data were retrieved from a Google Scholar search. We found 996 articles published in the 2012–2022 period from the search results. The results show that research on the green supply chain topic in 2012-2016 has not been widely carried out, and there has been an increase in 2017-2020. However, research on the green supply chain topic declined in 2021-2022. In conclusion, this study shows the importance of conducting bibliometric analysis, particularly on the green supply chain topic. This research is expected to be a reference for further research in conducting and determining the research theme.

Keywords: Green supply chain; environmental effects; bibliometric; VOSviewer

DOI: <http://dx.doi.org/10.15549/jeecar.v9i5.1051>

INTRODUCTION

Green Supply Chain integrates supply chain and environmental management to monitor and measure the environmental effect of supply chain activities. The goal is to aid industries in reducing their carbon emissions and minimizing waste while maximizing profit. To improve the supply chain for a green environment, the improvements in manufacturing and purchasing to distribution, warehousing, and transportation must be made. The emerging topic of the green supply chain has evolved significantly, as seen by a geometric increase in the number of academic publications in this field. Bibliometrics is a literature review method that uses statistical and quantitative analysis of published studies focusing on the article's structure included in the references. The unit of analysis includes the article and its sub-components, such as citation, author, journal, field and country. Given the variety of mappings, bibliometric analysis requires software tools to analyze and visualize data, such as VOSviewer, Publish, or Perish.

Previous studies discussing bibliometrics include bibliometric studies related to online registration (Dimisyqiyani et al., 2020) & (van Leeuwen et al., 2016). Research regarding online registration is always increasing and has become a trending topic to be developed by researchers. Another research is bibliometric analysis in the synthesis of carbon nanotubes. Research on carbon nanotubes is popular due to the COVID-19 pandemic situation, which limits researchers from reducing experimental activities and physical interactions (Aldhafi et al. 2021), (Jiang et al., 2018), (Zhao et al., 2018) & (Khudzari et al., 2018). Then, some studies discuss assessing quality for bibliometric studies that try to analyze the evolution of biotechnology research to map leading organizations and to study the interactions between science and technology (Xiao et al., 2022) & (Aleixandre-Benavent et al., 2018).

However, research on the green supply chain, which conducts bibliometric analysis, has not been widely discussed. Therefore, we chose the green supply chain topic in this study. This study provides an overview that has not previously been carried out or evaluated on matters related to this topic. This study used Visualization of Similarity (VOS) viewer software to map green supply chain materials to investigate the features of the

literature and the research relationship surrounding the green supply chain topic.

LITERATURE REVIEW

The green concept has a relatively broad and complex scope. It deals with environmental issues such as humanitarian issues, clean water, fair trade, animal welfare, equality, and sustainability. The term "green" also has different meanings for professionals in various fields. For example, in the field of health and medicine, "green" has the meaning of reducing damage to human health, and in the business field, it means the harmonization of the company's environmental performance. The green business promotes green management principles, policies, and practices that improve the quality of life for customers, employees, and the communities in which they operate. For example, when a product allows being environmentally friendly in some ways but at the same time unsafe in the long run, it could be argued that labeling it as green is wrong and even socially irresponsible to have this product in the market (Loknath et al., 2017).

A green concept in business and economy means producing goods efficiently without taking a lot of resources in, which the resulting products can be reprocessed into finished products. Examples of such products are recycled paper and solar water heaters. Therefore, it is hoped that reforestation becomes a standard principle in production, no longer treated as an additional feature or as an excess feature.

A supply chain is a network unit set that a company conveys to their final customer to distribute their service and product (El Mrabet et al., 2017). Every network in the supply chain flow is bound with each other, and it has its own role. The network in the supply chain includes various activities, entities, resources, people, and information (Azzi et al., 2019). The flow occurred in the supply chain, including transferring and converting raw materials into finished products, transporting them, and distributing them to final customers. It plays a significant role in maintaining economic growth and international trade development. If a company can organize or manage its supply chain adequately, its company development can decrease the incurred cost.

Furthermore, they can remain competitive in the business field as well. The entities involved in the supply chain include manufacturers,

warehouses, vendors, distribution centers, retailers, and transportation companies (Yu et al., 2017). The company needs to convey a proper supply chain because it can help it be more prepared to plan its future strategy.

Traditionally, supply chains have been designed to maximize customer satisfaction, reduce operating costs, and increase revenue and profitability. Over time, the purpose of the supply chain has changed and developed, namely towards more efficient use of resources (Lean Supply Chain) and more flexibility in responding to changes in demand or supply (Agile Supply Chain).

Focusing on environmental and sustainability issues is starting to become the focus of attention as a priority for business focus (Yusuf et al., 2022). Apart from providing a good image to the public, this is because implementing principles that prioritize this issue can also help reduce operational costs and increase the potential for business sustainability (Alexandrou et al., 2021). Facing environmental and sustainability issues have even become one of the main priorities of the millennium development goals set by the United Nations (Sachs et al., 2012). In supply chain management, applying a supply chain by considering environmental and sustainability issues is called Green Supply Chain.

