A bibliometric analysis on supply chain disruptions: Current status, development, and future directions

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CHRONICLE	ABSTRACT
	The complexity and vulnerability of supply chains in today's globalized economy have heightened the significance of understanding and managing disruptions. Supply chain disruptions, ranging from natural disasters to pandemics, can lead to substantial delays, increased costs, and reduced quality, thereby impacting the operational performance and stability of businesses. Considering the theoretical sophistication and substantial relevance of the field, this research seeks to conduct an extensive bibliometric analysis of supply chain disruption. The goal is to offer a thorough summary of recent advancements and ongoing progress in this specific area. Additionally, it aims to pinpoint emerging research patterns that can guide future studies. We performed a bibliometric review of the structure and global trends of disruptions among supply chains, from 1996 to 2024 using techniques such as analysis of (1) the dataset, (2) sources, (3) authors, (4) countries and institutions, (5) documents, and (6) keywords. A total of 1356 bibliographic records from Web of Science databases were analyzed to generate the study's research data through Scientometrics networks. The paper concludes by discussing the strengths and limitations of the study and suggesting potential avenues for future research, aiming to guide and inform future studies in this critical area of supply chain management. The findings of this study will enhance understanding of the prevailing patterns in this topic, thus laying the groundwork for future research initiatives in this field.

1. Introduction

Supply chain is a critical component of any business operation, encompassing the network of organizations, people, activities, information, and resources involved in the production and distribution of goods or services to the end consumer. It involves the flow of raw materials, components, and finished products from suppliers to manufacturers, then to distributors, retailers, and ultimately to customers. A well-functioning supply chain is essential for ensuring timely delivery of products, maintaining quality standards, and managing costs effectively. In today's globalized economy, supply chains have become increasingly complex and interconnected, making them vulnerable to various disruptions such as natural disasters, geopolitical events, economic fluctuations, and now even pandemics like COVID-19. A supply chain disruption is defined as any scenario that inhibits the manufacturing, sale, or distribution of commodities (Swan, 2018). Supply chain disruption resulted in significant delivery delays, decreased income and sales, and production shutdowns (Hassija et al., 2020). As a result, with the deployment of reaction planning activities and recovery plans, the current data-driven resilient supply chain architecture, including reactive control, is becoming an increasingly important concern in supply networks (Belhadi et al., 2024). Supply chain disruptions indirectly influence operations since they primarily rely on remote decision-making while ignoring credible data on interruptions (Alam et al., 2020). These interruptions create perplexing supply chain interruption situations and delay recovery policy arrangements (Blanchard, 2021). As a result, businesses are looking into ways to leverage databases to improve supply chain operations and how to use massive amounts of data to predict issues and increase supply chain flexibility (Nozari et al., 2022). Therefore, allowing comprehensive end-to-end real-time supply chain visibility at any point is essential to increase supply chain agility, flexibility, and alignment (Gohil & Thakker, 2021). This helps to increase supply chain operational performance. Under the circumstances, modifications to existing supply chain models must be included in planning and real-time management adoptions based on demand, inventory, and transportation data (Helo and Hao, 2022). Consequently, supply chain visibility should focus on technology-integrated, data-driven technical operations and intelligent decision-making.

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The significance of supply chain disruption has become more pronounced than ever before as supply chain components directly impact the performance and stability of businesses. Any disruption in the supply chain can lead to delays in product delivery, increased costs, reduced quality, heightened risks, and even loss of customer credibility. With the increasing complexity of supply chains in today's world and greater dependency on suppliers and ancillary services, any component in this chain can have widespread repercussions. Therefore, understanding and effectively managing the risks associated with supply chain disruptions are crucial for the survival and growth of organizations in the face of challenges arising from these disruptions. Considering the theoretical sophistication and substantial relevance of the field, this research seeks to conduct an extensive bibliometric analysis of supply chain disruption. The goal is to offer a thorough summary of recent advancements and ongoing progress in this specific area. Additionally, it aims to pinpoint emerging research patterns that can guide future studies. This paper utilizes a bibliometric analysis to investigate the current status and evolving tendencies of scholarly research on leveraging disruptions for supply chain management. The findings of this study will enhance understanding of the prevailing patterns in this topic, thus laying the groundwork for future research initiatives in this field.

The rest of this article is structured as follows: Section 2 details the data and methodology employed in this study. Section 3 discusses the results of the bibliometric analysis, which investigates the latest trends in the research area being studied. This analysis provides insights into key authors, journals, affiliations, and publications. Section 4 delves into the strengths and limitations of the study. Finally, Section 5 wraps up the paper by summarizing key points and suggesting potential directions for future research.

2. Materials and methods

Bibliometric investigations provide a thorough exploration that presents a unique perspective. The bibliometric capabilities of the R package are specifically designed to support quantitative analysis in Scientometrics and Informetrics. Furthermore, bibliometric tools enable the categorization and assessment of substantial amounts of past research data, enabling the retrieval of information from the repository (Eskorouchi et al., 2023; Ghanbari et al., 2023; Larni-Fooeik et al., 2024). In the specific research under consideration, bibliometric analysis was utilized to examine present trends in the occurrence of supply chain disruption. We conducted an examination of different instances of supply chain disruption by employing network analysis techniques, utilizing word diagrams and maps provided by Scientometric methods. Scientometric techniques were utilized to analyze (1) the dataset, (2) sources, (3) authors, (4) countries and institutions, (5) documents, and (6) keywords. The visualization of the research findings was accomplished using the VOSviewer software and the R Bibliometrix package. The scholarly database employed to conduct the search and selection of publications was Web of Science (WoS). The data retrieval process and final search equation are shown in Table 1.

Table 1
List of search keywords used in the WOS

Selected Search Keywords	Number of Records	Dataset Status
"Supply chain disruption"	624	Not Use
"Supply chain disruptions"	908	Not Use
"Supply chain disruption?"	908	Not Use
"Supply chain disruption*"	1365	Not Use
"Supply chain disruption" OR "Supply chain disruptions"	1365	Use

A total of 1365 studies were retrieved from WoS, spanning the period from 1996 to April 2024. It should be noted that among these 1365 articles, 9 articles were removed because they were printed in a language other than English (3 German, 2 Chinese, 2 Russian,1 French, and 1 Malay). Figure 1 illustrates the framework implementation of the current review.
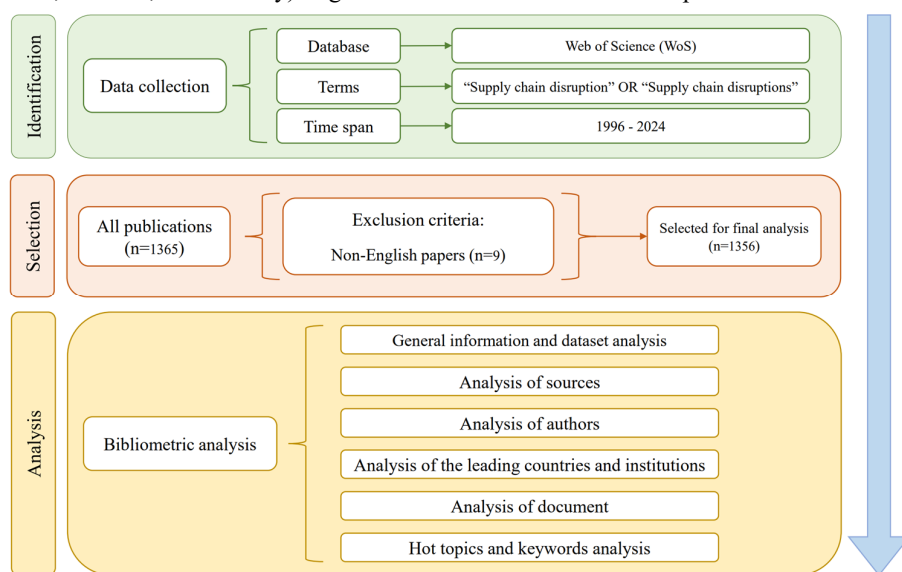

Fig. 1. Procedures and methods used in research on the application of supply chain disruption

3. Scientometrics analysis

In Section 3 of our review paper, we focus on Scientometrics, which involves the analysis of various aspects related to supply chain disruption. This section is divided into six parts, each addressing a specific area of investigation.

Firstly, we conduct an examination of the dataset used in our study. This involves analyzing the characteristics of the data, such as its size, scope, and temporal range, to gain a comprehensive understanding of the research landscape in the field of supply chain disruption. Secondly, we explore the sources of the literature included in our analysis. By identifying the journals, conferences, and other platforms where the research has been published, we can assess the dissemination patterns and identify key outlets for scholarly work in this area. The third part of our analysis focuses on the authors who have contributed to the field of supply chain disruption. By examining authorship patterns, collaboration networks, and individual author productivity, we gain insights into the key researchers and their influence within the community. Next, we investigate the countries and institutions associated with the research on supply chain disruption. This allows us to identify the geographical distribution of scholarly activities, highlight the leading countries and institutions in the field, and assess the global collaboration networks. Furthermore, we analyze the characteristics of the documents themselves. This includes examining publication trends, citation patterns, and the types of documents (e.g., articles, conference papers, reviews) that have contributed to the body of knowledge on supply chain disruption. Lastly, we employ Scientometric methods to explore the keywords associated with the literature on supply chain disruption. By utilizing network analysis techniques, word diagrams, and maps, we gain a visual representation of the key concepts, themes, and relationships within the research domain. Overall, this comprehensive Scientometric analysis provides a holistic view of the research landscape in the field of supply chain disruption. The combination of network analysis techniques and visualization tools enables us to uncover valuable insights and trends that contribute to a deeper understanding of this important area of study.

3.1. General information and data set analysis

3.1.1. Main information

Out of the 1356 documents selected for this study, a total of 3754 authors were identified. The average number of citations per document is 29.81, which is considered highly esteemed within the academic community. The annual growth rate experienced a significant increase of 16.44% per year. The primary document type is articles, accounting for 984 publications. Additionally, a total of 1839 Keywords Plus and 3483 author keywords were identified. Table 2 provides a concise overview of the general information pertaining to the analyzed papers in this study.

