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Mapping the Evolution of the European Union Retail Supply Chain Technology Management: A Bibliometric Analysis

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Abstract

Effective supply chain management (SCM) technology is crucial for the success of retail businesses in the European Union (EU). This research thesis aims to employ bibliometric analysis to provide a comprehensive examination of global contributions and contemporary keyword trends in the field of SCM technology within the EU. Using the Web of Science database, a systematic search was conducted, resulting in a total of 3,173 relevant articles. Bibliometric Analysis and VOSviewer (VOS) were employed to analyze the research landscape. The analysis shows that although this topic is based on the European Union, the scientific productivity and influence on the topic from China, Britain and the United States are higher than that of many EU countries. The European Journal of Operational Research emerged as the most influential journal in terms of both productivity and impact. Affiliations primarily consisted of universities, with a significant contribution from five universities showing consistent growth in research productivity. The results of Network visualization and Thematic Map analysis results of keywords show that technology-based red keyword clustering is very important for the research in this field, including demand response, microgrids, algorithms, price, policies, simulation and so on. This analysis highlights the importance of technology-related topics in the supply chain of EU retailers.

Keywords: supply chain management, technology, retail industry, European Union, bibliometric analysis

1. Introduction

The dynamics of supply chain management (SCM) have dramatically shifted with the evolution of technology, with substantial implications for retail sectors globally, which has followed the trajectory of global technological advancement. The 1990s saw the rise of Enterprise Resource Planning (ERP) systems, facilitating better control and coordination of supply chains (Akkermans et al., 2003; Tarn et al., 2002). In the early 2000s, the proliferation of e-commerce further transformed retail SCM, with a shift towards customer-centric models (Sun & Finnie, 2023). In the European Union (EU), retail sector has witnessed remarkable changes over the past few decades, largely attributed to the digital revolution(Gravili et al., 2018). The integration of advanced technologies has reshaped retail Supply Chain Management (SCM), with transformative implications for efficiency, cost, and competition. For instance, Artificial Intelligence (AI), Internet of Things (IoT), blockchain, and other digital technologies have integrated as game-changers in EU retail SCM (Maticevic et al., 2011; Rupa et al., 2019; Tsolakis et al., 2022). These advancements are redesigning the conventional methodologies, improving efficiency, reducing costs, and providing a competitive edge in the market (Sriram et al., 2021).

Despite the notable technological benefits, the sector has encountered numerous challenges. Among these, managing complex supply chains, tracking product life cycles, ensuring timely deliveries, reducing costs, and adapting to evolving consumer demands have remained persistent (Chae, 2009; Rebelo et al., 2021). Moreover,

technological disruptions, data security issues, and difficulties in technology adoption also pose significant challenges. Further, in an era characterized by the rise of e-commerce and increasingly discerning customers, these challenges have been rising substantial barriers for retail enterprises.

The innovative technologies development in SCM offers viable solutions to these challenges. For instance, IoT enables real-time tracking and monitoring of goods, AI assists in demand forecasting and inventory management, while blockchain enhances transparency and security (Rupa et al., 2019; Tsolakis et al., 2022). However, the assessment of scholarly contributions to this transforming field from a global perspective remains unexplored.

In the search results of this study, there are very few studies on supply chain management in the European Union, although the research on this topic is based on individual enterprises in the European Union, but the number is also in a small number, more from the study of the global supply chain, or several economic zones, such as (Raman et al., 2018) to the United States, the Middle East, Europe. In the research of multinational corporations in Asia and Australia, it is found that that vendor rating, Internet of things (IoT), demand management, data science and the analytics have a significant impact on the communication gap in supply chain management. The use of big data technology can reduce the communication gap in supply chain management, thus helping enterprises to seek more turnover. Another literature related to this study focuses on Europe and the United States, (Van Hoek, 2019) shows the role of regional chains in the supply chain and advocates that blockchains should adapt to the supply chain and other existing technologies and need to be targeted according to the local environment and supply chain objectives. In addition, a supply chain study from France has become the representative of the supply chain of EU enterprises, (Ageron et al., 2013) analyzes the main components that affect the innovation supply chain practice and supply chain performance of French enterprises, including reverse logistics, supply chain agreements and transportation and after-sales service.

Based on the review of the above literature, it is found that the international research on the supply chain has focused on the application of emerging technologies in the supply chain, such as big data technology and blockchain mentioned above, while the research of EU countries in this area has also followed the international pace. Although EU countries do not have more literature to discuss the application of emerging technologies in the supply chain, they also pay attention to the innovative research of the supply chain.

Bibliometric analysis can fill this gap by providing a systematic understanding of the scholarly landscape, which is a quantitative method used to analyze and measure the publication patterns within a specific research field (Ahi & Searcy, 2013; Muñoz-Villamizar et al., 2019). In the context of EU retail SCM technology, a bibliometric analysis could offer insights into the geographic distribution of research contributions, the global ranking of these contributing countries, and the identification of significant research keywords.

This thesis, therefore, aims to conduct a bibliometric analysis of EU retail SCM technology to answer the following research questions:

(1) Which countries contribute the most to the field of EU retail SCM technology?

(2) What is the global ranking of these contributing countries based on their research output?

(3) What are the current significant keywords in this field, and how are they correlated?

(4) The distribution of research on this topic in journals and the Affiliations of the articles.

By addressing these questions, this study aims to shed light on the ongoing research trends, dominant themes, and global contributors to the field of EU retail SCM technology, thus providing valuable insights for future research directions and collaborations.

2. Research Methodology

In order to achieve the objectives of this study, the Web of Science database was selected for literature retrieval. The keywords related to this topic are combined and screened from the search results of Web of Science, and then Bibliometric and VOSviewer is used to analyze the retrieved literature data, including the annual output of the topic, the country of origin, periodicals, institutions, authors, and the co-occurrence and development trend of keywords in the literature. Next, this paper will describe how to retrieve and filter data and how to use Bibliometric and VOSviewer software for analysis.

