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RESEARCH ON SUPPLY CHAIN PERFORMANCE UNDER DIGITAL BACKGROUND: A BIBLIOMETRIC REVIEW

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Abstract:

Supply chain digitalization improves the speed and accuracy of supply chain information processing and analysis, achieving real-time visibility to enhance the accuracy and timeliness of management and decision-making, enabling collaborative cooperation among suppliers, manufacturers, distributors, and logistics service providers, and Significantly enhancing the overall performance of the entire supply chain. Supply chain digitalization has emerged as a powerful instrument for augmenting supply chain performance, attracting considerable attention in relation to supply chain performance. In order to clarify the impact of supply chain digitalization on supply chain performance, as well as the related research frameworks and their evolution, we used 1690 papers from the Web of Science database from 2000-2023 as the data source and conducted quantitative and visual analysis using bibliometrics and visualization methods. This paper first analyzes the time series distribution of published papers, core authors, country distribution, keyword co-occurrence, and keyword clustering, and describes the research status, hotspots, and related research of supply chain digitalization and supply chain performance. Secondly, CiteSpace software is used for cluster analysis in this field. The research results illustrate the frontiers of supply chain digitization and supply chain performance research, and put forward research suggestions from five directions to provide theoretical and practical reference for future research.

Keywords:

Supply Chain Digitization, Performance, Resilience, Bibliometric Review, Citespace

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Introduction

Digitalization of the supply chain is an effective means to mitigate the risk of supply chain disruption. In recent years, the evolution of the US-China relationship and the harm caused by unexpected pandemics have led countries to become more conservative, accelerating the trend towards resilient supply chain construction, with digitalization of the supply chain gradually being viewed as a favorable tool for building resilient supply chains(Zhao et al., 2023). Supply chain digitalization provides necessary resources for developing risk management capabilities and recovery abilities to deal with disruptions caused by pandemics, wars, economic regionalization, economic recession, and other similar enormous challenges to the supply chain(Kumar et al., 2023). During crises, different degrees of supply chain disruptions occur due to blockades and other factors, and the lack of physical contact weakens business relationships between enterprises. However, the widespread adoption of digital technology and communication enhances collaboration among different participants, improves asset management capabilities, and creates new customer value(Hu, 2022). As environmental business uncertainty continues to increase, enterprises increasingly need to develop more flexible supply chains. Digital transformation is widely recognized as a key means of achieving supply chain flexibility, and studies have shown that intelligent supply chains exhibit a certain statistical correlation with the operating performance of enterprises through the intermediary role of the digital transformation strategy, digital foundational technologies, and digital front-end technologies across three dimensions(Enrique et al., 2022). Current challenges such as shortening of product lifecycles, increased outsourcing, expansion of product types, heightened customer focus, and improvement of technological levels have made the supply chain a more challenging and complex task, and supply chain digitalization can help alleviate these challenges(Menon et al., 2018). Effective digital strategies not only improve the resilience of enterprises in crises, but also optimize the allocation of resources, thereby improving the overall supply chain performance. In the process, companies are able to adapt more quickly to market changes, thereby maintaining a competitive edge.

Supply chain digitization optimizes business processes in the four different dimensions of procurement, production, logistics, and sales. Choudhury et al.(2021) acknowledged the challenges faced by traditional supply chain arrangements in meeting the continuously escalating customer demands and disruptive innovations. This realization highlights the necessity of an adaptive and innovative network in the future. Such a network should leverage the collaborative potential of ecosystem partners and digital tools to unlock unparalleled agility. Thorough analysis has unveiled that the success of digital supply chains hinges on pivotal factors, encompassing the implementation of a robust sales and operations planning strategy, strategic utilization of procurement technology, seamless integration of intelligent manufacturing processes, and optimized warehouse management. Rasool et al.(2022) believe that digital technology enables companies to simplify, accelerate, and automate procurement, manufacturing, and distribution processes. Digital technology can seamlessly integrate upstream suppliers and downstream customers into a company's activities. Choudhury et al.(2021) assert that digitizing the entire supply chain strengthens the collaborative combination of resources between companies. Through digital transformation, enterprises can not only improve the efficiency of resource use, but also enhance the transparency and responsiveness of the supply chain, which are key factors to improve supply chain performance.