Table 2
Summary of the descriptive information

Description	Results	Description	Results
MAIN INFORMATION ABOUT DATA		DOCUMENT TYPES	
Timespan	1996:2024	Article	984
Sources (Journals, Books, etc.)	586	Article; book chapter	35
Documents	1356	Article; early access	82
Annual Growth Rate %	16.44	Article; early access; retracted publication	1
Document Average Age	4.2	Article; proceedings paper	9
Average citations per doc	29.81	Book	1
References	53402	Book review	1
DOCUMENT CONTENTS		Editorial material	21
Keywords Plus (ID)	1839	Editorial material; book chapter	2
Author's Keywords (DE)	3483	Editorial material; early access	1
AUTHORS		Letter	2
Authors	3754	Meeting abstract	5
Authors of single-authored docs	93	News item	1
AUTHORS COLLABORATION		Proceedings paper	138
Single-authored docs	125	Review	69
Co-Authors per Doc	3.44	Review; early access	4
International co-authorships %	34.81		

3.1.2. Publication output

Figure 2a depicts a notable upward trend in the number of studies published in recent years. The annual growth rate has experienced a substantial change, increasing from 1 document in 1996 to 380 documents in 2023. As of April 2024, there have already been 80 published studies on this topic, indicating the expectation of this trend continuing throughout 2024 and beyond. However, the annual publication trends can be divided into two distinct time periods. The first period, until 2010, witnessed limited research contributions. The second period, from 2010 to April 2024, saw a significant surge in research output due to advancements in methodologies addressing the issue. Figure 2b also presents the average number of citations per year, revealing that the years 2024 and 2004 have the highest average number of citations, accounting for approximately 38% and 41% respectively.
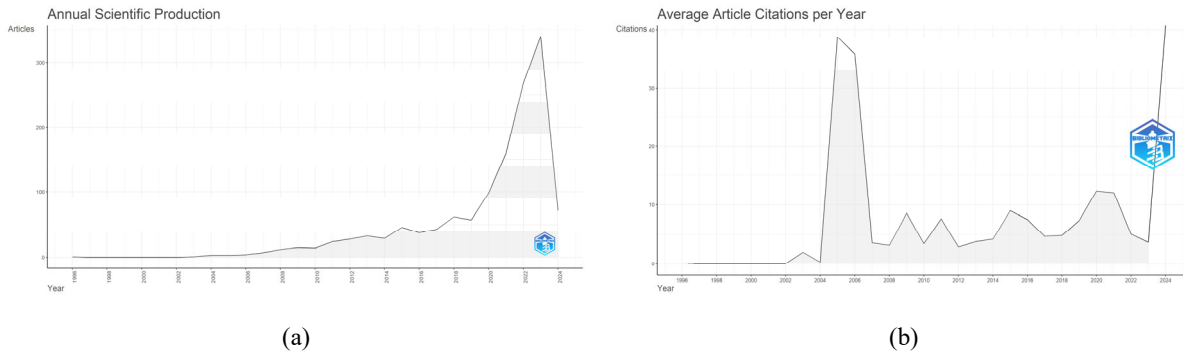
Fig. 2. Publication output. (a) Document output and (b) Average number of citations per year

Figure 3 also displays a comparison of the growth trends for the number of articles and citations between the years 1996 and 2024. The figure clearly illustrates that this trend has been consistently increasing over the specified period. Notably, 2022 witnessed the highest number of articles, while 2023 recorded the highest number of citations. It is important to note that the statistics presented in this chart are cumulative, meaning they represent the accumulation of articles and citations over time.
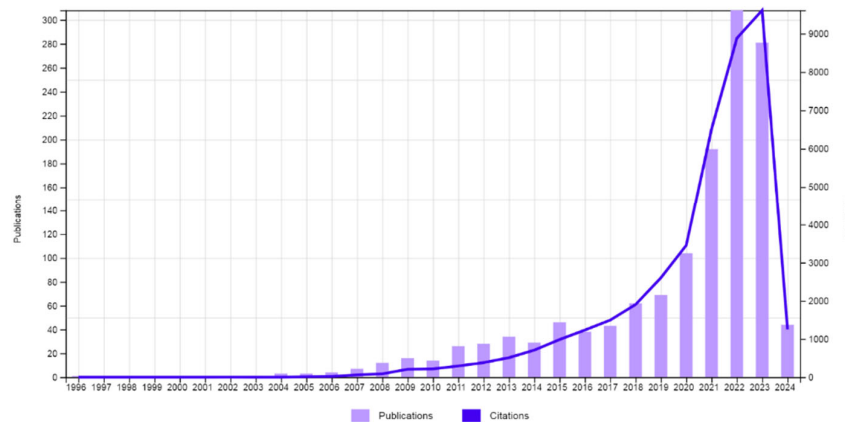

Fig. 3. Publication and citation over the time

3.2. Analysis of sources

3.2.1. Discipline-wise analysis

Table 3 presents the distribution of the most cited sources in the field. Based on the number of citations, it is evident that this topic has received significant attention, particularly in the International Journal of Production Research with 3305 citations. The second most prominent journal in terms of occurrences is the International Journal of Production Economics with 2858 citations. Following, the third and fourth journals are the Journal of Operations Management with 2089 citations, and Supply Chain Management with 1451 citations, respectively. These findings highlight the importance of these sources in the research related to the topic.

Table 3

Most cited sources

Sources	Number of Citation
International Journal of Production Research	3305
International Journal of Production Economics	2858
Journal of Operations Management	2089
Supply Chain Management	1451
Management Science	1253
European Journal of Operation Research	1250
Production and Operations Management	1086
International Journal of Logistics Management	1071
International Journal of Operations & Production Management	988
International Journal of Physical Distribution Logistics Management	910

3.2.2. Most relevant sources

This section discusses the most significant and influential sources in the research of supply chain disruption. In the realm of supply chain disruption research, several sources have emerged as highly significant and influential in shaping the field's understanding and knowledge base. One prominent method used to identify such sources is Bradford's Law, which provides

valuable insights into the distribution of scholarly publications. Bradford's Law, as illustrated in Figure 4, categorizes journals into different zones based on their publication frequency in a particular field. Zone 1, also referred to as the core area, comprises journals that are the most frequently published sources in the literature on supply chain disruption. These publications hold immense importance due to their extensive coverage and scholarly contributions.
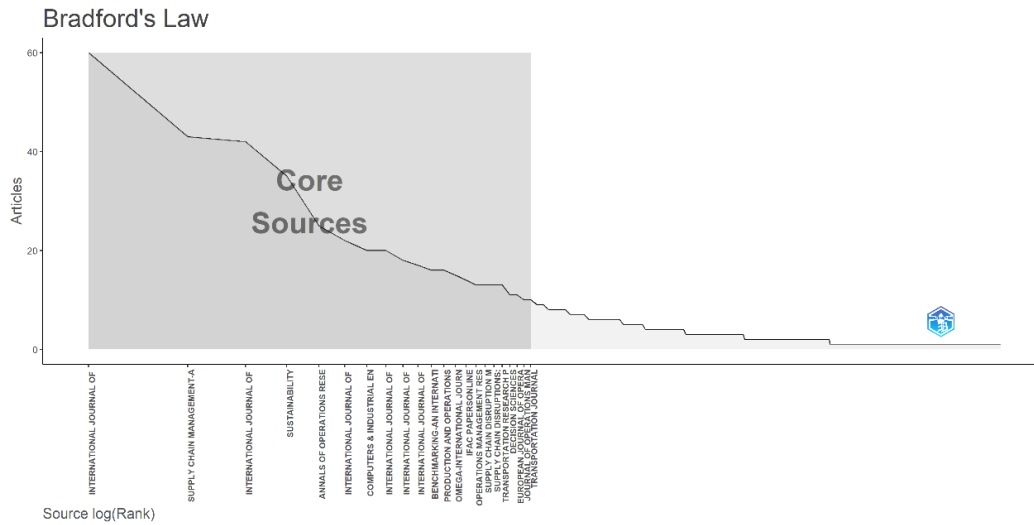

Fig. 4. Bradford's Law (Core sources)

Table 4 presents the frequency of the ten most influential sources in the research of supply chain disruption. This table provides valuable insights into the publication activity of these sources and allows us to gauge their impact and effectiveness within the field. Analyzing the data in Table 4, it becomes evident that the International Journal of Production Research stands out as the most effective source in this field. With the highest number of published documents among the top ten sources, this journal has established itself as a primary outlet for researchers and scholars interested in supply chain disruption. Its significant contribution to the field is reflected in the frequency of its publications, indicating a robust and consistent stream of research output.

Table 4
Effect of the sources

Sources	Rank	Freq	Zone
international journal of production research	1	60	Zone1
supply chain management-an international journal	2	43	Zone1
international journal of production economics	3	42	Zone1
Sustainability	4	35	Zone1
annals of operations research	5	25	Zone1
international journal of operations & production management	6	22	Zone1
computers & industrial engineering	7	20	Zone1
international journal of logistics management	8	20	Zone1
international journal of physical distribution & logistics management	9	18	Zone1
international journal of logistics-research and applications	10	17	Zone1

3.2.3. Sources dynamics

Figure 5 illustrates the growth trend of article publications in the top 10 journals mentioned in the previous section. The figure clearly demonstrates that the publication process in these journals has experienced a rapid and significant increase both on an annual and cumulative basis in recent years. This trend indicates a strong momentum in publishing articles in these journals, and it is anticipated that this process will continue in the forthcoming years.
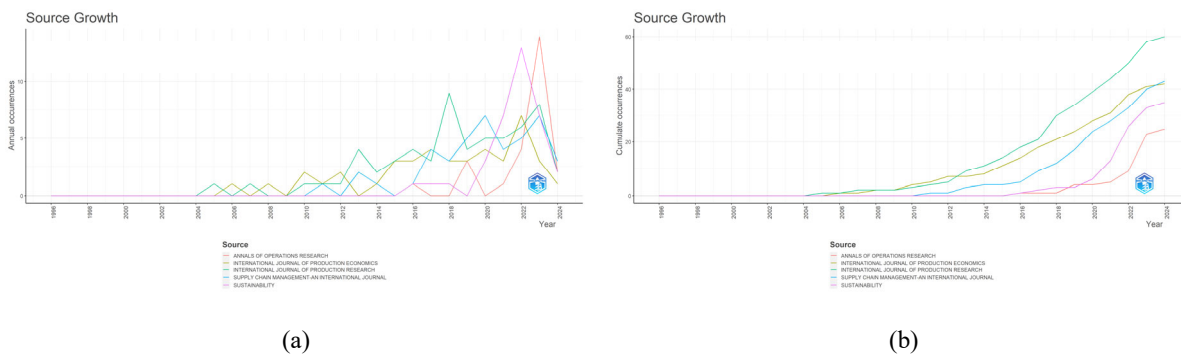