The occurrence of a rumor related to the environment makes organizations aware that improving the quality of the products is vital to support business actors in their production activities. Green Supply Chain Management (GSCM) is a concept that involves the flow of finance and information and facilitates performance by integrating environmental aspects into supply management practices to support efficient collaboration between partners, as well as gain customers' trust and more market share (Badi et al., 2019). Not only that, GSCM has an essential role in industrial systems that aim to reduce waste, air pollution, and the economy and reduce the use of chemicals that are harmful to humans (Ho et al., 2022). In the current competitive business era, GSCM does not only rely on environmental aspects but improves on aspects of business segment coordination and energy alignment such as production, logistics, quality, responsiveness, efficiency, etc. Therefore, GSCM makes the economic sector more advanced and the environmental sector more organized (Tampa et al., 2019). The importance of evaluating

the implementation of GSCM in an organization is to determine the success of each organization that has implemented the concept.

The main goal of GSCM is to ensure an organization is aware of environmental concerns while managing its supply chain concept. With this aim, it is expected that supply chain processes with high environmental risks can be minimized or even eliminated, thereby increasing the effectiveness of the business environment and reducing the negative environmental impacts caused by their business processes. Besides that, it can also help sustain profits and market share (Rahmi, 2018). The growing importance of GSCM stems mainly from reduced sourcing of raw materials, a saturation of landfills, and increased pollution.

The application of GSCM certainly has advantages that can be classified into three parts: legal, social and commercial. Businesses that implement GSCM can more easily comply with environmental laws as well as with the local government regulations of the social sector, waste production, reduction in energy consumption, emissions, environmental thread risk, consumption of raw materials, noise, and radiation. In addition, the commercial benefits of GSCM include increased access to markets, improved environmental performance, customer trust in products, increased brand reputation, and increased product and service quality (Sarkis, 2011) (Rahmi, 2018). However, applying GSCM is costly for researching the concept of an efficient supply chain for the company (Soegoto, E S. 2022).

METHODOLOGY

In collecting the data, we used a quantitative bibliometric approach. Quantitative research can be defined as the process of gathering and interpreting numerical data. It may be used to discover averages and patterns, verify causal linkages, generalize results to larger groups, and make predictions (Basias and Pollalis, 2018). Meanwhile, a descriptive method is used to obtain the results from the data collected. The descriptive method describes the research problem accurately (Sahin et al., 2021). According to Sahin et al., the descriptive method focuses on describing the segment's demographic rather than "why" a phenomenon may occur (Sahin et al., 2021). Publish or Perish software was used to retrieve data from journals published on Google

Scholar by entering the keyword "green supply chain."Based on these keywords, there were 996 related studies published regarding the green supply chain topic with a time span of 2012-2022.

Furthermore, the article data is saved in (RIS) format so it can be accessed on the VOSviewer software to map the data in a bibliometric form. VOSviewer software can describe maps into three types of mapping: network, overlay, and density visualization. In addition, we filter the terms on the VOSviewer software to eliminate irrelevant terms related to the topic.

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RESULTS

We entered the keyword "green supply chain" in the Publish or Perish software for 2012-2022. From this search, we found 996 articles that match the green supply chain topic published in Google Scholar. The graph regarding green supply chain article growth is shown in Figure 1.

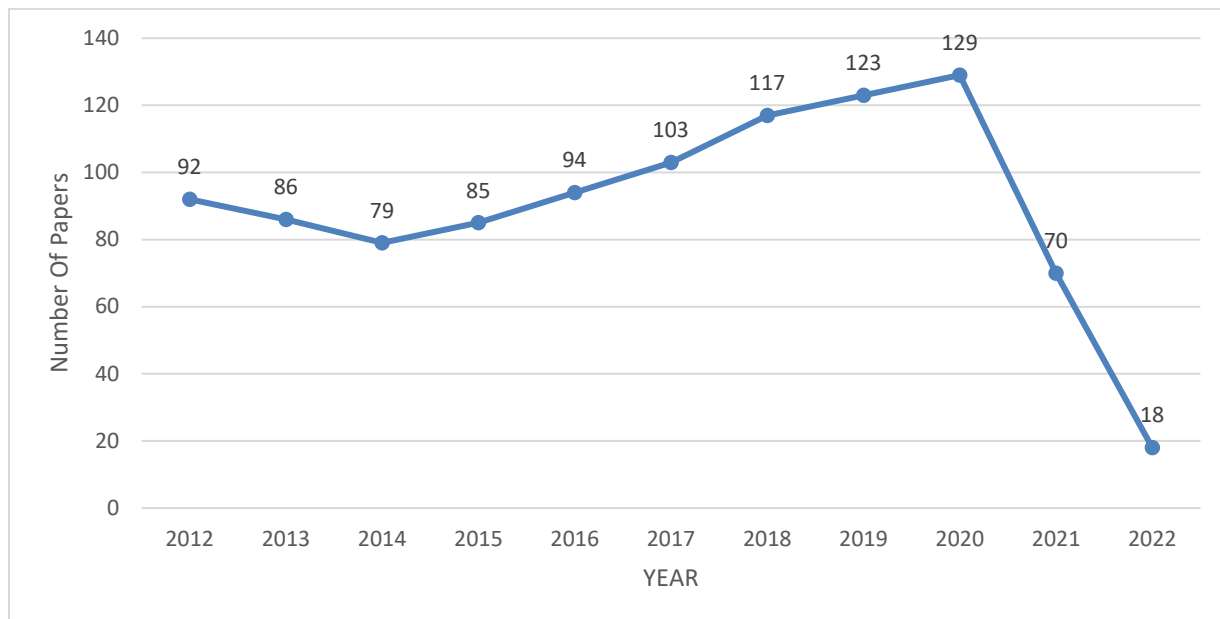


Figure 1: Green Supply Chain Article Growth in 2012-2022

Based on Figure 1, the research regarding this topic is still limited in 2012 to 2016. However, in 2017 to 2020, studies regarding this topic have increased. Moreover, the number of research regarding this topic declined from 2021 to 2022.