Web of Science is recognized as one of the high-quality databases (Birkle et al., 2020), encompassing renowned databases such as Elsevier, Springer Nature, and IEEE (Gusenbauer, 2022; Pranckutė, 2021). Therefore, Web of Science serves as a comprehensive data source for literature research on this topic. The retrieval strategy utilized a combination of keywords related to supply chain management, technology, retail industry, and the European Union to ensure the selected articles were relevant and aligned with the research objectives. Specifically, the search strategy included terms such as ((“supply chain*” OR “suppl*” OR “supply chain management” OR “SCM” OR “logistics*”) AND (“European Union*” or “Europe*” or “Eastern Europe*” or “Western Europe*” or “Northern Europe*” or “Southern Europe*” or “Central Europe*” or “Austria*” or “Belgium*” or

"Bulgaria*" or "Croatia*" or "Cyprus*" or "Czech Republic*" or "Denmark*" or "Estonia*" or "Finland*" or "France*" or "Germany*" or "Greece*" or "Hungary*" or "Ireland*" or "Italy*" or "Latvia*" or "Lithuania*" or "Luxembourg*" or "Malta*" or "Netherlands*" or "Poland*" or "Portugal*" or "Romania*" or "Slovakia*" or "Slovenia*" or "Spain*" or "Sweden*") and ("technique*" OR "technology" or "techn") AND ("retail*" OR "customer*")).

By applying various filters like publication year and document type, a total of 3,173 articles were retrieved for further analysis, please see Figure 1 for the screening process.

The retrieved articles were comprehensively analyzed using Bibliometric Analysis and VOSviewer. Bibliometric Analysis and VOSviewer are widely employed in literature research and are considered authoritative and popular analysis software tools (Cavalcante et al., 2021; Denti Nanda et al., 2021; Grabowska & Saniuk, 2022; Oladinrin et al., 2023). Bibliometric Analysis allows the examination of various factors such as country of origin, authors, and publishing channels. This analysis provides insights into the productivity and ranking of analyzed entities. Additionally, VOSviewer is used for visualizing keyword co-occurrence and temporal patterns to identify important trends and emerging themes in European Union retail supply chain management technology research. VOSviewer offers unique keyword filtering capabilities (Xu et al., 2022).

Bibliometric Analysis and VOSviewer can be downloaded from their respective official websites. To utilize Bibliometric for data analysis, it is necessary to install RStudio. The process begins with installing RStudio, an integrated development environment (IDE) for R language programming and data analysis. Afterward, the desktop version of Bibliometric can be downloaded from the official website. Following the installation of Bibliometric, it should be added to RStudio. Once successfully added, the interface and tools provided by RStudio can be used, or the R language command line can be utilized to perform Bibliometric functions.

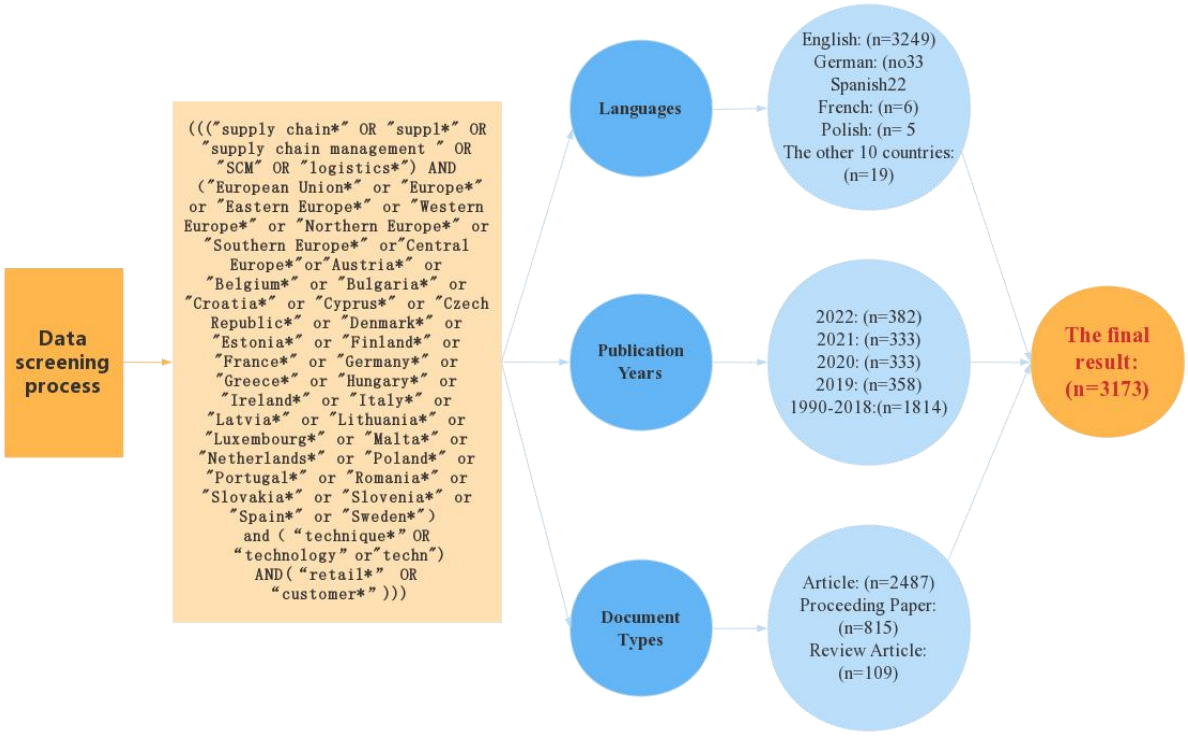

Figure 1. The retrieval process designed by the author

3. Analysis Result

3.1 Main Information

The analysis results of the Main Information section provide an overview of the overall data obtained from the search results, as shown in Table 1. The search was conducted from 1990 to 2022, covering a span of 32 years. A total of 3,173 articles were retrieved, indicating a high average annual growth rate of 20.59%, which suggests the increasing output of new articles on this topic each year. The average number of citations per article is 23.41, indicating the level of recognition and impact within the academic community. Higher citation counts reflect greater influence and recognition among scholars. The literature on this topic involves a total of 9,000

contributing authors, with 347 articles being authored by a single author. On average, each article has 3.37 co-authors. Out of the 3,173 articles, 2,177 are categorized as articles, and 202 are classified as papers.