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Digital transformation has become a mandatory task to improve supply chain performance. Building a flexible and efficient digital supply chain can help companies better manage their supply chain, develop different forms of returns, adapt to dynamic market demand changes, and maintain the growth of supply chain performance, thus ensuring future rapid growth(Agrawal et al., 2020). In today's digital environment, a data-driven corporate culture has become an important emerging driving force for corporate growth, greatly affecting product innovation strategies and organizational process changes, thereby improving overall performance and creating higher business value(Chaudhuri et al., 2021). Ultimately, by increasing business value, companies can improve overall performance. A noteworthy positive correlation has been observed between digital procurement capabilities, data analysis capabilities, and supply chain performance. It is important to highlight that digital procurement capabilities play a crucial role in moderating the positive correlation between external data analysis capabilities and supply chain performance.(Hallikas et al., 2021). A large number of empirical studies have shown that digital supply chains have a significant impact on operational performance, including real-time visibility, quality, productivity, business process improvement, and cost reduction(Aninda & Karyani, 2022;Gupta et al., 2021; Ma et al., 2023).

In summary, scholars have studied the development of digitalization in supply chain management from various perspectives, including the role of advanced technology integration and innovation in driving digitalization, as well as the relationship between digitalization and supply chain performance. However, it is still unclear which mediator and moderator variables exist between supply chain digitalization and performance, and how related research will evolve. These questions warrant further exploration, as they provide clues for the future development of this research field. Therefore, we conducted a literature review and quantitative analysis of the relationship between supply chain digitalization and performance, and provided a qualitative analysis of the results.

The research contribution of this paper can be summarized as follows: 1. Based on the current literature research, this is the first bibliometric analysis that studies the relationship between supply chain digitalization and supply chain performance, which enriches the relevant literature. 2. We studied the time evolution of supply chain digitalization and supply chain performance, conducting an objective, quantitative, and systematic analysis, providing valuable insights into the current research status and prominent topics in the field. This analysis not only sheds light on the existing state of supply chain digitalization and supply chain performance but also offers valuable guidance on future development trends in these areas.

Data Sources And Research Methods

This article focuses on the research of supply chain performance under the digitalization background. The research sample includes articles published in journals on supply chain digitalization and supply chain performance. The data used in this study comes from Web of Science, obtained by searching the Web of Science core collection. The keywords searched were "supply chain performance" and "digi*". The research period was from January 2000 to December 2023, and the search was completed on January 15, 2024. Through manual screening of the subject information, literature irrelevant to the research direction, such as digital humanitarianism, was deleted, and non-academic articles such as advertisements were removed. Finally, 1690 valid literature were obtained.

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The research on supply chain performance under the background of digitalization with citespace software is faced with multiple challenges of data management, collection and analysis. First, there is a huge amount of literature in the field of supply chain digitization, which brings significant challenges to data management and organization. After sifting through 1,690 valid articles, this extensive data set required careful management to ensure meaningful analysis. After sifting through 1,690 valid articles, this extensive data set required careful management to ensure meaningful analysis. In addition, relying on digital databases like Web of Science introduces additional complexity. The accessibility of databases, potential bias in content, and the challenge of capturing the latest research are all important issues to consider. We used version 5.7R1 of the CiteSpace software for quantitative scientific knowledge graph analysis, using ‘‘topic + abstract + keywords” as the text to be analyzed by the software.

A scientific knowledge graph is a graphical representation that displays the development process and structural relationships of scientific knowledge. It belongs to the field of scientometrics. By visualizing knowledge graphs, the overall picture, structural characteristics, and development trends of research areas can be intuitively, quantitatively, and efficiently displayed, and the forefront of research areas can be explored.