From the data obtained using the publish or perish software by entering the keyword green supply chain, it was found that 996 data articles were published on Google Scholar. After filtering the data, we obtained the 10 most cited articles

from different sources. The articles with the highest number of citations were published in 2013, with as many as 1414 citations. However, the lowest citation number was in 2012, with 432 citations. The data for articles on the green supply chain topic is shown in Table 1.

Table 1: Data-Articles on The Green Supply Chain Topic

Cites	Authors	Title	Year	Source
1414	P Ahi, C Searcy	A comparative literature analysis of definitions for green and sustainable supply chain management (Ahi et al., 2013).	2013	Journal of cleaner production
1285	KW Green, PJ Zelbst, J Meacham	Green supply chain management practices: impact on performance (Green et al, 2012).	2012	Supply Chain
1146	B Fahimnia, J Sarkis, H Davarzani	Green supply chain management: A review and bibliometric analysis (Fahimnia et al., 2015).	2015	International Journal of Production
1090	S Seuring	A review of modeling approaches for sustainable supply chain management (Seuring et al., 2013).	2013	Decision support systems
870	Q Zhu, J Sarkis, K Lai	Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices (Zhu et al., 2013).	2013	Journal of Purchasing and Supply Management
574	H Walker, N Jones	Sustainable supply chain management across the UK private sector (Walker et al., 2012).	2012	Supply Chain Management: An International
491	S Elhedhli, R Merrick	Green supply chain network designed to reduce carbon emissions (Elhedhli et al., 2012).	2012	Transportation Research Part D: Transport and
474	L Shen, L Olfat, K Govindan, R Khodaverdi	A fuzzy multi-criteria approach for evaluating green suppliers' performance in a green supply chain with linguistic preferences (Shen, 2013).	2013	Resources, Conservation
461	RYK Chan, H He, HK Chan, WYC Wang	Environmental orientation and corporate performance: The mediation mechanism of green supply chain management and the moderating effect of competitive intensity (Chan et al., 2012).	2012	Industrial Marketing
432	Q Zhu, J Sarkis, K Lai	Green supply chain management innovation diffusion and its relationship to organizational improvement: An ecological modernization perspective (Zhu et al., 2012).	2012	Journal of Engineering and Technology

Indicator Relevance Evaluation Results

From the data obtained, there are 68 items that were divided into seven clusters with different colors. Cluster 1 is red, cluster 2 is green, cluster 3

is blue, cluster 4 is yellow, and cluster 5 is purple. Cluster 6 is light blue, and cluster 7 is orange. Each cluster shows a group of related terms on the same research topic. With this mapping,

researchers get an idea of which areas of the term can be explored more deeply to find the latest research topics that have not been discussed much.

1. Cluster 1 has 18 items, namely, customer, dimension, effect, environmental performance, green design, green innovation, green manufacturing, green marketing, green performance, green purchasing, green supply chain integration, green supply chain management practice, impact, institutional pressure, operational performance, organizational performance, and smes type (See Figure 2).
2. Cluster 2 has 15 items, namely, adoption, barrier, critical success factor, economy, enterprise, evidence, green initiative, green supply chain initiative, green supply chain management, implementation, gsc, gscm practice, initiative, pressure, supply (See Figure 3).
3. Cluster 3 has 12 items namely chain, contract, coordination, dual chanel green supply chain, government, green product, manufacturer, order, pricing, product, retailer, strategi, and work (See Figure 4).
4. Cluster 4 has 7 items, namely, component, environmental impact, environmental management, green, green supply chain performance, investigation, lean (See Figure 5).
5. Cluster 5 has 6 items, namely, green supply chain management strategy, green supply chain strategy, importance, scm, section, and term (See Figure 6).
6. Cluster 6 has 6 items, namely, application, issue, researcher, review, sustainable supply chain, and sustainable supply chain management (See Figure 7).
7. Cluster 7 has 4 items, namely, green supply chain network, green supply chain network design, model, and uncertainty (See Figure 8).