Table 1 provides a comprehensive analysis and statistical summary of the core data obtained in this analysis, offering insights into previous research on this topic.

Table 1. Main Information (Made by the author)

Description	**Results**
MAIN INFORMATION ABOUT DATA	
Timespan	1990:2022
Sources (Journals, Books, etc.)	1286
Documents	3173
Annual Growth Rate %	20.59
Document Average Age	7.4
Average citations per doc	23.41
References	116014
DOCUMENT CONTENTS	
Keywords Plus (ID)	4263
Author's Keywords (DE)	8895
AUTHORS	
Authors	9000
Authors of single-authored docs	331
AUTHORS COLLABORATION	
Single-authored docs	347
Co-Authors per Doc	3.37
International co-authorships %	38.86
DOCUMENT TYPES	
article	2177
article; book chapter	26
article; early access	48
article; proceedings paper	202
proceedings paper	613
review	106
review; book chapter	1

3.2 Annual Scientific Production

Table 2 clearly visualizes the annual distribution of retrieval data, and explains for this article the annual scientific productivity during the 32-year period. The scientific productivity of this topic has experienced three productivity jumps before 2016. The article output at this stage is the lowest relative to the time after that, and at the same time experienced many fluctuations during this period of productivity development, especially in 2009. But the annual output before 2016 did not exceed 150.

Then, from 2017 to 2021, scientific productivity has increased significantly, far beyond the annual productivity of about 300 to 350 articles before 2016, but this is not the highest productivity period in 32 years. As the most recent year, 2022 shows us the future productivity trend of this topic, with an annual output of 400 articles in 2022.

Generally speaking, the research on this topic has been greatly developed in the past five years, with an annual output of 300 to 400 articles. In the first stage, it shows that this topic is still in the early stage of development and has just been paid attention to by the academic circles. In the second stage, relatively speaking, in the growth

stage of the research on this topic, the number of articles may get more attention and financial investment due to the success of the first stage.

Another fundamental reason may be that economic development promotes the transformation of enterprises in the supply chain and enhances the influence of supply chain in the operation of enterprises, which makes the academic circle follow the needs of enterprises. and may also get a lot of research funds from enterprises and the government, resulting in a large number of related research.

This topic has received academic attention in the last five years, and has been discussed by scholars, indicating that the inflow of researchers and funds have been in the last five years.

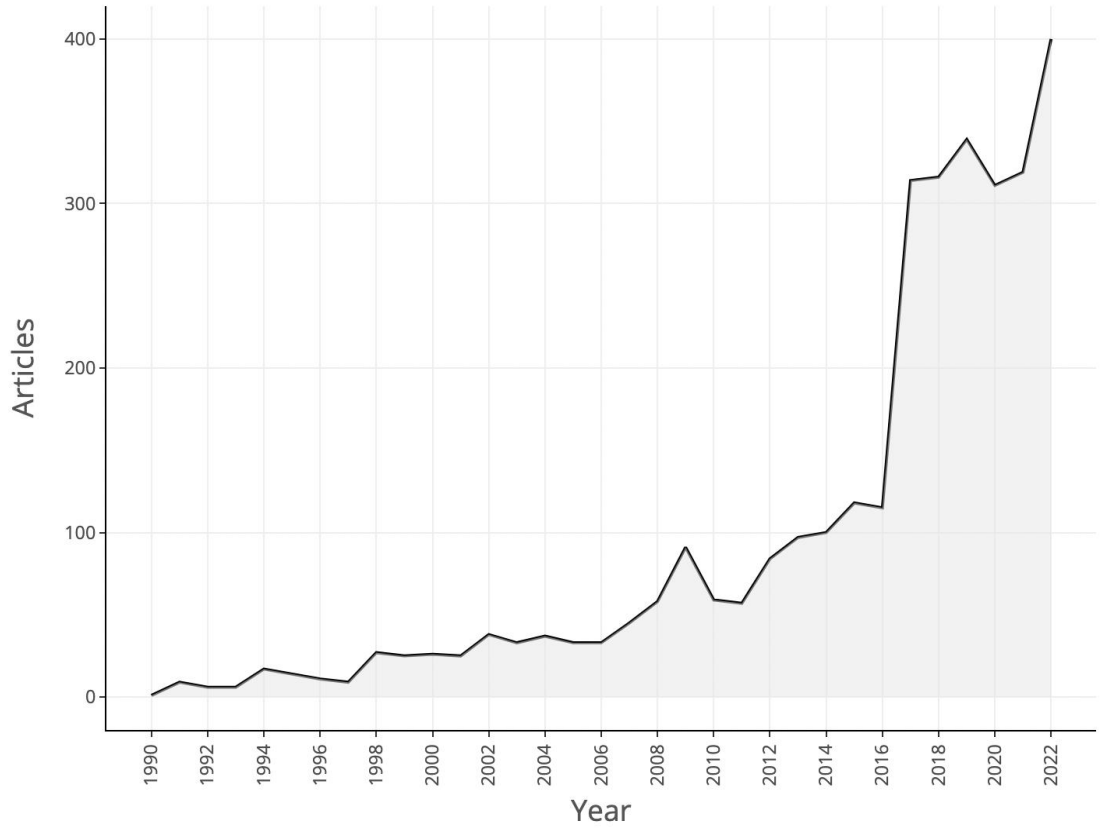

Figure 2. Annual Scientific Production (Made by the author)

3.3 Country Scientific Production

The scientific productivity and scientific influence of a country can be determined by the number of articles published and the number of articles cited. The number of articles published can be directly understood as the national productivity. The more the number of articles, the higher the scientific productivity of the country. And whether these articles are cited by other articles can explain the influence and recognition of this article in academic circles. Therefore, the higher the number of citations, the more influential the corresponding national research in this field.