(a)   (b)

Fig. 5. Top sources dynamics (a) Annual occurrences (b) Cumulative occurrences

3.2.4. Most relevant publishers

Figure 6 presents the number of articles published on the topic of supply chain disruption by various publishers. As depicted in the figure, Elsevier emerges as the leading publisher in this field, with 308 articles, constituting 25% of the total publications. Following closely, Emerald Group Publishing accounts for 195 articles (16%), while Springer Nature, Taylor & Francis, and Wiley have published 149 articles (12%), 146 articles (12%), and 105 articles (9%) respectively. These publishers stand out as the most prolific contributors to the literature on supply chain disruption.
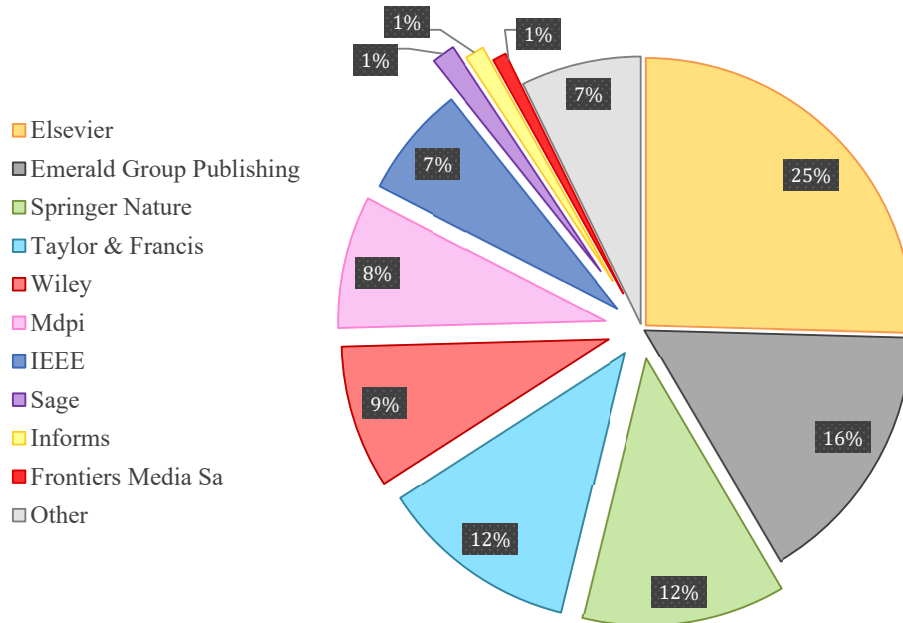
Fig. 6. Most relevant publishers

3.3. Analysis of authors

3.3.1. Authors productivity

Lotka's Law is a principle that identifies and characterizes researchers who exhibit a higher frequency of production within a specific knowledge area. Figure 7 presents the findings for papers on supply chain disruption, along with the predicted distribution according to Lotka's Law. In this study, the results indicate a Lotka's index in which 85.7% of authors would write one article, 9.4% would write two articles, 3.0% would write three articles, and 0.9% would write four articles. This suggests that the authorship distribution in the field of supply chain disruption does not currently conform to Lotka's Law. The dashed line in the figure represents the graph that would be expected if Lotka's Law were followed.
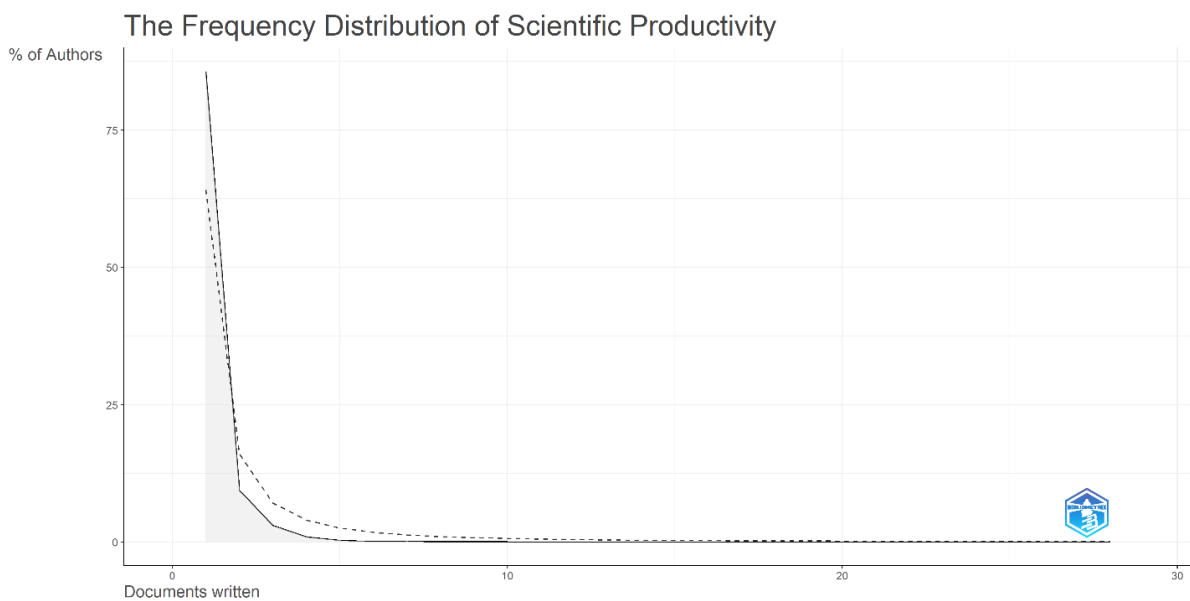
Fig. 7. Lotka's Law (The frequency of scientific productions)

Table 5
The frequency of scientific productions

Documents written	Number of Authors	Proportion of Authors
1	3217	85.7%
2	354	9.4%
3	113	3.0%
4	35	0.9%
5	13	0.3%
6	5	0.1%
7	6	0.2%
8	3	0.1%
9	4	0.1%
11	1	0.0%

3.3.2. Authors productivity over time

Figure 8 showcases the top author's documents on the subject of supply chain disruption over the years. The color intensity displayed in the graph corresponds to the citation year, while the size of the bubbles represents the author's yearly publication count. As an example, in 2018, Ali SM published his first article on this topic, which garnered a total of 65 citations. Subsequently, in 2020, two papers were published by the same author, and in 2021, three documents were published. The graph provides a visual representation of the author's publishing activity and the corresponding citation counts across different years.
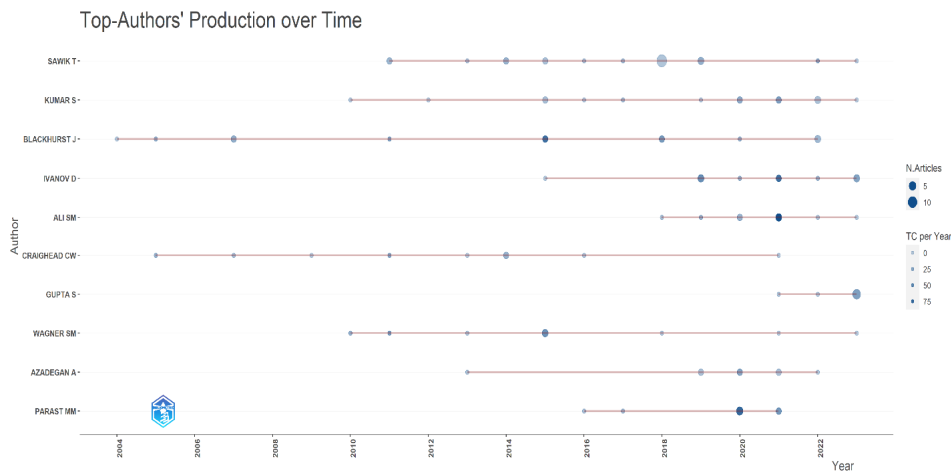

Fig. 8. Top author's production over time in researching the supply chain disruption

3.3.3. Most relevant authors and authors impacts

In this section, we present an analysis of the most notable authors who have contributed significantly to the field of supply chain disruption. Figure 9 provides an overview of the top 10 authors based on the number of published articles, while Table 6 highlights the top 10 authors based on the number of local citations, indicating their impact on the study of supply chain disruption. The first author of significance is Sawik T, who has made substantial contributions to the field through their published works. Another influential figure is Kumar S, whose work has greatly contributed to our understanding of the challenges and strategies related to mitigating supply chain disruption.
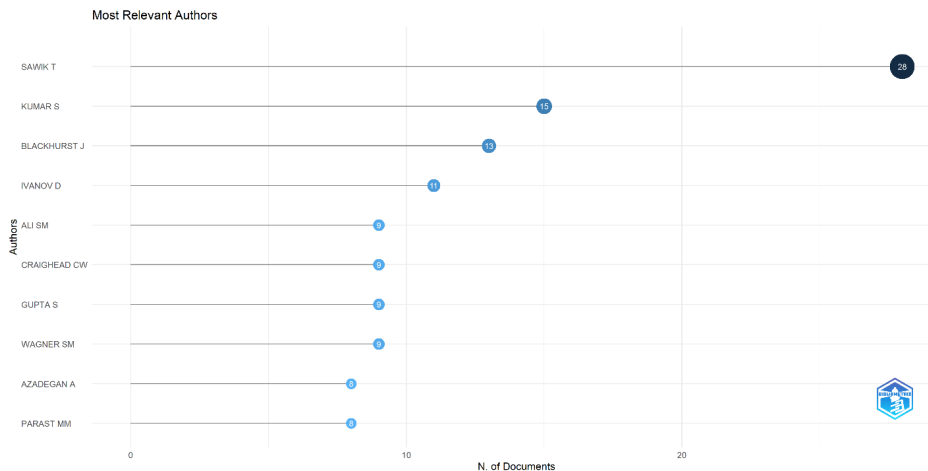

Fig. 9. Effect of the authors (Number of publications by authors)

These authors have not only contributed to the body of knowledge surrounding supply chain disruption but have also had a significant impact on the field as evidenced by the number of local citations they have received. The local citations serve as a measure of their influence and recognition within the research community, highlighting their contributions to the advancement of supply chain disruption studies. Overall, the collective works of these authors have significantly shaped the field of supply chain disruption and continue to inspire further research and exploration in this area.