Figure 2: Cluster 1 Network Visualization in Green Supply Chain Topic

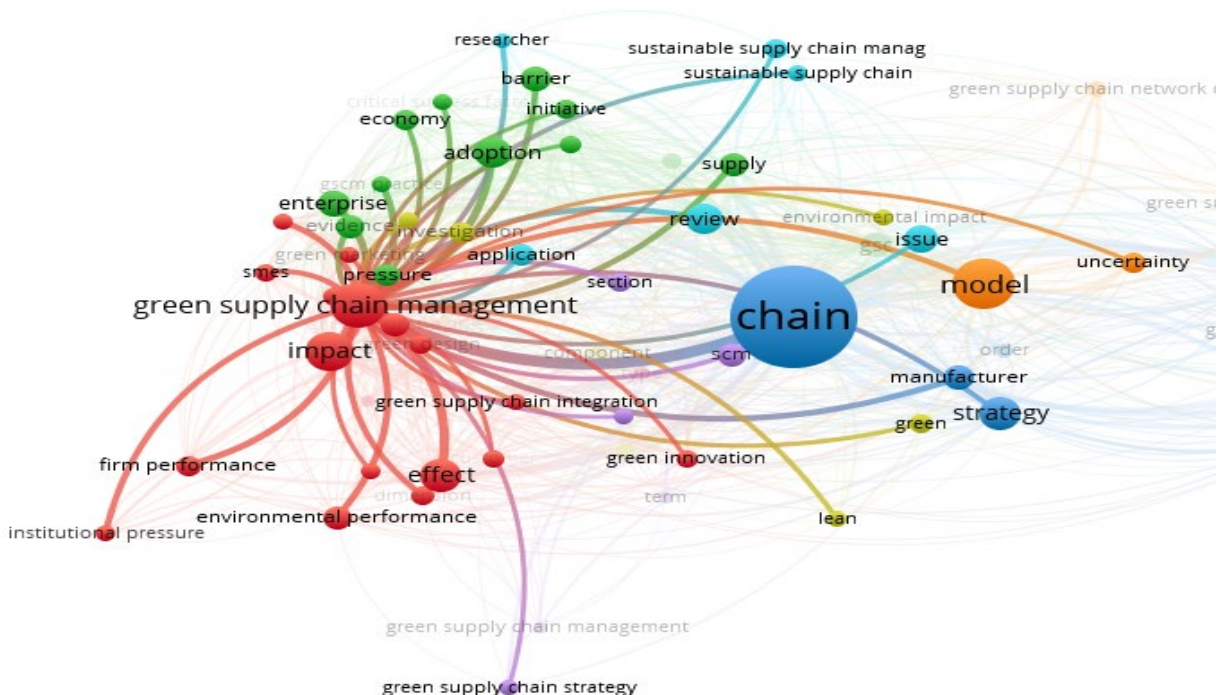


Figure 3: Cluster 2 Network Visualization in Green Supply Chain Topic

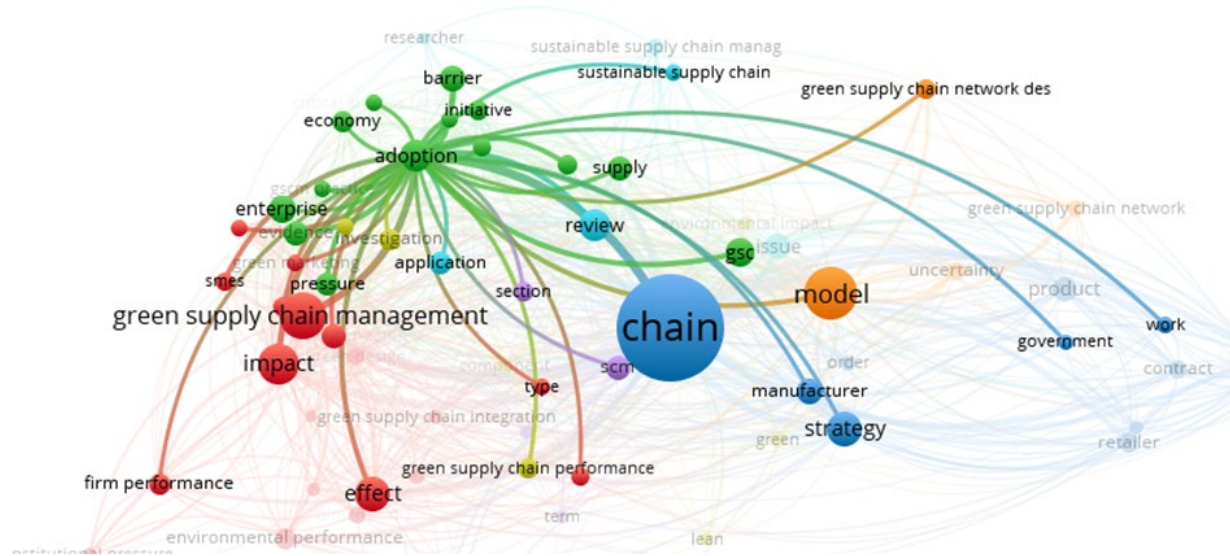


Figure 4: Cluster 3 Network Visualization in Green Supply Chain Topic

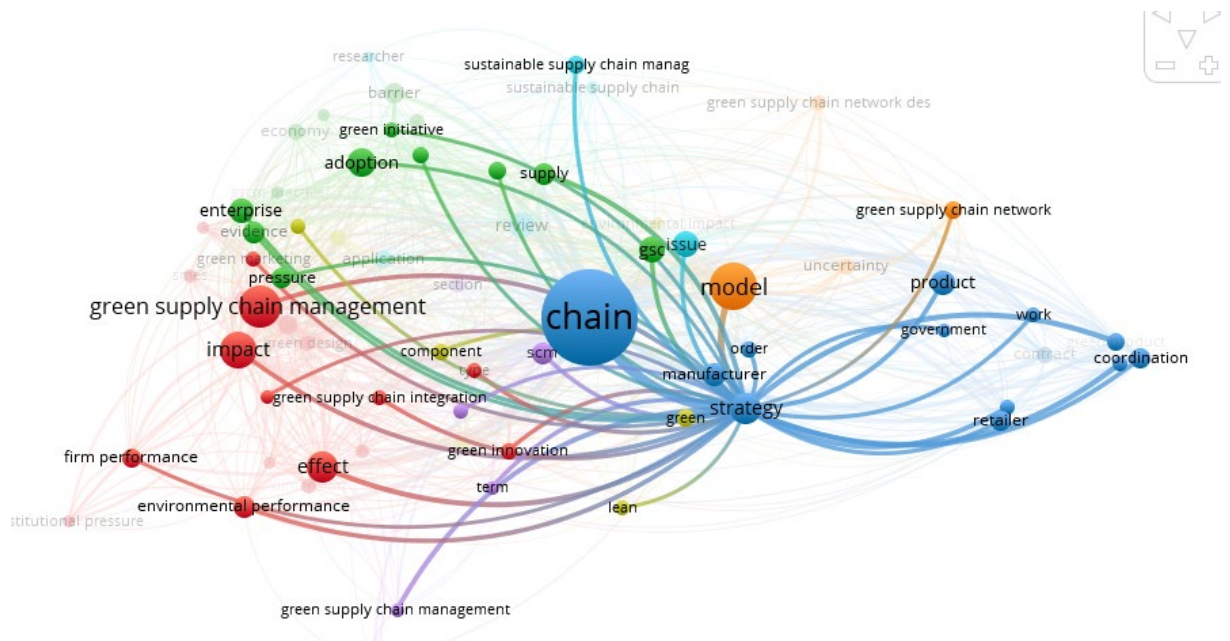