First of all, combined with the country productivity rankings in figure 3 and Table 2, the top 10 countries cover Europe, America, Asia, as well as Oceania. The research object of this paper takes the EU countries as the theme, and the most productive countries also come from the EU. Germany ranks first with 599 articles. In addition, China, the United States and the United Kingdom, which are not the European Union, also appear in the top 10. And China ranks second with 583 articles. Through simple calculation, the productivity of the three non-EU countries accounts for about 36% of the top 10 most productive countries. The other 8 countries from the European Union account for about 64% of the productivity. This shows that although this topic is about the supply chain research of EU countries, it has the participation of countries outside the EU, especially the United States and China, the two largest economies in the world. Scientific productivity can only represent the number of articles published by the corresponding country, but not its influence in academia. Table 2 directly illustrates the scientific influence of the country through the total number and average number of citations of the country's

articles. As expected, the influence of China, the United States and the United Kingdom also appears in the top 10, while TC represents the total number of citations of the corresponding countries.

Although it represents the overall influence of the corresponding country, this set of data is affected by the number of articles. The more the number of articles, the more the number of citations, which does not mean that the quality of the articles in the corresponding countries is higher. Average Article Citations is a more accurate description of the article quality of the corresponding country, which represents the average number of citations of the article. Therefore, the higher the value of Average Article Citations, the stronger the influence of the article quality of the corresponding country. At the same time, it is also the most recognized by the industry. The total number of citations in the United States is the highest, and the average number of citations of articles is the most, respectively, 7434 and 47.96. And there is a very big gap with the Netherlands, which ranks second.

Thus, it can be seen that the United States, as the world's first economy, has the most influence on the supply chain technology of the European Union, while the total data from the European Union surpasses that of the United States only in the number of articles.

Table 2. The scientific productivity and influence of a country

Most Cited Countries			**Country Scientific Production**	
Country	**TC**	**Average Article Citations**	**Country**	**Freq**
USA	7434	47.96	GERMANY	599
ITALY	7029	26.93	CHINA	583
GERMANY	6058	20.82	ITALY	500
CHINA	5005	22.44	UK	499
UNITED KINGDOM	4894	26.31	USA	481
NETHERLANDS	4509	39.21	SPAIN	435
SPAIN	4444	20.96	FRANCE	402
FRANCE	3967	24.04	NETHERLANDS	321
FINLAND	3787	29.13	PORTUGAL	276
SWEDEN	3620	27.85	FINLAND	274

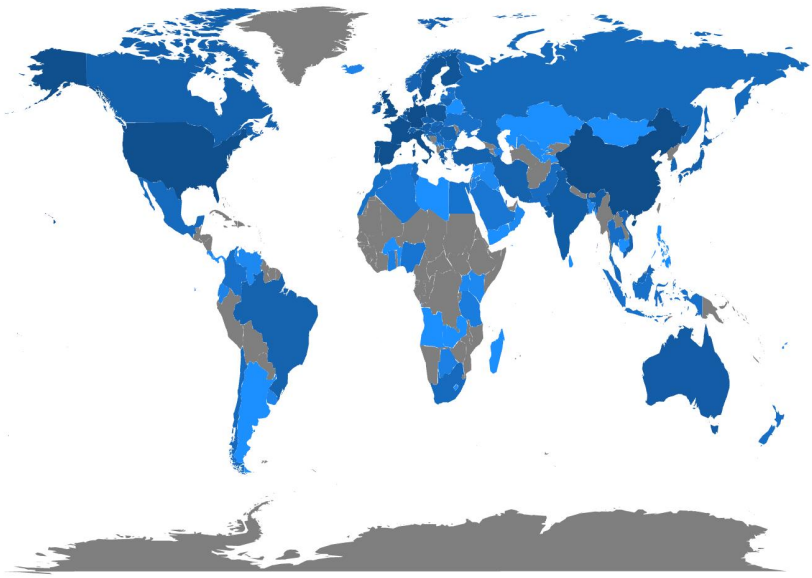

Figure 3. Country Scientific Production (Made by the author)

3.4 The Distribution of Articles in Journals

Which journals are the journals through which the literature related to this topic are published, and how many

articles are published in these journals?

Figure 4 shows us the top 10 journals with the largest number of published articles, and the circles in the picture are different in size and color, which is related to the number of articles published and the number of articles cited, and represents the productivity and influence of the periodical. The larger the circle, the more the number of articles, and the darker the circle, the more times it is cited.

The picture clearly shows that the influence and productivity of European journal of operational research are the highest, indicating that this journal has received the highest attention in this field, but also represents the quality of the journal, and more influence can improve the ranking of journals in the quality division of periodicals.