Table 6

Effect of the authors (Most local cited authors)

Authors	Articles	Articles Fractionalized
SAWIK T	28	27.50
KUMAR S	15	5.13
BLACKHURST J	13	4.12
IVANOV D	11	4.08
ALI SM	9	1.90
CRAIGHEAD CW	9	2.67
GUPTA S	9	2.00
WAGNER SM	9	3.08
AZADEGAN A	8	2.20
PARAST MM	8	4.03

Table 7 presents the comprehensive rankings of the top 10 most influential authors in the field of supply chain disruption research from 1996 to 2024. The rankings are based on several prominent citation metrics, including the H-index, G-index, and M-index, as well as other relevant indices. These metrics are widely accepted and utilized in academia to evaluate an author's research impact and productivity.

- The H-index is a measure that combines an author's productivity and citation impact. It quantifies the number of papers an author has published (h) that have received at least h citations each. Authors with a higher H-index are considered to have a more significant influence in their field.
- The G-index is another citation-based metric that measures an author's total number of highly cited papers. It takes into account the distribution of citations among an author's publications, giving more weight to highly cited articles. A higher G-index indicates a higher number of influential papers.
- The M-index, on the other hand, focuses on the author's h-core, which consists of the h most highly cited papers. It measures the average number of citations received by an author's h-core publications. The M-index provides insight into an author's citation impact beyond the H-index.

Table 7 provides a comprehensive overview of these metrics for the top 10 authors in supply chain disruption research. By considering these indices, researchers and practitioners can gain valuable insights into the most influential contributors to the field, and their respective research impact and productivity.

Table 7

Top 10 most relevant authors on supply chain disruption

Element	H index	G index	M index	TC	NP	PY Start
SAWIK T	12	28	0.857	912	28	2011
BLACKHURST J	10	13	0.476	2161	13	2004
IVANOV D	10	11	1	776	11	2015
CRAIGHEAD CW	9	9	0.45	1210	9	2005
KUMAR S	9	15	0.6	492	15	2010
ALI SM	8	9	1.143	660	9	2018
PARAST MM	8	8	0.889	673	8	2016
AZADEGAN A	7	8	0.583	274	8	2013
SCHMITT AJ	7	7	0.438	944	7	2009
WAGNER SM	7	9	0.467	1231	9	2010

Notes. TC: Total Citation, NP: Number of Publications, PY start: Publication Year Start

3.4. The leading countries and institutions

3.4.1. Most relevant countries

In this section, we delve into the examination of the prominent nations and institutions in the field, shedding light on their contributions and impact. Through our analysis, we have discovered compelling insights regarding the document production of various countries during the specified period. Unsurprisingly, the United States emerges as the leader, ranking first in terms of document production. A staggering total of 972 publications were attributed to the United States, showcasing its significant presence and influential role within the field. This noteworthy achievement highlights the nation's dedication to research and development, as well as its commitment to advancing knowledge in this domain. China, a rising global power, secured the second position in the rankings, demonstrating its growing influence and contributions to the field. With an impressive count of 511 publications, China has made significant strides in research and has become a formidable force within the international landscape of this domain. Not far behind, the United Kingdom claims the third position, with 229 publications. Despite its relatively smaller count compared to the United States and China, the United Kingdom has consistently demonstrated its commitment to academic excellence and research advancement. Its contributions, although fewer in number, have been impactful and have paved the way for important breakthroughs and discoveries. Figure 10 provides a

comprehensive compilation of other leading nations that have made notable contributions in this regard. These countries, though not occupying the top positions, have significantly contributed to the field and have played a crucial role in shaping its progress. Their collective efforts have enriched the knowledge base and fostered collaboration within the global scientific community.

Country Scientific Production

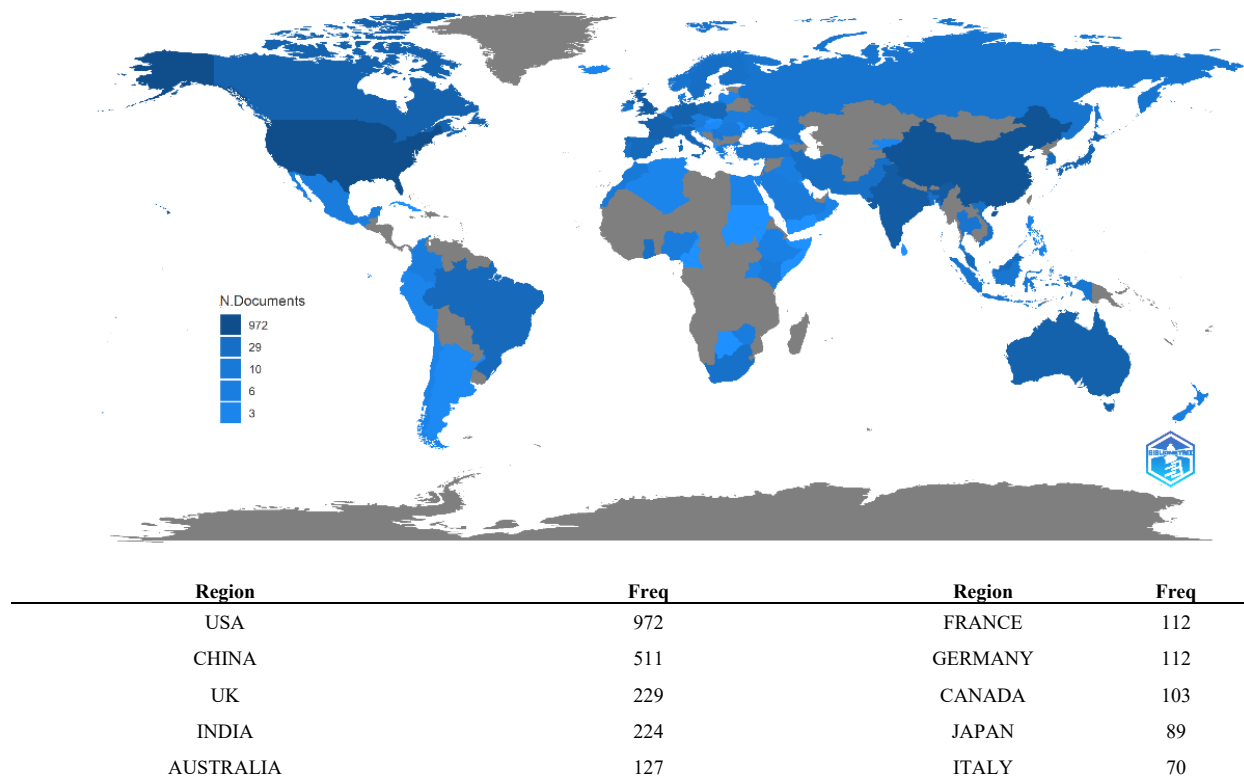| Region	Freq	Region	Freq
USA	972	FRANCE	112
CHINA	511	GERMANY	112
UK	229	CANADA	103
INDIA	224	JAPAN	89
AUSTRALIA	127	ITALY	70

Fig. 10. Scientific production by countries

Table 8, offers insights into the countries that have received the highest number of citations in the field of supply chain disruption. These citations reflect the impact and influence of research contributions originating from these countries. The table presents the rankings of the top 10 countries based on their citation counts. At the forefront of the rankings is the United States, which has accumulated a remarkable total of 18,021 citations. Following is China, securing the second spot with 3,051 citations. Germany takes the third position, with 3,004 citations, highlighting its noteworthy contributions to the field. The table further includes rankings for other countries within the top 10, providing a comprehensive overview of their citation counts. This information allows researchers and practitioners to identify the countries whose research has been most extensively cited and whose contributions have had a significant impact on the field of supply chain disruption.

Table 8
Most cited countries

Country	TC	Average Article Citations
USA	18021	46.93
CHINA	3051	14.32
GERMANY	3004	55.63
UNITED KINGDOM	2999	38.45
CANADA	1451	42.68
INDIA	1429	19.31
AUSTRALIA	1271	26.48
SWITZERLAND	961	68.64
POLAND	895	22.38
BRAZIL	874	39.73

3.4.2. Most relevant affiliations

The University of Michigan in the United States holds the top position among the top 10 institutions, having published 28 articles on the topic of supply chain disruption. Following closely, AGH University of Science and Technology in Poland and Iowa State University in the United States both have 27 articles. The National University of Singapore in Singapore and Northeastern University in the United States have contributed 21 articles each. The table provides a list of other distinguished institutions that have made notable contributions in this field.

Table 9
Most relevant affiliations.

Affiliations	Articles
UNIV MICHIGAN	28
AGH UNIV SCI AND TECHNOL	27
IOWA STATE UNIV	27
NATL UNIV SINGAPORE	21
NORTHEASTERN UNIV	21
ARIZONA STATE UNIV	20
MICHIGAN STATE UNIV	18
UNIV TOKYO	18
UNIV CALIF BERKELEY	16
PENN STATE UNIV	15

In addition to the information provided in Table 9, there is further insight available through Figure 11. Figure 11 showcases the productivity of research affiliations over time in the field of supply chain disruption. The figure provides a graphical representation of the productivity of affiliations, which could include universities, research institutes, organizations, and other academic or industry entities involved in supply chain disruption research.
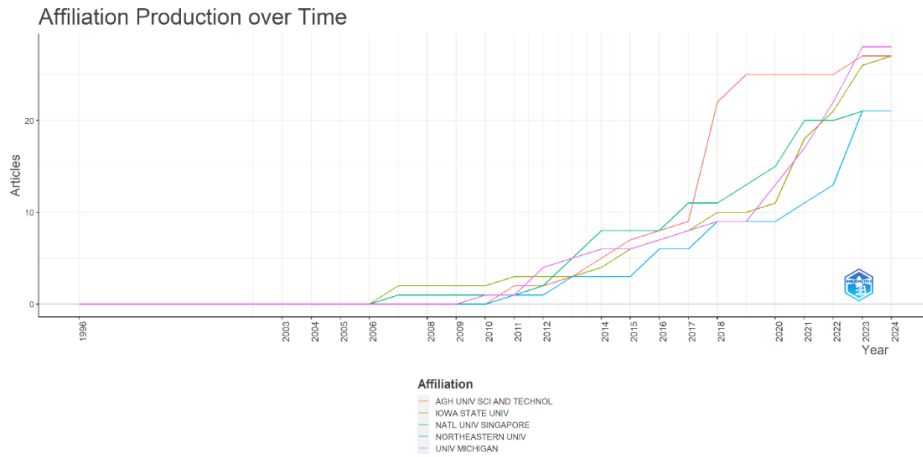