Descriptive Statistics And Quantitative Analysis

Annual Growth Of Number Of Journal Papers

The research literature on supply chain performance under the digitalization background in Web of Science from 2000.01 to 2023.03 is shown in Figure 1. Over the past 23 years, with the increasing attention on supply chain digitalization, the number of research literature in this field has continued to grow. From the annual publication volume, it can be seen that the number of publications from 2000 to 2014 was relatively small, mainly because most scholars were not familiar with the concept of supply chain digitalization and it was still in its infancy, thus not attracting much attention in the academic community. From 2014 to 2023, with the practical application of digital technology, the academic community's attention to supply chain digitalization has grown rapidly, and the number of publications has not yet reached its peak, indicating that research in the field of supply chain digitalization will continue to be intense in the future.

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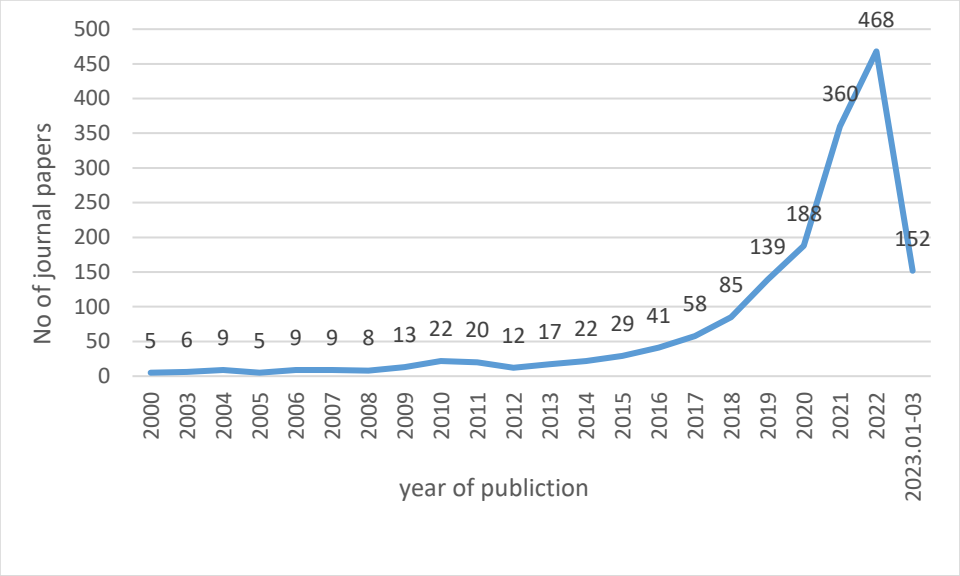

Fig.1 Supply Chain Digitization And Supply Chain Performance Number Of Published Documents.

Author Analysis

Quantitative Analysis Of Core Authors

To further elucidate the distribution of the number of publications, this article conducted a study on core authors. In bibliometrics, the renowned scholar Price proposed a formula for calculating the number of core authors:

$$M = 0.749 * \sqrt{Nmax}$$

In the formula, M is the lowest value of the number of publications, and Nmax is the maximum number of papers. Using M as a standard and based on the rounding principle, when an author's number of publications is greater than M, the author is considered a core author in the current research field. The study shows that Kumar A has the highest number of publications in the sample (18 papers), and the value of M is 3.18. Therefore, to become a core author in the field of digital supply chain, the number of publications needs to be greater than or equal to 3.18. By organizing authors who have published four or more papers, it can be found that there are 124 core authors, with a total of 737 papers, accounting for 43.6% of the total sample size. This result is close to 50% of the total sample size, indicating that a certain group of core authors has been formed in the research on supply chain performance under the background of digitalization, in accordance with the requirements of Price's law.

Visual Analysis of Core Authors

We used Cite Space 5.7.R1 software to create a collaborative network map of authors in the field of supply chain performance under digital background from 2000 to 2023, as shown in Figure 2. The nodes are labeled with the number of papers published by each author, and the font size of the author label increases with the number of papers published. According to the statistical data of the sample, Kumar A has the highest number of publications, followed by Gunasekaran A, Ivanov D, Khan SAR, and others. At the same time, it can be seen that a certain collaborative network has been formed among the core authors. With the peak of research in

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the field of supply chain digitalization, scholars' communication and cooperation will become closer.