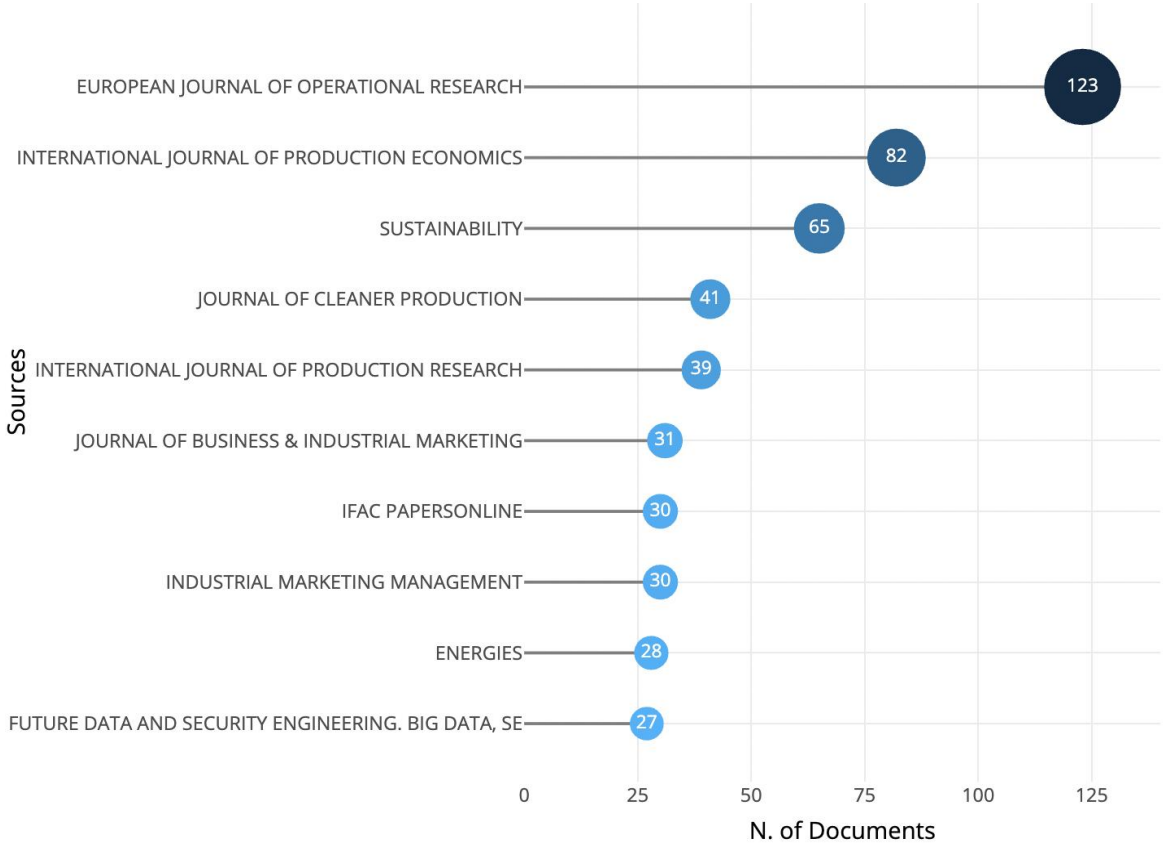

Figure 4. Most Relevant Sources (Made by the author)

3.5 Affiliations' Production over Time

With the passage of time, the productivity of institutions is shown in figure 5. When authors publish articles through journals, they will bring their own institutions. In general, universities are the main institutions. As shown in the figure, the five institutions with the highest productivity are all universities. In 2009, the scientific productivity of these five universities began to increase significantly, while the growth trajectory and range of the five universities are almost the same.

However, it is worth noting that Univ Seville is the first institution with productivity, but its later development is generally lower than that of other institutions, especially since 2020, the productivity of this institution is completely lower than that of the other four universities, indicating that although this university is the first institution to study this topic, the number of articles published is not the largest in recent years, but the quality of articles is more important than the number of articles.

In order to evaluate the research ability of an institution, it is more important to evaluate the influence of articles besides scientific productivity.

For this reason, the analysis can only be used as an assessment of institutional productivity, but not the quality of the organization.

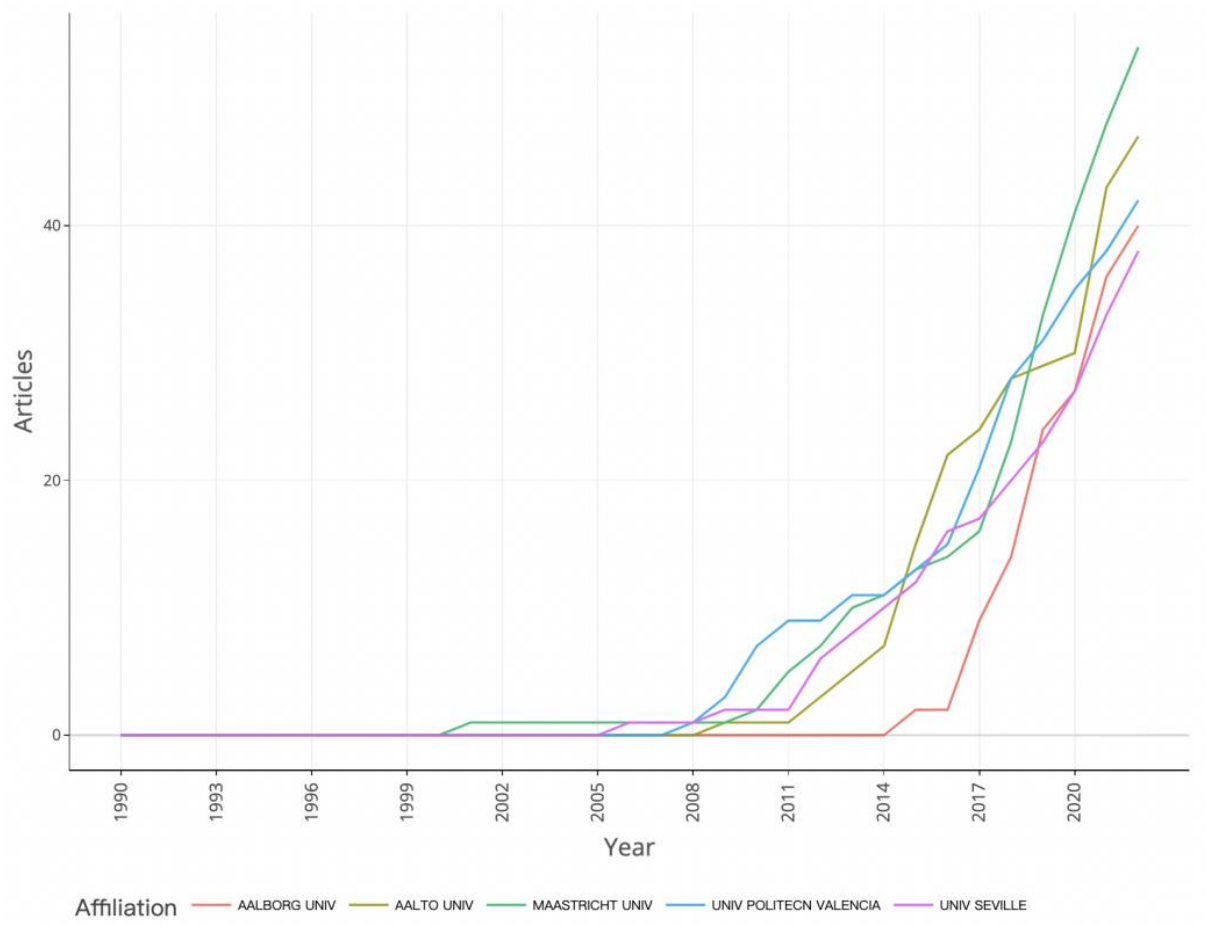

Figure 5. Affiliations' Production over Time (Made by the author)

3.6 Author's Productivity over Time

Figure 6 not only visualizes the scientific productivity of the authors, but also shows the time when the productive forces of these authors are produced. In this analysis, we selected the top 10 authors whose scientific productivity spans from 1995 to 2022.