Fig. 11. Affiliation production over time

3.4.3. Countries and authors collaborations

An in-depth analysis of the level of international collaboration between countries in the field of supply chain disruption provides valuable insights into the most active collaborators and the leading international research efforts in this domain. These insights are crucial for fostering academic collaboration and facilitating the exchange of ideas and expertise on a global scale. Figure 12 depicts the collaboration between countries in the world, highlighting the nodes that represent clusters of collaborating countries. The thickness of the connecting lines between the nodes indicates the strength of collaboration. According to the figure, the United States possesses the most extensive collaboration network, linking with multiple countries across the globe. This indicates that the United States plays a leading role in international research efforts and actively engages in collaborative endeavors with researchers from various nations.
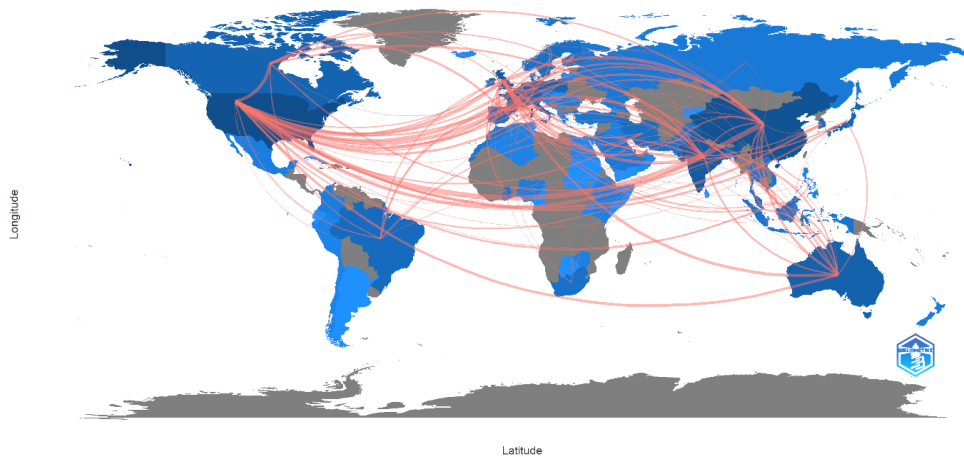

Fig. 12. Network map of cooperation countries/regions

From Figure 13, it is possible to explore the intra and inter-country collaboration using the MCP (intercountry collaboration index) and SCP (intra-country collaboration). MCP refers to intercountry collaboration, while SCP refers to intra-country collaboration. It is evident from Figure 13 that the United States has the highest MCP and SCP, suggesting its significant influence over both inter- and intra-country collaboration. On the other hand, the United Kingdom, Australia, and France exhibit a higher percentage of MCP (intercountry collaboration) compared to SCP (intra-country collaboration). This indicates that these countries actively engage in collaborative research efforts with researchers from other nations. In contrast, countries such as the United States, China, India, Germany, Australia, and Japan demonstrate a higher percentage of SCP (intra-country collaboration). This implies that researchers within these countries tend to collaborate with colleagues from the same country. The analysis of MCP and SCP provides insights into the nature and extent of collaboration within and between countries in the field of supply chain disruption.
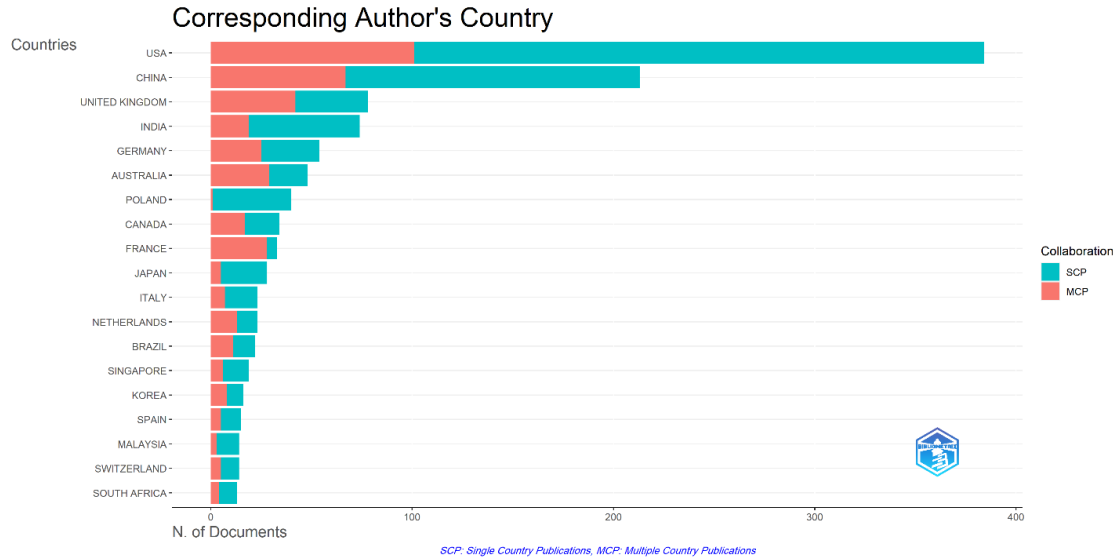
Fig. 13. Top corresponding author countries

Table 10

The top 10 corresponding author countries

Country	Article	SCP	MCP	Freq	MCP_Ratio
USA	384	283	101	0.283	0.263
CHINA	213	146	67	0.157	0.315
UNITED KINGDOM	78	36	42	0.058	0.538
INDIA	74	55	19	0.055	0.257
GERMANY	54	29	25	0.04	0.463
AUSTRALIA	48	19	29	0.035	0.604
POLAND	40	39	1	0.029	0.025
CANADA	34	17	17	0.025	0.5
FRANCE	33	5	28	0.024	0.848
JAPAN	28	23	5	0.021	0.179

3.5 Analysis of documents

3.5.1. The most impactful documents

Table 11 shows the 10 most globally cited documents in the research of Supply chain disruption, with worldwide citation counts ranging from 480 to 1358. Tang (2006), Kleindorfer and Saad (2005), Tomlin (2006), Ponomarov and Holcomb (2009), and Hendricks and Singhal (2005) have the most citations worldwide, receiving 1358, 1155, 1043, 991 and 701, respectively, and their paper are listed as the top five most referenced publications.

Table 11

Top 10 cited documents in the research of supply chain disruption

Authors	Top cited documents	TC per year	Normalized TC
TANG CS, 2006,	1358	71.47	2.11
KLEINDORFER PR, 2005,	1155	57.75	1.57
TOMLIN B, 2006,	1043	54.89	1.62
PONOMAROV SY, 2009,	991	61.94	7.72
HENDRICKS KB, 2005,	701	35.05	0.95
ADAMO A, 2016,	655	72.78	10.92
JÜTTNER U, 2011,	602	43.00	6.05
AMBULKAR S, 2015,	596	59.60	7.34
HECKMANN I, 2015,	530	53.00	6.53
TANG C, 2008,	480	28.24	9.55

Tang (2006) conducted a comprehensive review of quantitative models designed to effectively manage supply chain risks. he went beyond theoretical discussions and examined how these models are implemented in real-world practices. The main objectives of the paper were three-fold. Firstly, the author aimed to develop a unified framework that can be used as a classification system for articles related to supply chain risk management (SCRM). This framework allows researchers to easily navigate through the vast amount of literature in this important field. Secondly, the author intended his review to serve as a practical guide for researchers working in the area of SCRM. By synthesizing and presenting the key findings of existing studies, the paper provides valuable insights and knowledge that can guide researchers in their own investigations. It helps researchers understand the current state of the field, identify gaps in knowledge, and determine areas where further research is needed. Lastly, the author sought to inspire the development of new models and strategies for mitigating supply chain disruptions. he highlighted the significant impact that disruptions can have on a firm's performance, both in the short-term and long-term. Examples were given, such as companies experiencing major financial losses due to supply shortages caused by natural disasters or disruptions in the production process. To address these challenges, the authors emphasized the necessity of proactive risk management approaches and the continuous improvement of existing models.

Kleindorfer and Saad (2005), addressed the risks affecting supply chain design and management, namely disruptions to normal activities. These disruptions can arise from natural disasters, economic disruptions, and deliberate actions. The paper presents a conceptual framework that integrates risk assessment and risk mitigation as fundamental components of disruption risk management in supply chains. It draws on empirical data from the U.S. Chemical Industry between 1995 and 2000 to gain insights into the implications of designing management systems capable of handling disruption risks. The study emphasizes the distinction between disruption risks and normal supply-demand coordination risks that have been extensively studied in the supply chain management literature. Disruption risks encompass operational risks, natural hazards, terrorism, and political instability. The paper highlights the increasing significance of disruption risks due to longer supply chain paths and shorter timeframes for recovery. Notable examples of disruptions, such as the Taiwan earthquake in 1999 and the terrorist attack on the World Trade Center in 2001, are cited to underscore the potential impact on supply chains. The authors analyze the negative effects of disruptions on company performance, including stock performance, costs, sales, and profits. The paper aims to develop a conceptual framework that integrates risk assessment and mitigation and provides strategic directions and actions for cost-effective mitigation practices. The authors discuss the future evolution of management systems addressing disruption risk management and security threats, drawing parallels to the ISO 9000 quality management system standard. The paper concludes by discussing the implications of the analysis and empirical findings for implementing best practices in managing disruption risks in supply chains, offering proposed directions, actions, and necessary conditions for effective implementation in practice

