

Big data analytics in supply chain management: Uncovering emerging trends through a bibliometric network analysis and a systematic literature review

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Abstract

Purpose: This study aims to investigate the intersection of supply chain management (SCM) and big data analytics (BDA) through a multidimensional approach incorporating bibliometric and network analysis (BNA) and systematic literature review (SLR).

Design/methodology/approach: BNA and SLR are academic research methods, each with distinct purposes and limitations. BNA manages large datasets, while SLR focuses on smaller ones for in-depth review. As of January 2023, we analysed 851 articles retrieved from the Web of Science (WoS) core collection via BNA. To mitigate against BNA's limitations, we performed an SLR of 194 articles in 2023-2024, unveiling new themes in the “BDA in SCM” domain not apparent through BNA alone.

Findings: The findings demonstrate global collaboration patterns, highlighting China's lead in publications but lower international engagement than the USA's. BDA and the emerging discipline of supply chain resilience are closely interlinked; Industry 4.0 intertwines with sustainability and circular economy (CE) themes, and both are contributions that have been underexplored in previous reviews. Future studies will explore how BDA and other digital technologies enhance Supply Chain Ambidexterity by improving information processing in uncertain environments. Healthcare 4.0 technologies—specifically BDA, AI, and Blockchain—boost efficiency, innovation, and risk management. However, the full potential of an intelligent Food Supply Chain (iFSC) lies in the integration of AI-driven systems, Big Data Analytics (BDA), and advanced analytics — a step still in its early stages.

Originality/Value: Big data analytics in supply chain management is a rapidly evolving research domain without a review paper since 2020 and with more than 500 papers published in 2021-2022. Our novel methodology of supplementing BNA with an SLR allows us to capture newer or niche contributions in the domain of big data analytics in supply chain management. This approach sets the study apart, ensuring insights into the field's current state and future directions. Integrating quantitative (BNA) and qualitative (SLR) approaches provides a well-rounded perspective on the field.

Keywords: big data analytics, big data, supply chain analytics, supply chain management, bibliometric network analyses, systematic literature review

List of Abbreviations in Alphabetical Order

AFSC: Agri-Food Supply Chains
AI: Artificial Intelligence
BDA: Big Data Analytics
BDAC: Big Data Analytics Capabilities
BDPC: Big Data Personal Capabilities
BDTC: Big Data Technological Capabilities
BI: Business Intelligence
BNA: Bibliometric and Network Analysis
CE: Circular Economy
CPS: Cyber-Physical Systems
CSCM: Circular Supply Chain Management
DEP: Data Extraction Protocol
DSC: Digital Supply Chains
FSC: Food Supply Chain
GSCI: Green Supply Chain Integration
ICT: Information and Communications Technology
IDT: Information and Digital Technologies
iFSC: Intelligent Food Supply Chain
IJPE: International Journal of Production Economics
IJPR: International Journal of Production Research
IoT: Internet of Things
JCP: Journal of Cleaner Production
OLAP: Online Analytical Processing
OSCM: Operations and Supply Chain Management
PEBDA: Platform-Enabled Big Data Analytics
PSC: Pharmaceutical Supply Chain
SCI: Supply Chain Innovation
SCOR: Supply Chain Operations Reference
SCM: Supply Chain Management

SCMC: Supply Chain Management Capabilities
SCRes: Supply Chain Resilience
SLR: Systematic Literature Review
SME: Small and Medium-sized Enterprises
SSCM: Sustainable Supply Chain Management
UK: United Kingdom
US: United States
USA: United States of America
WoS: Web of Science

1 Introduction

Big data applications in organizations are expanding rapidly (Narwane et al., 2021; Patil et al., 2023; Pratap et al., 2024). In Australia, 44% of supply chain practitioners across various industry sectors have adopted Big Data Analytics (BDA), following the adoption of the Internet of Things (IoT) at 47% (Hopkins, 2021). Similarly, a study of Midwestern U.S. companies found that supply chain managers ranked BDA as the second most utilized digital technology after enterprise resource planning (ERP) software, with 50% of respondents integrating it into their supply chains (Akalın et al., 2022). This study underscored the increasing recognition of the value of large datasets in enhancing decision-making and overall supply chain performance. It highlighted the strategic importance of data as a critical organizational asset, encouraging companies to adopt digital technologies that enable data-driven decision-making and provide a competitive advantage in an increasingly dynamic business environment.

Big data analytics techniques refer to a variety of methods and approaches used to extract valuable insights and knowledge from large and complex datasets. These techniques encompass a range of processes, algorithms, and tools designed to handle the volume, velocity, variety, veracity, and value of big data. The field continues to evolve with advancements in technology and methodologies. BDA is a digital technology as well as an essential component of Industry 4.0, alongside other key components such as AI, Blockchain, Cloud Computing, and Digital Twin. Big data analytics enables the utilization of vast volumes of data to enhance efficiency and productivity, as well as increase flexibility and agility (Ghadge et al., 2020).

Analysing large volumes of data helps make informed decisions, optimize processes, and identify areas for improvement. In the current digital era, supply chains are becoming increasingly networked and generating vast amounts of real-time big data. Real-time analytics in SCM represents a novel and promising paradigm. Unlike conventional online analytical processing (OLAP)-based business intelligence (BI), real-time analytics involves direct transactional data analysis, offering a dynamic and immediate perspective. This innovative approach holds considerable potential to transform supply chain management (SCM) practices by providing timely insights derived from granular, transactional data rather than aggregated information. The shift towards real-time analytics opens up new avenues for enhanced decision-making, responsiveness, and overall optimization within the SCM domain. This advancement is made possible by using in-memory database technology (Hahn and Packowski, 2015), which enables edge computing. This approach allows data to be processed closer to where it is generated, at greater speeds and volumes.