Since 2013, the author's productivity has suddenly developed greatly. The size and number of circles show the number of articles published by the author, and the color of the circle in the picture represents the influence of the author. The darker the circle, the higher the influence of the author in that year, that is to say, the more times the author's article was cited in that year.

Therefore, it can be seen from the chart that the most influential author is not the most productive author. The first author, Govindan K, is the most productive, while the third author, Mahr D, is the most influential.

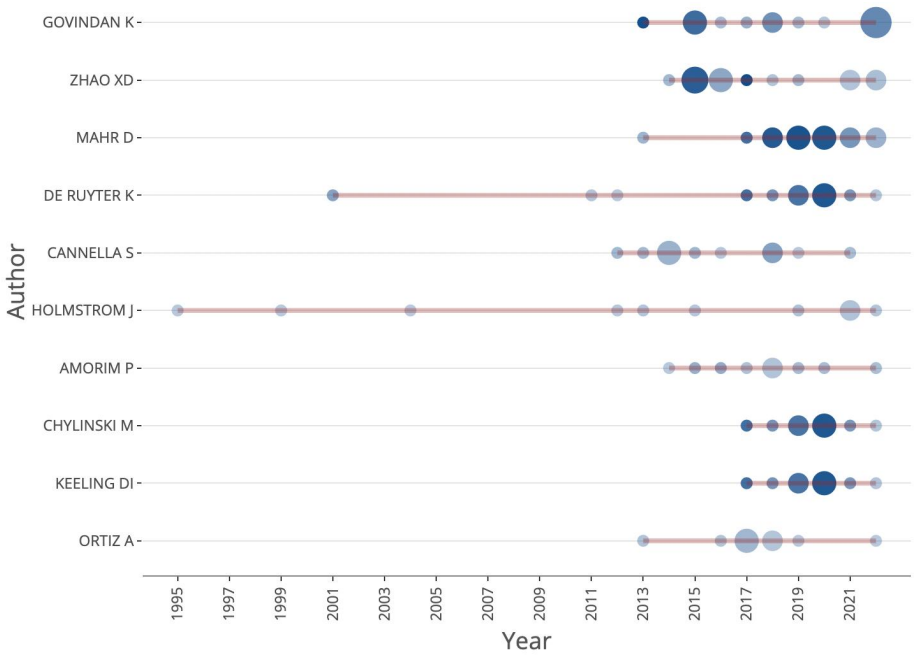

Figure 6. Authors' Production over Time (Made by the author)

3.7 Keyword- VOS-Network Visualization

Co-occurrence of keywords with more than 10 times in all documents, and through the screening of keywords, deletion of keywords not related to this topic, finally get 201 keywords closely related to this topic, and visualize their co-occurrence, such as the results of figure 7 analysis, the results of this Network visualization analysis obtained 7 clusters, the first is the red cluster. This kind of clustering is mainly technology-based key phrases, such as optimization, algorithm.

The second is green clustering, such keywords include big data, COVID-19, industry 4.0 and other market environment. There are also dark blue-based corporate strategies and strategic goal types, such as foreign direct investment, innovation, corporate social responsibility and so on.

In addition, there are four clusters, namely, yellow enterprise digital category, orange enterprise assessment category, purple enterprise management category, and light blue supply chain assessment category.

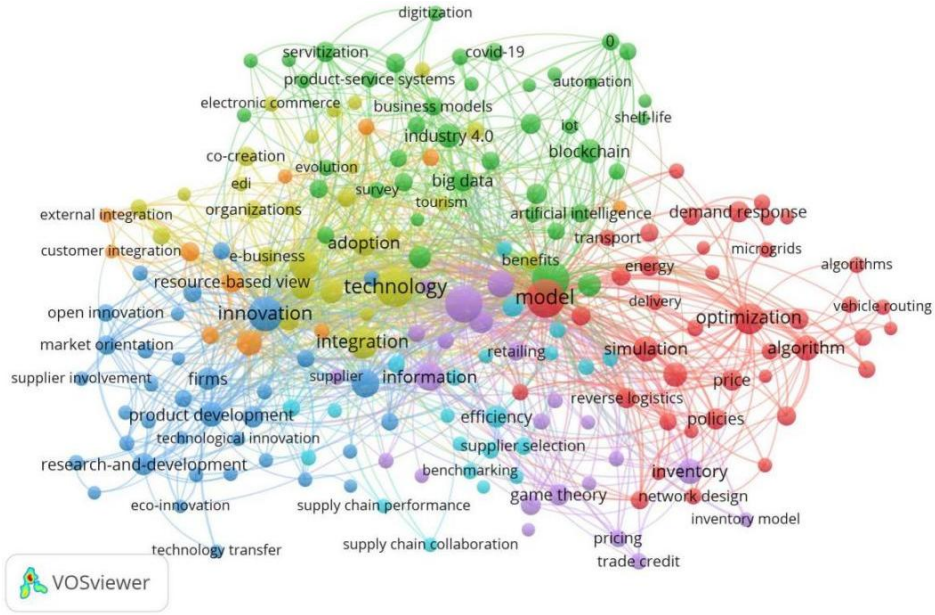

Figure 7. Network visualization (Made by the author)

The cluster analysis conducted on the core keywords provides valuable insights into their interconnections and associations. This analysis reveals the relationships and correlations among the keywords, enabling the identification of common themes and topics within the research. Through visualizing the co-occurrence of keywords in clusters, it becomes evident how closely related keywords frequently appear together in the literature. This aids in understanding the underlying patterns and connections between different aspects of the topic, ultimately offering valuable insights into the relationships among the core keywords. The Network visualization feature of VOS further enhances this analysis by providing a valuable filtering function for analyzing the co-occurrence of a large number of keywords. It enables precise and clear visualization of the co-occurrence results, allowing for a focused and comprehensive understanding of the relationships and patterns among the keywords. By filtering out irrelevant keywords and clustering related ones, this feature enhances the accuracy and clarity of the analysis, providing valuable insights into the interconnections and associations among the keywords.