Fig.2 Map Of Author Cooperation Network Produced By The Citespace Software.

Analysis Of Countries

We used CiteSpace 5.7.R1 software to draw a network map of the country distribution in the field of digital supply chain performance from 2000 to 2023. As shown in Figure 3, the size of the circle represents the number of publications. The USA has the highest number of publications, with 219, followed by China, India, and England, with 201, 134, and 132 publications, respectively. It can be predicted that research in the field of digital supply chain performance will continue to increase in the future.

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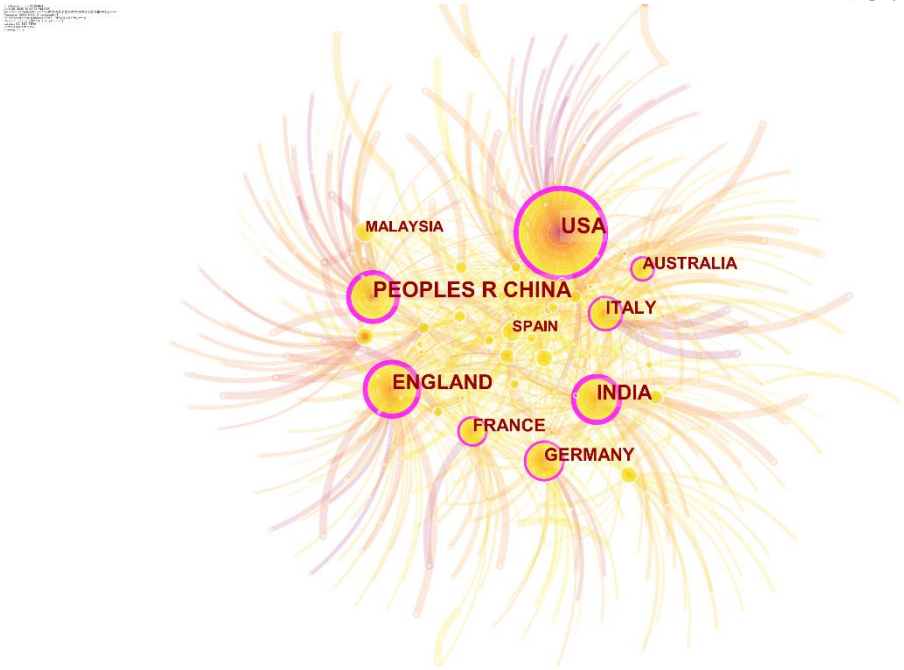

Fig.3 Map of National Cooperation Network 2000-2023

Research Hotspots Analysis

Co-Occurrence Analysis Of Keywords

Using the visualization function of CiteSpace software, the co-occurrence of keywords in the research field of supply chain performance under the digital background can be displayed, as shown in Figure 4. Keywords represent the core viewpoints of research, which condense the essence of the article. Each node in the figure represents a keyword, and the larger the cross node, the higher the frequency of the keyword. The thicker the line, the stronger the co-occurrence. The calculation results of CiteSpace show that there are 557 nodes and 1841 links in the network, and the network density is 0.0119.The most frequently appearing keywords are performance (474 times), digitalization (370 times), management (329 times), supply chain (228 times), impact (254 times), model (175 times), framework (171 times), technology (166 times), system (171 times), sustainability (171 times), and other nodes with relatively larger size. These are high-frequency keywords and indicate that these research areas are quite popular. Among them, the frequency of the keyword "digitalization" is the sum of the frequencies of five keywords, including digitalization, information technology, digital transformation, digital technology, and digital twin. Based on the information in the figure, the research hotspots in the field of supply chain performance under digitalization can be divided into several directions, including: supply chain management, impact of digitalization and supply chain performance, supply chain model, supply chain framework, Technology merges with digital, supply chain system, supply chain sustainability.