Tomlin (2006), examined the optimal strategies for managing supply chain disruption risks in a single-product setting. The study considers a scenario where a firm has two suppliers: one is unreliable but cheaper, while the other is reliable but more expensive. The suppliers have capacity constraints, and the reliable supplier may have volume flexibility. The research demonstrates that the optimal strategy depends on the percentage uptime of the suppliers and the characteristics of the disruptions—whether they are frequent but short or rare but long. In situations where disruptions are less frequent but longer, sourcing mitigation tends to be favored over inventory mitigation. The paper also explores the use of mixed mitigation strategies, contingent rerouting, and the impact of supplier volume flexibility. The findings indicate that contingent rerouting can significantly reduce costs and that a combination of tactics may be appropriate for managing disruption risks. The study emphasizes the importance of considering operational tactics such as inventory management, sourcing decisions, and rerouting strategies in supply chain disruption risk management. Ponomarov and Holcomb (2009), provided an integrated perspective on resilience in the fields of risk management and supply chain management. The authors conduct an extensive literature review in various disciplines, including developmental psychology and ecosystems, to develop a conceptual model and address theoretical gaps in existing research. The study highlights that the key elements of supply chain resilience, their relationships, the connection between risks and supply chain management implications, and the methodologies for managing these issues are not well understood. The authors suggest the need for empirical testing of the proposed model in future research. From a practical standpoint, supply chain disruptions can have adverse effects on revenue and costs, emphasizing the importance of resilient supply chains that are prepared for events, capable of efficient responses, and capable of recovering to their original or improved states. The paper contributes to the development of an interdisciplinary understanding of supply chain resilience, bridging knowledge gaps and leveraging existing knowledge in the logistics perspective. The conceptual model proposed in the study establishes a link between logistics capabilities and supply chain resilience, recognizing the vital role of logistics in enabling efficient and effective responses to disruptions. Hendricks and Singhal (2005), presented an empirical analysis that investigates the long-term effects of supply chain disruptions on stock prices and equity risk of firms. The study examines a sample of 827 disruption announcements made during the period of 1989-2000. The analysis focuses on the stock price effects starting one year before the disruption announcement and extending to two years after. The findings reveal that firms experiencing disruptions exhibit an average abnormal stock return of approximately -40%. The majority of this underperformance is observed in the year preceding the announcement, the day of the announcement, and the year following the announcement. Additionally, the study indicates that firms do not quickly recover from the negative effects of disruptions. Moreover, the equity risk of the firm significantly increases around the announcement date, with a 13.50% higher equity risk observed in the year after the announcement compared to the year before. The research sheds light on the importance of supply chain disruptions and their potential economic impacts. Previous studies have mainly relied on anecdotes and case studies, and this paper contributes to the emerging field by providing

a more comprehensive analysis. The paper also addresses the impact of disruptions on the risk of the firm. Changes in risk can have significant implications for various stakeholders, including investors, management, employees, suppliers, and customers. Increased risk may raise the cost of capital, reduce the attractiveness of the firm's equity for acquisitions, and increase the probability of financial distress. It may also lead to conflicts between stakeholders and affect employee compensation, supplier and customer relationships, and credit ratings. Understanding the relationship between disruptions and risk is crucial for assessing the overall economic consequences.

3.5.2. Cluster analysis

In co-author analysis, the examination of the number of documents in which two or more researchers collaborate as co-authors is a significant aspect. To visually represent this collaboration network, a map visualization can be employed. In this visualization, colored lines are used to depict the connections among the items, which represent the researchers. The weight attributes assigned to the items, reflected in their size, indicate the importance of the identified network. Furthermore, the number of lines among co-authors in the visualization reveals their relevance within the bibliographic data analysis. The more lines connecting researchers, the stronger their collaborative relationship and the higher their level of co-authorship. By employing map visualizations and analyzing the connections, weights, and number of lines among co-authors, valuable insights can be gained into the collaborative networks and relationships within the field of study. Figure 14 presents the connection between researchers according to the conjointly elaborating documents. Thus, this figure allows us to examine the existence and characteristics of collaboration networks and possible established groups of authors that center on studying the supply chain disruption.
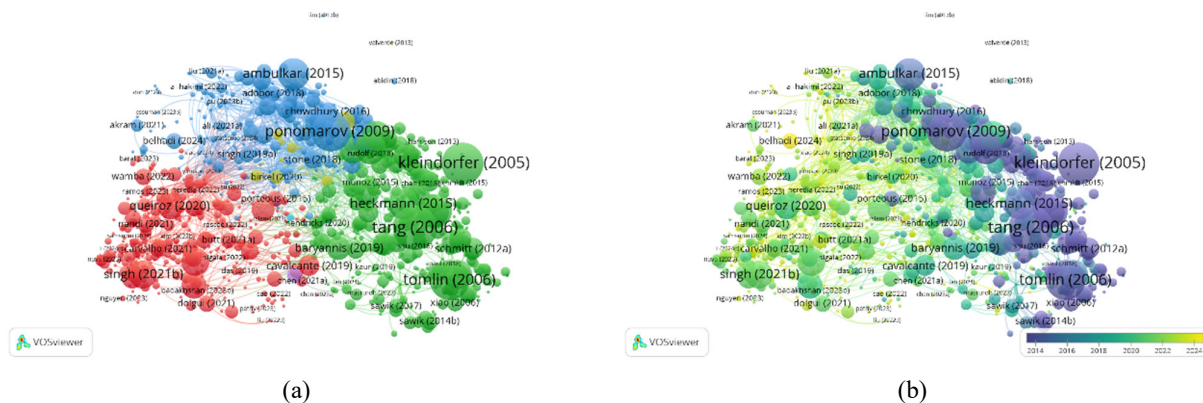

(a)   (b)

Fig. 14. Bibliographic coupling (a) Cluster analysis based on subjects (b) Cluster analysis based on periods

3.6 Hot topics and keywords analysis

3.6.1. Most frequent words

The most frequent keywords (author keywords and keyword plus) in the 1996 - 2024 period are presented in Table 12. The author's keyword analysis offers information about research trends from the researcher's point of view (Garfield, 1970). The keywords plus are terms extracted from titles or abstracts (Aria & Cuccurullo, 2017). in the author's keywords analysis, "COVID-19" and "supply chain disruption" are the most common with 219 and 207 Occurrences respectively. On the other hand, "management" and "performance" with 283 and 232 occurrences are the most common in keywords plus analysis. It would be said that "risk management" and "resilience" were also found in both categories.

Table 12

Most frequent words (author keyword and keywords plus) found in the research of supply chain disruption

Author's Keywords	Occurrences	Keywords Plus	Occurrences
COVID-19	219	management	283
supply chain disruption	207	performance	232
supply chain disruptions	169	impact	204
supply chain	117	risk	166
supply chain resilience	114	resilience	136
resilience	103	model	121
supply chain management	87	design	109
risk management	79	framework	96
supply chain risk management	66	risk-management	88
COVID-19 pandemic	50	strategies	78

In Figure 15, known as the "three-field plot" three parameters "Author, Disciplinary Evolution (Author's keywords), and Author Country" are adjusted and related to one another based on their significance and prominence in the literature. The size of the tiles in the diagram indicates the magnitude or importance of the relationship between these parameters. By examining the size of the boxes or tiles, one can discern the effective parameters in the literature. This suggests that larger boxes represent parameters that have a stronger influence or presence within the analyzed literature. The three-field plot

offers a visual representation of the interplay and significance of authors, disciplinary evolution, and countries in the context of the specific research area or field.
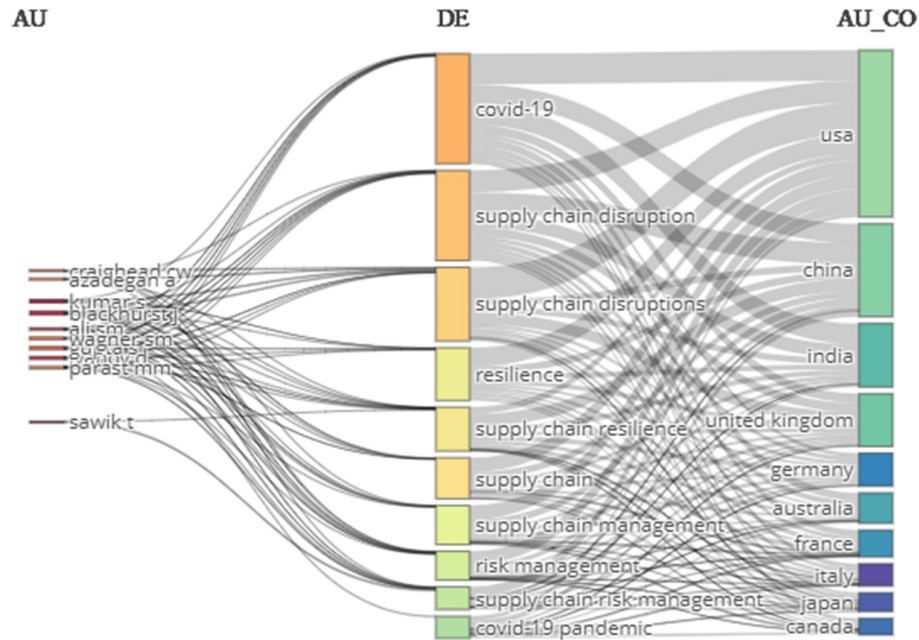

Fig. 15. Three-field plot

3.6.2. Trend topics over time

A trending topic analysis serves as a valuable mapping tool that aids in illustrating the progression of literature over time. Figure 16 illustrates the identified subjects derived from scrutinizing author keywords, ensuring a minimum occurrence of five words per article on a triannual basis.
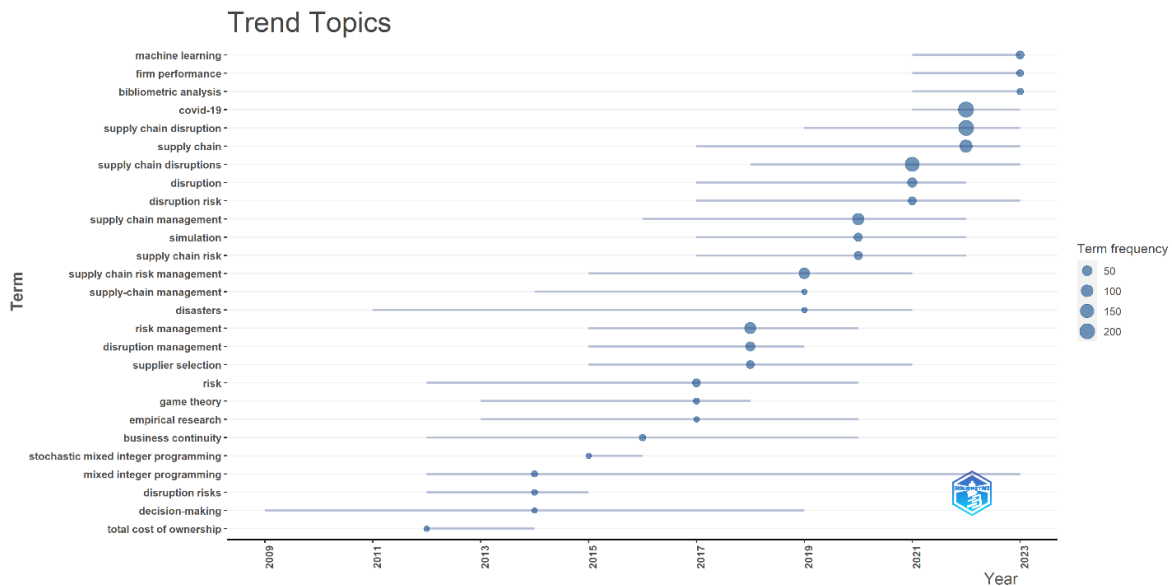