3.8 Keyword-VOS-Overlay Visualization

Graph 8, based on Graph 7, visualizes the co-occurrence of keywords over time, providing a clear visualization of the development history of the keywords. As shown in Graph 8, around 2014, the gray-colored popular keywords were primarily focused on terms related to corporate strategic objectives. In contrast, the yellow-colored portion in the past two years predominantly consists of popular topics related to digitalization and the promotion of artificial intelligence, such as “big data, COVID-19, 3D printing, blockchain technology, and the Internet of Things.” This set of keywords overlaps with the green-colored market environment cluster in the Network visualization.

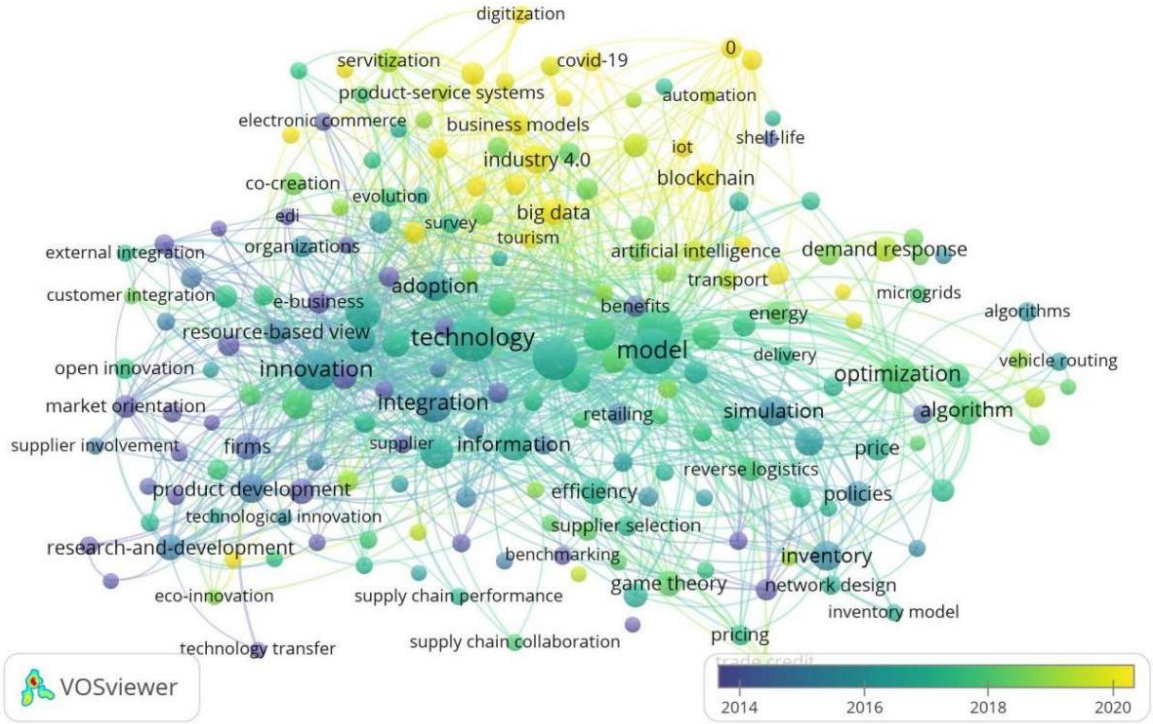

Figure 8. Overlay Visualization (Made by the author)

3.9 Network Approach-Thematic Map

Bibliometric is used to analyze the development history and trend of keywords. As shown in figure 9, the keywords used this time come from all the keywords in the literature, and the keywords are not screened in this analysis.

The Thematic Map employs two axes to illustrate the evolution of terms: the horizontal axis represents density, and the vertical axis represents the progression over time.

The first quadrant of the map reveals “motor themes,” which are highly developed and significant keywords. The

second quadrant accommodates “niche themes,” which have experienced considerable growth but lack current relevance in the field. Within the third quadrant, we encounter “emerging or declining themes,” representing lesser-explored areas that exhibit uncertain development. They may be nascent or on the verge of disappearing. The fourth quadrant is dedicated to “basic themes,” pivotal concepts that hold substantial importance but have not witnessed significant development. These themes typically constitute fundamental ideas.

Each circle in figure 9 represents a topic. By setting the parameters, there are 7 keywords for each group of topics. As shown in figure 9, the current popular and significant keywords in this field are the topic in the upper right corner, and the key words are management, performance, impact, technology, systems, framework, quality.

The key words that are very important to this field but do not get the opportunity for development are model, design, supply chain, demand, strategies, models.