Figure 5: Cluster 4 Network Visualization in Green Supply Chain Topic

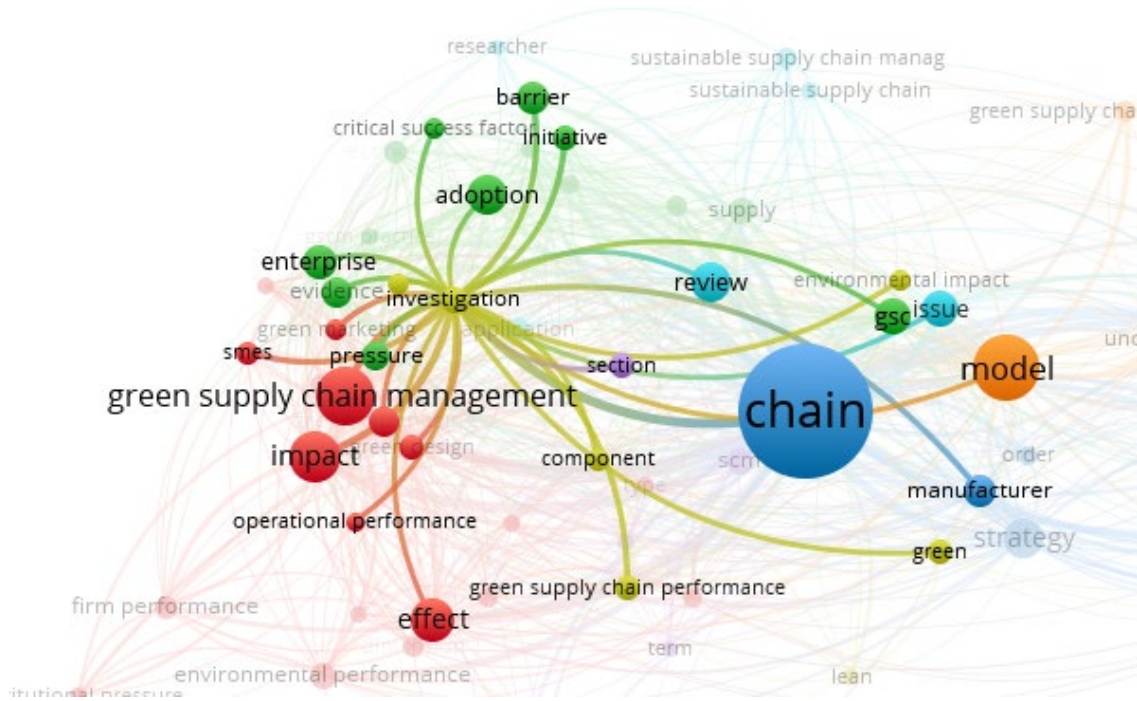


Figure 6: Cluster 5 Network Visualization in Green Supply Chain Topic

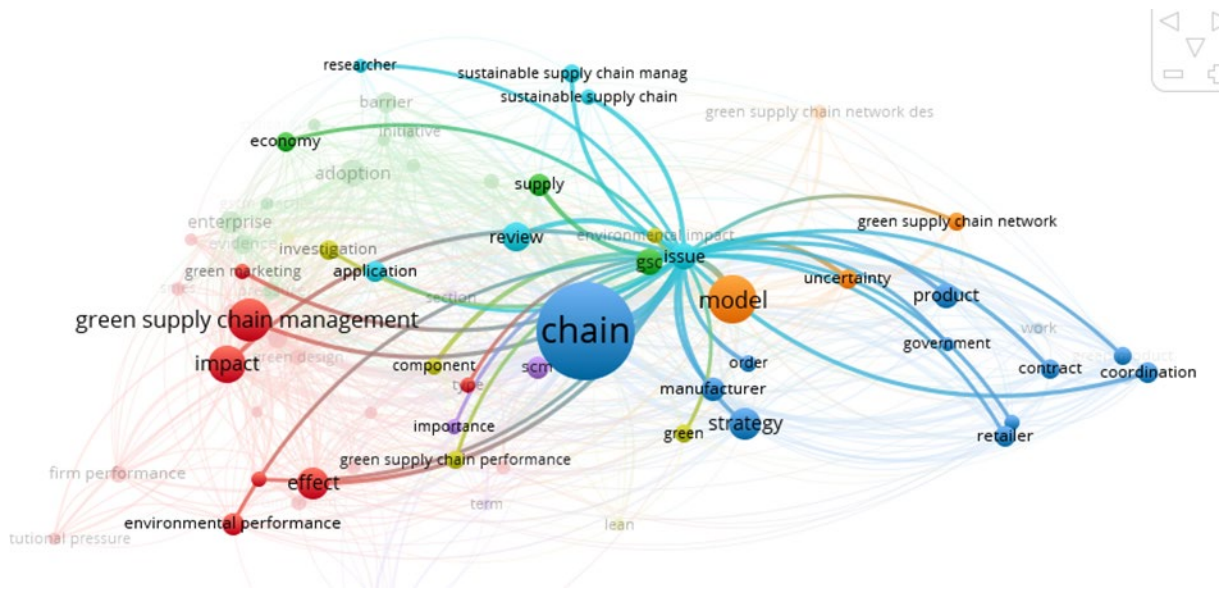


Figure 7: Cluster 6 Network Visualization in Green Supply Chain Topic

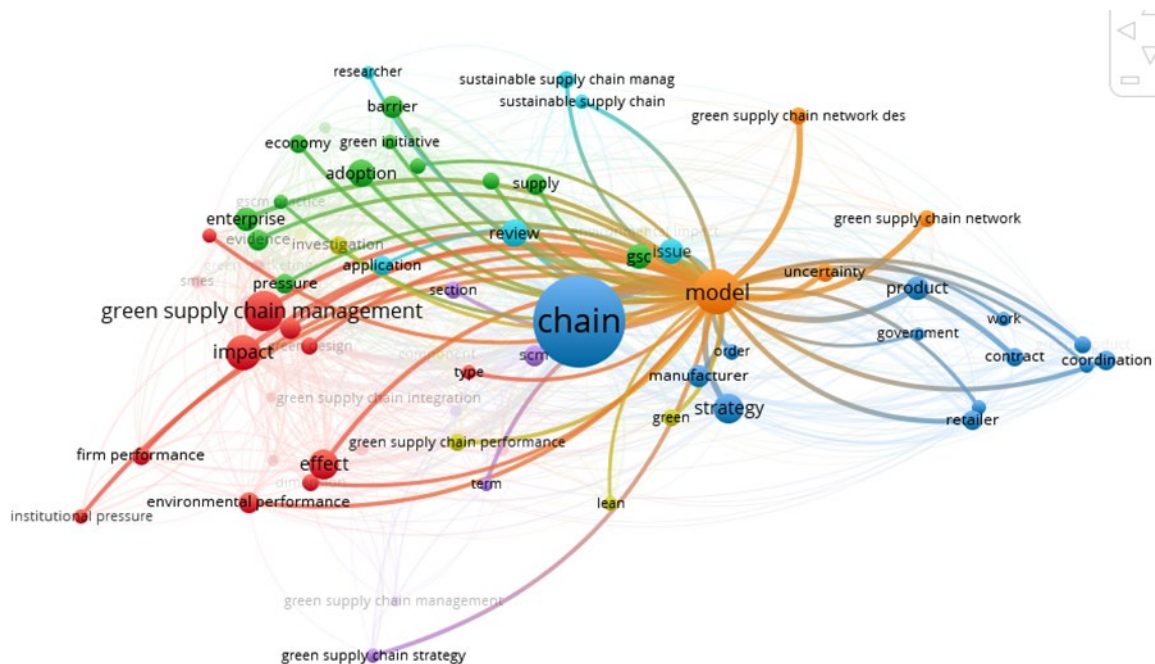


Figure 8: Cluster 7 Network Visualization in Green Supply Chain Topic

VOSviewer software has three types of mapping: network, overlay, and density visualization (Hakim, L. 2020).

Network visualization is a description of the relationship between terms on a map. Figure 9

shows a network visualization of a green supply chain from the VOSviewer software application.