Fig. 16. Trends topics over the years

During recent years (2022, 2023), several prominent topics have emerged in the literature, including machine learning, firm performance, bibliometric analysis, COVID-19, and supply chain disruption. Notably, there has been a rise in research focusing on supply chain disruption, which can be attributed to the outbreak of the COVID-19 disease and the subsequent recognition of its impact on supply chains. Between 2021 and 2022, the prevailing topics were supply chain disruptions, disruption, and disruption risk, further highlighting the growing significance of studying and understanding supply chain disruptions during this period. Table 13 presents the Trending Topics in Supply Chain Disruption literature from 2009 to 2023, categorized by year. Notably, during the first quarter of 2012 and the third quarter of 2015, the dominant trending theme was "total cost of ownership". In the first quarter of 2012 and the third quarter of 2023, "mixed integer programming"

gained prominence, making it the most popular theme in the literature during those years within the field of supply chain disruption. Furthermore, "disruption risks" consistently maintained its status as one of the most trending subjects in the domain. Overlaying the trends, it can be observed that from 2020 to 2023, "empirical research", "risk management", "business continuity", and "mixed integer programming" emerged as notable trending topics in the field of supply chain disruption.

Table 13
Trending topics by year

Item	Freq	Year q1	Year med	Year q3
total cost of ownership	5	2012	2012	2014
mixed integer programming	7	2012	2014	2023
disruption risks	6	2012	2014	2015
decision-making	5	2009	2014	2019
stochastic mixed integer programming	5	2015	2015	2016
business continuity	8	2012	2016	2020
risk	19	2012	2017	2020
game theory	7	2013	2017	2018
empirical research	5	2013	2017	2020
risk management	79	2015	2018	2020

3.6.3. Thematic map

One of the analyses conducted in this study is the creation of a thematic map of supply chain disruption. The purpose of this analysis is to gain a deeper understanding of the current status of the field and to explore its future sustainability. By creating a thematic map, researchers and stakeholders can acquire valuable insights into the potential areas for future research development within the field of supply chain disruption. This analysis proves to be beneficial in providing knowledge and guidance to researchers and stakeholders, enabling them to identify and explore the thematic areas that hold promise for further advancement and exploration. The thematic analysis involves examining clusters of authors' keywords and their interconnections to identify and define themes within the field. These themes are characterized by their properties, namely density and centrality. Density is represented on the vertical axis, while centrality is represented on the horizontal axis. Centrality refers to the degree of correlation among different topics within the thematic network. It measures the level of interconnectedness and importance of specific topics. Nodes with a higher number of connections to other nodes in the network indicate higher centrality and importance, placing them in essential positions within the network. Density, on the other hand, measures the cohesiveness among nodes within a research field. It indicates the extent to which topics are well-developed and cohesive. Higher density signifies a research field's capability to develop and sustain itself. In Figure 17, the thematic map of the field of supply chain disruption is presented, divided into four quadrants labeled Q1 to Q4. This map provides a visual representation of the themes, their density, and centrality within the field, offering insights into the structure and development of the research area.
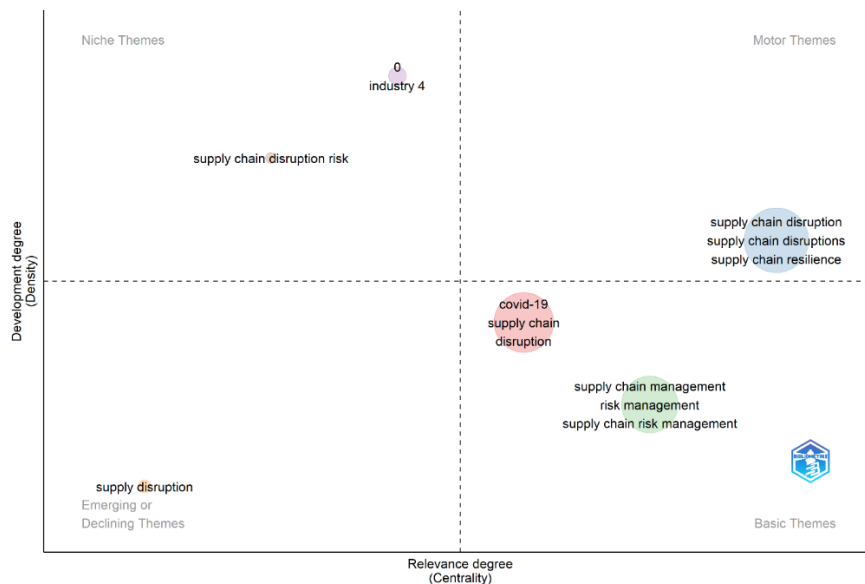

Fig. 17. Thematic map

In the thematic map presented, the upper right quadrant (Q1) represents driving themes within the field of supply chain disruption. These themes have a strong presence and influence, shaping the research field. The lower right quadrant (Q4) consists of underlying themes that form the foundation of the field, providing essential concepts and knowledge. Themes in the upper left quadrant (Q2) are considered very specialized, having developed internal connections but making marginal contributions to the overall development of the field. Lastly, the lower left quadrant (Q3) includes emerging or disappearing

themes, indicating components that are in the process of emerging or fading within the field. From the figure, it is apparent that themes like "Supply chain disruption" and "supply chain resilience" hold a prominent position and are well-developed, contributing significantly to the structure of the research field. These themes remain the leading topics within the field of supply chain disruption. Furthermore, themes such as "COVID-19 supply chain disruption", "supply chain management", "risk management", and "supply chain risk management" found in Q4, are foundational and crucial for the development of the field. They provide fundamental concepts and knowledge that underpin the research in supply chain disruption. The themes in Q2, such as "industry 4.0" and "supply chain disruption risk" have developed internal connections but have yet to make substantial contributions to the field's overall development. These themes have the potential for further advancement by establishing stronger connections to the concept of supply chain disruption. Lastly, the theme in Q3, "Supply disruption" signifies that some of its components are basic and necessary for the development of the field of supply chain disruption, but they may also be undergoing changes or experiencing diminishing relevance. Overall, the thematic map provides insights into the various themes within the field of supply chain disruption, their interconnections, and their contribution to the field's development and structure.

3.6.4. Thematic evaluation

Thematic evolution is a technique in bibliometrics for introducing a historical perspective on research and contributing to a science-based paradigm for directing further research themes (Moral-Munoz et al., 2018). It emphasizes the most significant research themes of evolution across time, presenting insights into the area's further path. Figure 18 illustrates the progression of the most frequently used terms in studying Supply chain disruption from 1996 to 2024 by dividing it into three time slices or subperiods. Accordingly, we are looking at the evolution of keywords during three different periods (1996-2010; 2011-2020; 2021-2024). From 1996-2010 (first phase), the most popular keywords were disruption, risk management, supply chain disruption, supply chain, and disruptions. During the second phase (2011-2020). It is clear that research on the concept splits up into several themes, and studies on supply chain disruption relate to concepts such as supplier selection, the COVID-19 pandemic, supply chain risk management, manufacturing, inventory management, logistics, and uncertainty. In the third phase (2021-2024), we see the continuation of some themes such as supply chain disruption, COVID-19, and supplier selection. It is quite clear that themes such as supply chain risk management, inventory management, and logistics during the recent years and after the spread of COVID-19, have been directed towards themes such as supply chain disruption.
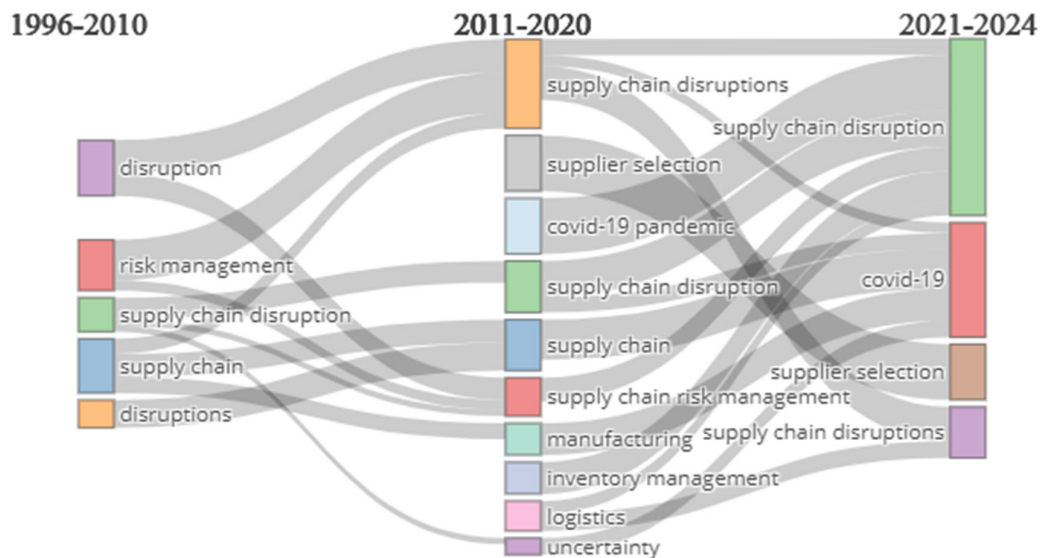