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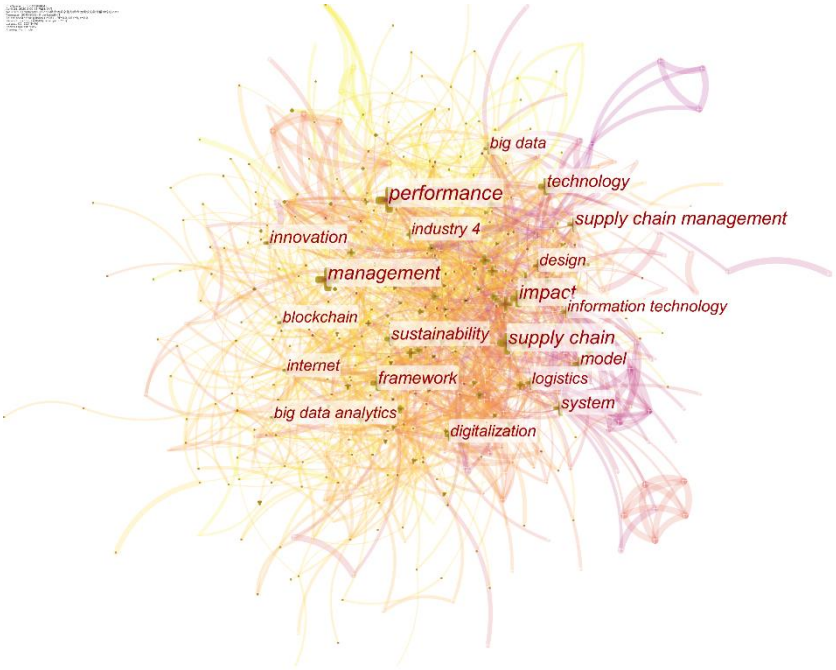

Fig.4 2000-2023 Keyword Co-Occurrence Network Map

Keyword Clustering Analysis

Due to the inability of individual high-frequency keywords to identify specific research areas and content, this study further utilizes keyword co-occurrence matrix for cluster analysis. Based on the keywords contained in each cluster, cluster names can be summarized. Furthermore, this study calculates the attention of each cluster and summarizes the top ten clusters with the highest attention as the current hot research areas in the field of supply chain performance under digitalization. To further analyze the core clusters, we export the LLR algorithm Cluster member list. The Cluster members are shown in Table 1. The first one is the cluster category, followed by the Cluster member related to it. The first value in the parentheses indicates the representativeness of the cluster, and the second value indicates the degree of association between the Cluster member and the cluster. Supply chain digitalization ranks first, literature metric analysis ranks second, and Industry 4.0, simulation, and supply chain integration are the most popular hot topics in this field. Pricing strategy, lean manufacturing, intelligent transportation, corporate strategy, and blockchain are among the top ten research hotspots. Based on the keyword co-occurrence analysis and the information in the table, the hot topics in the field of supply chain performance in the context of digitalization can be divided into five aspects:

Firstly, supply chain digitalization. The research on supply chain digitalization is mainly focused on sustainable development, agility, competitive advantage, business value, big data, e-commerce and other topics. For example, by using Internet of Things and big data analysis technology, logistics processes can be optimized and carbon emissions can be reduced. By real-time monitoring and analyzing supply chain data, rapid response and adjustment to supply chain risks can be achieved, while improving the response speed and flexibility of the supply chain. Through digital technology, supply chain collaboration and cooperation can be realized, thereby improving the overall value of the supply chain, helping enterprises achieve supply chain innovation and differentiation, and enhancing their competitiveness and profitability.