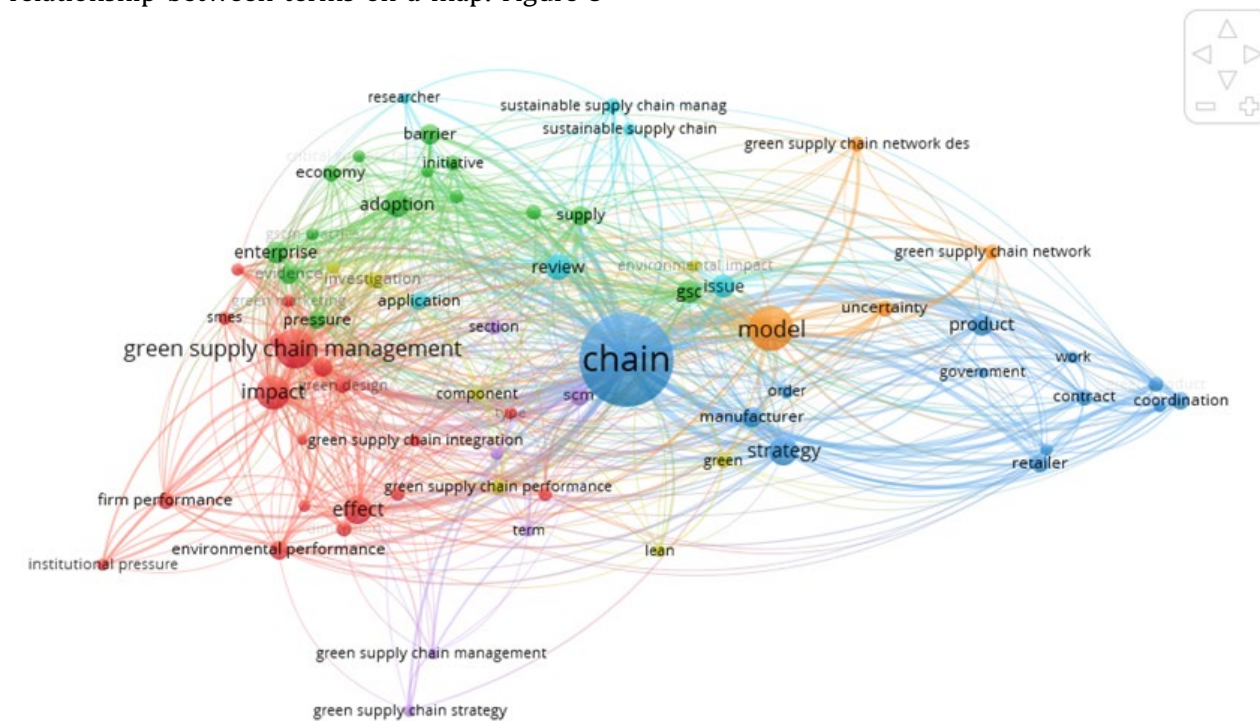


Figure 9: Network Visualization in Green Supply Chain Topic

There are several colors in the green supply chain network visualization image. The colors show the relationship between the term and one connected by a line. The term with the largest research circle is the chain with the broadest linkage with other terms. Furthermore, the terms Supply Chain Management and Model and other terms tend to be small in size, indicating that the green supply chain research topic can still be

explored more deeply to be used as a research theme. Overlay visualization is the display of research topic data based on the range of years to map the latest research topics from the topics studied (Komalasari et al., 2021). Mapping in the overlay visualization in the green supply chain topic with a time of 2012-2022 is shown in Figure 10.