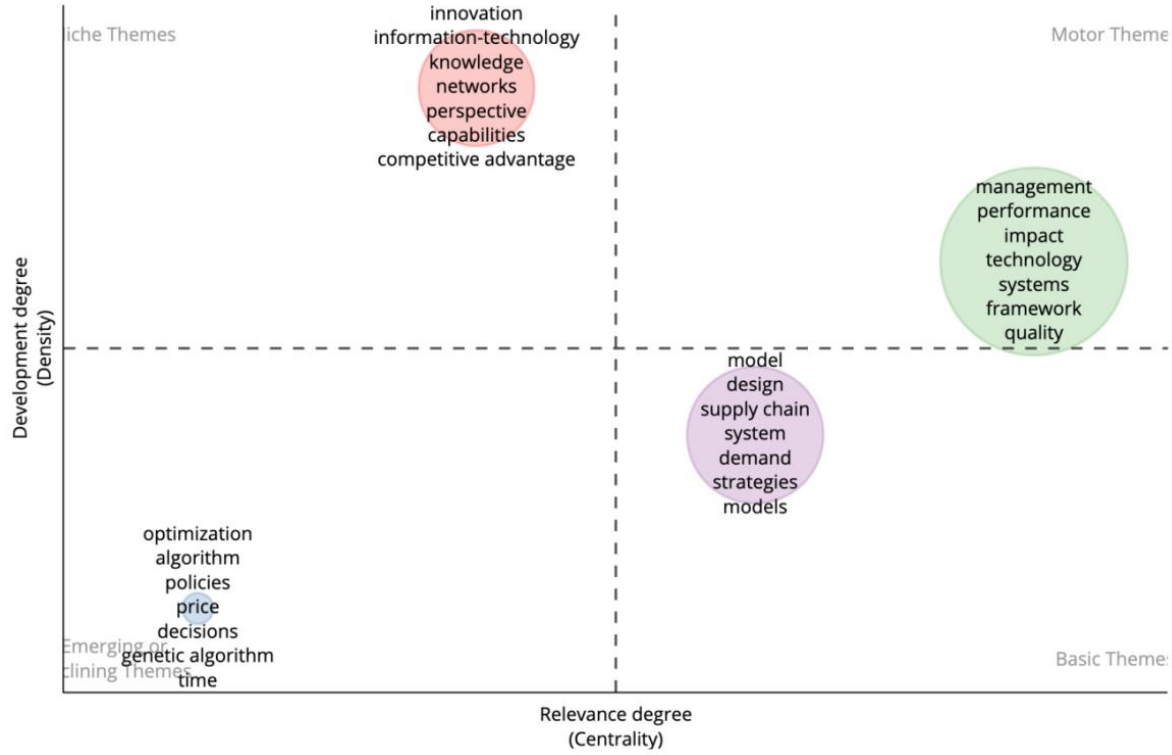

Figure 9. Thematic Map (Made by the author)

This analysis provides a group of valuable information to scholars. The Thematic Map function of this Bibliometric comprehensively summarizes the keywords of previous research and evaluates the trend of future research, but it is worth noting that because there is no keyword screening, some keywords that are not related to the topic also appear, which is somewhat different from the keyword analysis of VOSviewer software. But the combination of the two will be a very good basis for literature research. Combining the results of Thematic Map in figure 9 with the results of Network visualization in figure 7, we can expand the range of keywords in Thematic Map, such as the keywords in motor themes and basic themes in figure 9, which play a very important role in this field and have important research significance. At the same time, these keywords also represent the corresponding research topics. The words related to this topic in these two groups of keywords are technology, system, strategies, models.

Supply chain, these keywords are closest to and partially overlap with the red clustering in figure 7, so they can be summarized as the technology-based red clustering in figure 7. At the same time, it also shows that the keywords in the clustering in figure 7 are the most important keywords in this field, in turn, combined with the results of basic themes analysis in figure 9.

We can know which keywords are very important in the red clustering in figure 7 but have not yet obtained the research opportunity, so we can infer some keywords, such as demand response, microgrids, algorithms, price, policies, simulation and so on.

Scholars can use these keywords as research topics in the future research of supply chain technology, which will

be an opportunity for research on topics that have been ignored but are very important to the field.

4. Conclusion

Through the analysis of the above literature data, this paper obtains the basic situation of the current research on this topic as well as the development process and trend of more specific keywords and provides a practical research direction for the future research of this topic. and use this to answer the three research questions raised in this paper.

First of all, the whole alliance of EU has the largest scientific productivity in the field of SCM technology in EU retail, but in terms of countries, Germany makes the greatest contribution, followed by China, and Italy, which ranks third. This shows that although this topic is about the EU supply chain, it is also concerned by non-EU countries, and other countries rank more than many EU countries in the number of studies on the EU supply chain.

The study finding implies that the country with the highest average scientific influence is the United States. This finding indicates that the highest average number of citations, and the national scientific influence is not directly related to the productivity of the article. Throughout the study it is evidenced that the United States has the lowest number of publications compared to China and the UK, but highest number of citations, which convinces that the number of many publications are not a grantee to have many citations and becoming influential. However, if we look at the average number of citations, the influence represented by the United States is less than that of the EU, so it can be judged that the United States has the greatest scientific influence in this field.

The distribution of this topic in journals is mainly concentrated in European journal of operational research, and its scientific influence and scientific productivity are the highest in all journals, so there is no doubt about the influence status of European journal of operational research in this field. Almost all of these articles are published in the corresponding journals on the basis of universities, and the development of another organizations (Affiliations) began to improve after the year of 2009. It can be said that the five universities in Affiliations are research pioneers in this field, and the research in this field has played a leading role. The research in this field has laid the foundation, and it also shows that universities play a very important role in this topic.

In the analysis of keywords, seven clusters were generated on this topic, and the correlation between the results was analyzed by referring to Thematic Map and Network visualization (Alkhammash, 2023; Cobo et al., 2011). The largest clustering is technology-based red keyword clustering, and combined with Thematic Map analysis shows that red keyword clustering is a very important topic in this field. These topics that have not received attention and need to be concerned in this field are demand response, microgrids, algorithms, price, policies, simulation and so on.

In the Overlay Visualization analysis, the most popular keywords in recent years and the most concerned keywords in the research field are closer to the keywords in the niche themes region of Thematic Map analysis, indicating that the popular keywords in recent years are not important or important enough to the research in this field. There are two factors leading to this situation. One is that scholars use current gimmick keywords due to the guidance of the market environment. Second, it may be that the development of these keywords in this field is not mature, but in the initial stage of research, in the literature research, these data have not reached enough influence to show their importance to this topic.

For this reason, scholars can focus on high-quality articles from the United States, articles from European journal of operational research and other nine top journals in the analysis results in the future research on this topic. On the other hand, the formulation of future research topics in this field requires the author to pay attention to more important topics in this field, such as demand response, microgrids, algorithms, price, policies, simulation and so on. If scholars want to continue to Bibliometric Analysis on this topic, please consider whether those emerging keywords are just gimmicks or whether they are mature enough to be used as keywords in literature research.

In any case, this study comprehensively summarizes the past, present and future research on this topic, and provides practical suggestions for future research.

In conclusion, this study demonstrates the significance of bibliometric analysis in understanding the research landscape of European retail supply chain technology management. The findings contribute to the existing body of knowledge and provide a foundation for future research endeavors in this field. By leveraging bibliometric approaches, researchers can gain valuable insights into the evolution of research topics, identify research trends, and make informed decisions for future studies in the domain of European retail supply chain technology management.

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