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The second aspect is Industry 4.0. Industry 4.0 is a concept that represents the fourth industrial revolution, emphasizing the application of digital technology in the manufacturing industry, with digitization being an important means to achieve Industry 4.0. Industry 4.0 is a hot topic in the current industry, and related research is also very active. It mainly combines topics such as system dynamics, the Internet of Things, and big data for research. The application of system dynamics in the field of Industry 4.0 mainly focuses on production processes and supply chain management. The medical Internet of Things is mainly used for the development and popularization of smart medical devices. In the field of Industry 4.0, Internet of Things technology can be used to realize intelligent manufacturing, intelligent warehousing, and logistics management. In the field of Industry 4.0, big data technology can be used to analyze and predict production data, market data, etc., to help enterprises make decisions.

The third is virtual simulation. Virtual simulation is a method of simulating and modeling using computer technology, which can help researchers simulate and predict the performance and results of different systems, processes, and scenarios. It is mainly studied in combination with topics such as the chain effect, digital twin, visualization, and blockchain. Researchers can use the chain effect to simulate and predict the potential impact of a series of events. Digital twins can be used to build virtual simulation models of physical systems to better understand their performance and behavior. Visualization can help researchers better understand the data and information of virtual simulation models, and can also present the results and performance of virtual simulation models through visualization techniques. Blockchain can be used to build a distributed database for virtual simulation models, so that data and information can be shared in different locations and times, thus better collaborating and cooperating.

The fourth is supply chain integration. Supply chain integration is an important business strategy that can improve efficiency, reduce costs, and enhance customer satisfaction. It is mainly studied in conjunction with multi-level theoretical frameworks, network embeddedness, financial performance, and other aspects. The multi-level theoretical framework can also help researchers explore the dynamic process and influencing factors of supply chain integration, thereby improving enterprise performance. Network embeddedness can help enterprises better understand their roles and responsibilities in the supply chain, and improve their performance by establishing closer cooperative relationships. Financial performance is one of the important indicators for evaluating the success of enterprise supply chain integration. Visualization is an important tool for supply chain integration, which can help enterprises better understand and manage the supply chain.

The fifth is pricing strategy. Supply chain pricing strategies are usually studied in conjunction with specific industries such as cold chain and automotive industry, focusing on digital interactions between suppliers and customers. It is necessary to consider the costs at different stages and the fluctuations in market demand, and to study how to formulate pricing strategies to improve efficiency.

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Table 1. LLR Cluster Analysis Of Supply Chain Performance In The Digital Background