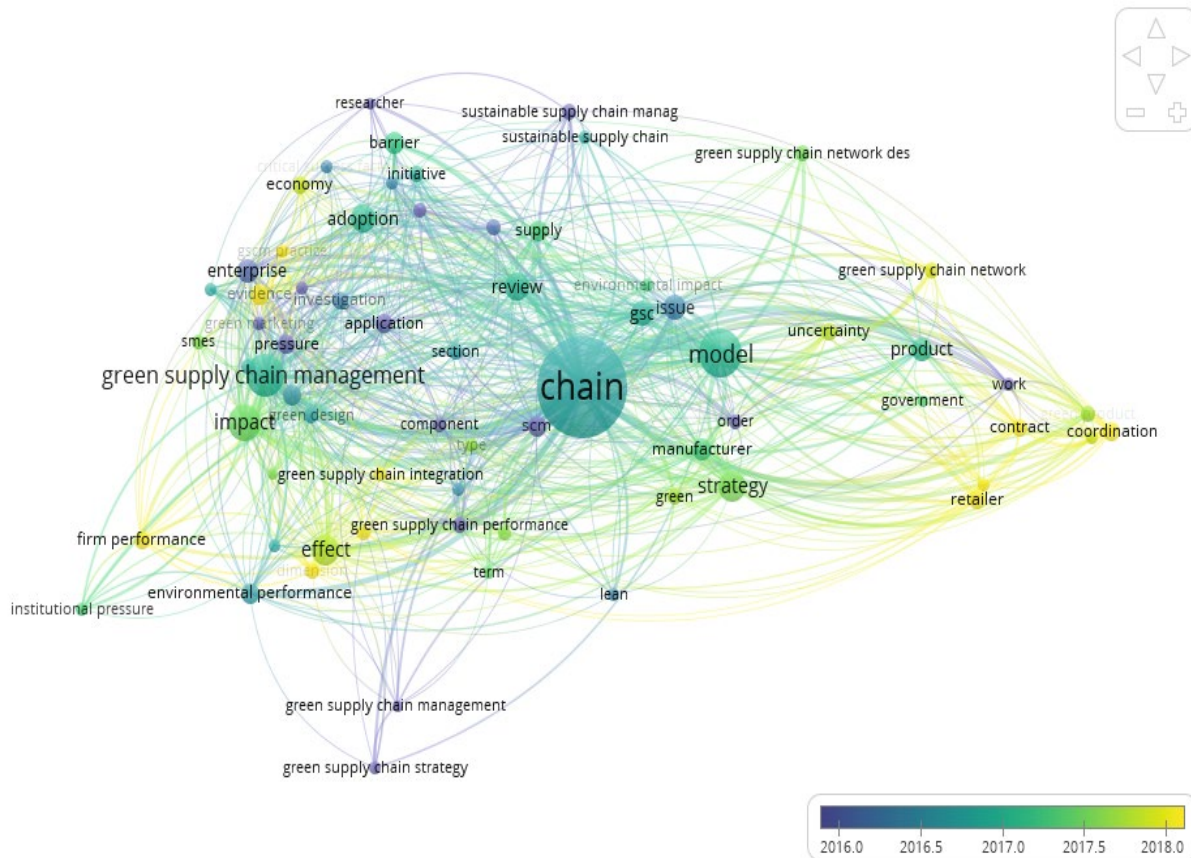


Figure 10: Overlay visualization of green supply chain topic

From Figure 10, it can be seen that the color obtained is getting darker. It indicates the research was conducted closer to 2012. Meanwhile, if the color is getting lighter, the research was conducted recently, around 2022. The terms with lighter colors tend to be fewer than those with darker colors (Aldhafi et al., 2021), (Maulidah et al., 2021), (Soegoto et al., 2022), (Al Husaeni et al., 2022) & (Finandhita et al., 2022). Recent research has not discussed the green supply chain as shown in the graph of the number of studies in Figure 1. A significant decline will occur in 2021.

Density Visualization of Green Supply Chain Topic

The last type of mapping visualization in the VOSviewer software is Density Visualization. In this type, it is explained that each term is divided according to its popularity. If the color displayed is dark or faded, then the term is rarely researched (Siswadi et al., 2020), (Nandiyanto et al., 2021), (Al Husaeni, 2022) & (Ragadhita, 2022). However, if the color obtained is lighter or yellow, the term is popular or often studied (See Figure 11).

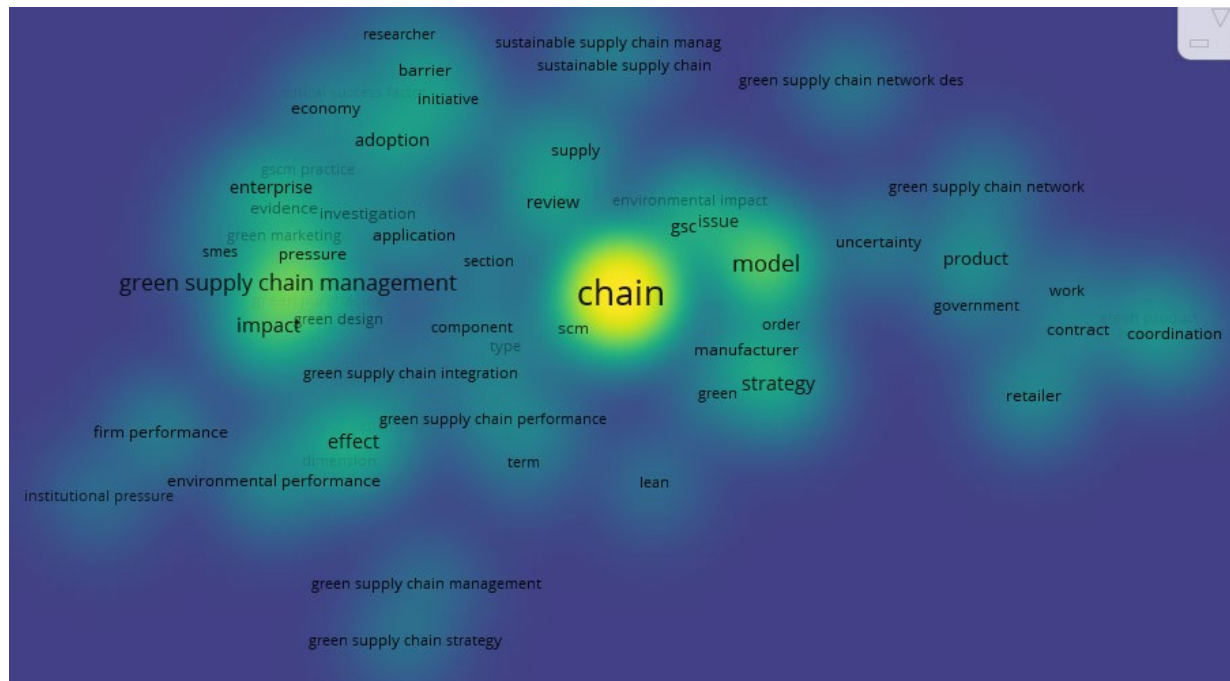


Figure 11: Density Visualization of Green Supply Chain Topic

In Figure 11, it is shown that the most popular research is on the term chain, where the term is yellow and the brightest. Moreover, if the color is dark and faded, the term has not been studied as much as a green supply strategy.

DISCUSSION AND CONCLUSION

This study aims at examining the bibliometric literature on green supply chains. We used Publish or Perish by inserting the keyword "green supply chain" and identifying 1000 studies published on Google Scholar. From the search results, we obtained 996 articles related to the topic with a time of 2012–2022. Then, we saved the data in the .ris form so that it could be opened in the VOSviewer software and see the mapping of terms contained in the green supply chain topic. There are three types of mapping in VOSviewer software: network, overlay, and density visualization. Therefore, it is found that research on the topic of the green supply chain has increased from 2017 to 2020.

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