Fig. 18. Thematic evaluation

3.6.5. Co-Word and Word-Cloud analysis

The co-word or co-occurring keywords analysis is a method used to identify the principal keywords that frequently appear together in bibliographic records. This analysis helps determine the most relevant categories of analysis within a specific field of study. In the analysis, the size of the keywords represents their frequency, with larger sizes indicating higher occurrence rates (refer to Figure 19). This analysis is valuable because it allows researchers to focus on the most relevant and prominent words that emerge from the research results. In the analyzed documents, the keywords "COVID-19", and "resilience" stand out as the most frequent author keywords (as depicted in Figure 19 (a)). Additionally, keywords such as "risk management", and "COVID-19 pandemic" have made significant contributions to the literature. The keyword analysis serves a dual purpose of identifying research topics and exploring their temporal evolution. A visual representation of this

evolution can be observed in Figure 19 (b), which presents an overlay visualization of the keyword network. The color assigned to each keyword corresponds to the average year of publication (avg. pub. year). Older documents are depicted with a violet color, while more recent ones are represented by shades closer to yellow. Notably, some of the most recent keywords in the field include "COVID-19", "Sustainability", and "Supply chains." These keywords reflect the ongoing trends and contemporary issues that have become significant within the study of supply chain disruption. By analyzing the color-coded representation of keywords, researchers can gain valuable insights into the temporal development and emerging themes in the field, facilitating a deeper understanding of the research landscape.
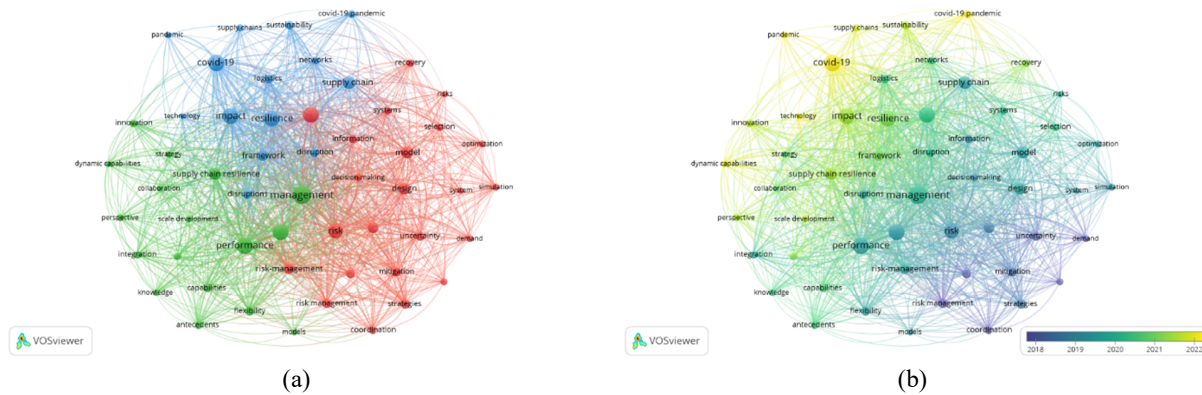

(a)   (b)

Fig. 19. Co-occurring keywords analysis (min: 30 times occurring), (a) Cluster analysis based on subjects (b) Cluster analysis based on periods

A word cloud is a visual representation of text data, where the size of each word corresponds to its frequency or importance within the given text. It provides a quick and intuitive way to analyze and understand the prominent words or themes present in a body of text. This section presents two types of word cloud images that offer valuable insights into the keywords utilized in a paper discussing supply chain disruption. The first type focuses on authors' keywords, while the second type concentrates on keywords plus. the author's keywords (as shown in Figure 19 (a)) reveal that "COVID-19", and "resilience" stand out as the most frequent author keywords. On the other hand, the keywords plus (as shown in Figure 19 (b)) reveal that "risk" and "impact" are crucial keywords in the analysis. Furthermore, methodologies such as "resilience", "framework", "risk management", "strategies", and "uncertainty" emerge as essential keywords within the field. By identifying these frequently occurring keywords and their relationships, researchers gain insights into the key topics and methodologies that are prevalent in the field of study.
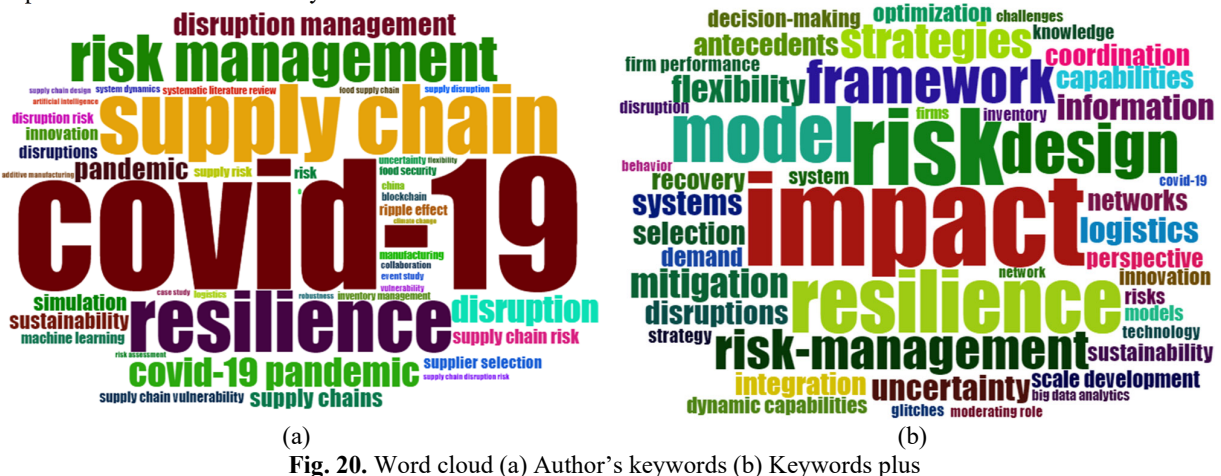

(a)   (b)

Fig. 20. Word cloud (a) Author's keywords (b) Keywords plus

Overall, the analysis of the Co-occurring and Word Clouds plots indicates that the paper focuses on the challenges posed by the COVID-19 pandemic in supply chain management. The authors emphasize the need to build resilient supply chains capable of withstanding disruptions while also considering the risks and impacts associated with such disruptions.

4. Discussion

The volume of scholarly work addressing supply chain disruptions has surged in recent years, as reflected in the bibliometric analysis conducted in this study. The heightened focus on supply chain disruptions can be attributed to the profound impacts of the COVID-19 pandemic on global supply chains, which exposed the vulnerabilities and inadequacies of existing supply chain models. These disruptions have led to significant delivery delays, decreased income and sales, and production shutdowns, underscoring the criticality of a robust and resilient supply chain architecture (Hassija et al., 2020). As highlighted by Belhadi et al. (2024), the current data-driven resilient supply chain architecture, encompassing disruption management and risk management strategies, is becoming an increasingly important concern in supply networks. The importance of

leveraging data-driven approaches and technology-integrated operations to enhance supply chain resilience, agility, and flexibility has been a predominant theme in recent literature (Nozari et al., 2022). The findings of this bibliometric analysis support this trend, revealing a growing emphasis on incorporating real-time management based on demand, inventory, and transportation data into existing supply chain models. This underscores the need for comprehensive end-to-end real-time supply chain visibility to increase supply chain agility, flexibility, and alignment (Gohil & Thakker, 2021). Furthermore, the current study suggests that businesses are increasingly looking into ways to predict and mitigate supply chain disruptions by leveraging massive amounts of data. This aligns with the findings of Blanchard (2021), who posited that supply chain disruptions create perplexing situations and delay disruption management and risk management policy arrangements. Therefore, there is a pressing need for intelligent decision-making and advanced analytics to facilitate proactive rather than reactive strategies in managing supply chain disruptions. Despite the growing body of literature on supply chain disruptions, there remain several avenues for future research. First, there is a need for more in-depth studies exploring the specific impacts of different types of disruptions, such as natural disasters, geopolitical events, and economic fluctuations, on supply chain operations. Second, further research is needed to investigate the effectiveness of different disruption management and risk management strategies, as well as technologies such as blockchain, artificial intelligence, and Internet of Things (IoT), in enhancing supply chain resilience and adaptability. Lastly, there is a need for studies examining the role of government policies and regulations in mitigating the impacts of supply chain disruptions and fostering collaboration and coordination among supply chain stakeholders.

5. Conclusions and future research directions

This review paper has conducted an extensive bibliometric analysis to explore the field of supply chain disruption management, highlighting the escalating importance of data-driven and technology-integrated strategies in addressing the intricacies and vulnerabilities of contemporary supply chains. Our analysis has spotlighted an increasing emphasis on enhancing supply chain visibility, agility, and flexibility to mitigate the adverse impacts of disruptions, including delays, elevated costs, and compromised quality, on business operations and performance. The insights gleaned from this study emphasize the imperative for organizations to adapt and modify their existing supply chain models to integrate real-time management strategies based on demand, inventory, and transportation data. Furthermore, the study has identified emerging research patterns and key contributors in the field, providing valuable guidance and informing future research initiatives. While this study contributes significantly to the existing body of knowledge by offering a detailed summary of current trends, key authors, and emerging research patterns in supply chain disruption management, it is not without limitations. The bibliometric analysis is contingent upon the quality and comprehensiveness of the data extracted from the Web of Science, and the findings may be influenced by the selection criteria and search terms employed. Looking ahead, future research endeavors should continue to explore innovative approaches and solutions to further bolster the resilience and responsiveness of supply chains in the face of evolving disruptions and uncertainties. This paper lays the groundwork for future research initiatives and provides valuable insights to guide businesses in developing robust and resilient supply chain strategies to navigate the challenges posed by disruptions effectively.

However, there remains a need for further research to address the complex and multifaceted nature of supply chain disruptions and to develop effective disruption management and risk management strategies and solutions to mitigate their impacts.

Future research directions may include:
1. Advanced Predictive Analytics: Investigating the potential of advanced predictive analytics and machine learning algorithms in forecasting and mitigating supply chain disruptions more effectively.
2. Integration of Blockchain Technology: Exploring the integration of blockchain technology to enhance transparency, traceability, and trust in supply chain operations, thereby reducing the risks associated with disruptions.
3. Resilience and Adaptability: Conducting empirical studies to evaluate the resilience and adaptability of different supply chain models and strategies in response to various types of disruptions, including natural disasters, geopolitical events, and pandemics.

By addressing these research directions, future studies can contribute to the development of innovative and effective strategies to enhance the resilience, responsiveness, and sustainability of supply chains, ultimately aiding organizations in navigating the challenges and uncertainties posed by disruptions in today's globalized economy.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used OpenAI's tool Chat GPT in order to edit and write some parts of the paper. After using this service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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