Cluster sorting	Cluster name	LLR algorithm Cluster member
1	digital supply chain	digital supply chain (11.14, 0.001); digitization (5.01, 0.05); sustainable development (5.01, 0.05); agility (4.8, 0.05); competitive advantage (4.8, 0.05); business value of it (4.8, 0.05); blockchain (4.18, 0.05); inter-dependencies (4.17, 0.05); streams of big data (4.17, 0.05); e-business process (4.17, 0.05); product effectiveness
2	bibliometrics	bibliometrics (9.98, 0.005); order picking (9.98, 0.005); germany (6.34, 0.05); internet of things (iot) (6.34, 0.05); resource-based view (6.34, 0.05); industry 4.0 (5.04, 0.05); bullwhip effect (4.98, 0.05); intelligent lighting (4.98, 0.05); supplier responsiveness (4.98, 0.05); social good (4.98, 0.05); logistics 4.0 (4.98, 0.05);
3	industry 4.0	industry 4.0 (7.58, 0.01); system dynamics (6.55, 0.05); internet of medical things (4.95, 0.05); internet of things (4.75, 0.05); fourth industrial revolution (4.25, 0.05); indicators (4.25, 0.05); mhealth (4.25, 0.05); open innovation (4.25, 0.05); fourth industrial revolution (industry 4 (4.25, 0.05); semiconductor (4.25, 0.05);
4	simulation	simulation (10.14, 0.005); ripple effect (10.14, 0.005); digital twin (9.62, 0.005); viability (9.62, 0.005); blockchain (6.7, 0.01); lean (5.99, 0.05); digital twins (4.8, 0.05); circular economy (ce) (4.8, 0.05);
5	supply chain integration	supply chain integration (7.32, 0.01); multi-level theoretical framework (5.49, 0.05); r&d cooperation (5.49, 0.05); book publishing (5.49, 0.05); publishing industry (5.49, 0.05); logistics competencies (5.49, 0.05); network embeddedness (5.49, 0.05); financial management (5.49, 0.05); green innovation (5.49, 0.05); financial performance (5.49, 0.05); digital-based supply chain integration (5.49, 0.05); green product innovation (gpi) (5.49, 0.05);
6	pricing strategy	pricing strategy (10.38, 0.005); cold chain (10.38, 0.005); automotive industry (7.74, 0.01); triple bottom line (5.18, 0.05); store brand (5.18, 0.05); channel move strategy (5.18, 0.05); resource constrained project scheduling (5.18, 0.05); green logistics (5.18, 0.05); healthcare (5.18, 0.05); asymmetric information (5.18, 0.05); responsible purchasing (5.18, 0.05); game theory (5.18, 0.05); sustainable purchasing (5.18, 0.05); smart city (5.18, 0.05);
7	lean manufacturing	lean manufacturing (6.66, 0.01); pandemics (5.15, 0.05); blockchain taxonomy (5.15, 0.05); bahrain (5.15, 0.05); regional logistics (5.15, 0.05); maritime supply chain (5.15, 0.05); interorganizational governance (5.15, 0.05); framework (5.15, 0.05); cyber-attack (5.15, 0.05); crisis-driven logistics (5.15, 0.05); vulnerability (5.15, 0.05); digital technology (5.15, 0.05);
8	intelligent transportation	intelligent transportation (11.31, 0.001); cyber-infrastructure (11.31, 0.001); information integration (11.31, 0.001); global network flow (11.31, 0.001); wireless sensor networks (11.31, 0.001); data fusion (11.31, 0.001); enterprise information systems (11.31, 0.001);
9	corporate strategy	corporate strategy (8.86, 0.005); procurement integration competence (8.86, 0.005); index framework (8.86, 0.005); capability hierarchy (8.86, 0.005); performance evaluation (8.86, 0.005); banking (8.86, 0.005); electronic procurement (8.86, 0.005);

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10	blockchain	blockchain (22.32, 1.0E-4); iot (13.8, 0.001); stakeholders (13.8, 0.001); ethereum (11.21, 0.001); data integrity (9.19, 0.005); demand planning (9.19, 0.005); smart contracts (8.17, 0.005); cloud computing (7.5, 0.01); security (7.11, 0.01); 0 (7.07, 0.01);

Conclusions

This article uses the CiteSpace visualization software to sort and analyze relevant journal literature in the field of supply chain performance under the digital background. The analysis is conducted from several aspects such as time distribution, core authors, country distribution, research hotspots, and evolutionary paths. The following conclusions are mainly drawn: Firstly, a relatively detailed sorting of the research literature in the field of supply chain performance under the digital background has been conducted, which enriches the research literature in this area. Secondly, through sorting the research hotspots in the field of supply chain performance under the digital background and comparing the co-occurrence of keywords, it is found that Industry 4.0, the Internet of Things, big data, blockchain, virtual simulation, sustainable development, and circular economy play a significant role in the development of supply chain digitalization and supply chain performance. The research conclusion effectively answers the research questions raised in this paper. At the same time, the development of supply chain digitalization has also given birth to new technologies, new business models, and new modes. There is still vast research space in this area.

This article has some limitations. First, the literature used is limited to the Web of Science Core Collection, so the number of references is limited, and the research on supply chain performance under the digital background is not comprehensive enough. Secondly, this article did not conduct a detailed comparative analysis of the achievements and research methods in the field of supply chain performance under the digital background, and there is also little discussion on the practical applications of the research. Finally, this article did not conduct citation analysis on relevant literature in the digital supply chain field, and it is unable to observe the correlation between various disciplines in this field. Therefore, in future research, we will expand the selection range of relevant literature, use bibliometric methods, visual scientific knowledge maps, and citation analysis methods to explore and compare the research on supply chain performance under the digital background from different angles, providing scholars in the digital supply chain field with more in-depth reference and information.

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