The intersection of SCM and BDA is becoming increasingly crucial for companies seeking a competitive advantage. One of the key benefits of this intersection lies in the strong link between supply chain flexibility and resilience. BDA does not directly enhance supply chain resilience, but it indirectly contributes by improving flexibility (Lee et al., 2024). This suggests that companies should focus on strengthening flexibility as a pathway to resilience, with BDA acting as a critical enabler. Investing in innovation-focused assets can further amplify BDA's benefits, enhancing adaptability and long-term resilience. In addition to enhancing operational responsiveness, BDA plays a vital role in sustainable digital supply chains by enabling environmental monitoring, supporting circular economy (CE) initiatives, and promoting green supply chain integration. Indeed, big data-driven supply chains can positively influence sustainable corporate performance, particularly among small and medium-sized enterprises

(SMEs) in emerging economies like Vietnam (Le, 2023), reinforcing BDA's transformative potential in modern supply chain strategies.

Companies are achieving significant results using BDA to improve supply chain performance and gain greater contextual intelligence (Govindan et al., 2018; Gawankar et al., 2020). The evolution of Industry 4.0, the Internet of Things (IoT), and other digital technologies has led to increased attention on BDA and related capabilities, resulting in a positive and significant impact on SCM (Dubey et al., 2019; Akbari et al., 2023).

As of January 2023, we found only two bibliometric and network analyses on BDA in SCM. "Sustainable supply chain management under big data: A bibliometric analysis," by Zhang et al. (2021a) discussed the state-of-the-art as of 2019, and "Big Data and supply chain management: a review and bibliometric analysis" by Mishra et al. (2018) reviewed papers published from 2006 to 2016.

Zhang et al. (2021a) conducted a literature review and bibliometric analysis of sustainable SCM using big data, covering the years 2012 to 2019, and analysed 777 articles. This study revealed that this interdisciplinary field has gained global popularity, with China and the U.S. being the leading contributors and Western countries exhibiting greater collaboration. The study emphasized the integration of big data into industries, including SCM, to achieve sustainability goals.

Mishra et al. (2018) employed bibliometric and network analysis techniques to analyse and compare influential works in big data and SCM. Based on this analysis, they identified and proposed six research clusters that cover various aspects of big data, including conceptualization, tools and algorithms, applications in SCM and healthcare, forecasting, and data mining. The study acknowledged that while significant attention has been given to big data and SCM, the research in this area is still in its early stages. The findings of this

investigation underscore the necessity for additional in-depth research in this field (Talwar et al., 2021). Therefore, there are many opportunities for further exploration and advancements in understanding the intersection of big data and SCM.

In our preliminary search results on BDA applied to SCM, we found that the existing bibliometric and network analysis (BNA) studies have focused on papers up to 2020. We also uncovered the following noteworthy trend: 62% of the articles in this domain were published between 2021 and 2022. This underscores the need for updated BNA and systematic literature review (SLR) research focusing on more recent studies. Our review study fills this gap and contributes to the existing body of knowledge, offering insights that align with the latest advancements and trends in the field. Therefore, we answer three research questions in this paper:

- 1) What are the current research trends, global collaboration patterns, and emerging themes at the intersection of BDA and SCM?
- 2) What contributions and gaps exist in this field, particularly concerning sustainability, Industry 4.0, and CE?
- 3) What are the emerging topics in big data-enabled supply chain management?

To answer these research questions, this study conducts a bibliometric analysis in conjunction with a network analysis, coupled with a systematic literature review. It highlights the impacts of applying BDA to SCM by providing an up-to-date review of the most recent literature since 2010. Such a review is crucial due to the growing significance of BDA applications and research in SCM. A comprehensive understanding of the current state-of-the-art is facilitated through bibliometric analysis, providing a holistic view of scholarly contributions. Coupled with network analysis, bibliometric tools illuminate research clusters and employ analytical techniques such as citation analysis, co-citation analysis, and co-occurrence analysis. These

methods enable the identification of thematic clusters and, through the visualizations of the bibliometric network, contribute to formulating a roadmap for future research (Feng et al., 2017). However, while valuable, bibliometric and network analysis has limitations. It prioritizes highly cited publications, potentially overlooking less cited or newer contributions that may be equally significant. This bias can exclude recent publications addressing niche topics or emerging areas that have yet to accumulate substantial citations (Donthu et al., 2021). To address this limitation, our study adopts a multi-faceted approach, supplementing bibliometric and network analyses of articles published up to the end of 2022 with an SLR of articles published in 2023-2024 to discover nascent themes and topics related to "big data analytics in supply chain management".

The contributions of this paper are threefold. First, our research's theoretical contribution expands the understanding of the BDA-SCM intersection, particularly regarding supply chain resilience, Industry 4.0, sustainability, and the circular economy.

Second, our paper's practical contribution focuses on identifying future research directions, highlighting underexplored areas with real-world relevance for enhancing digital supply chains, supported by evidence from the latest studies published in 2023–2024. These new areas are specifically,

- a) Platform-Enabled BDA and its Impact on SCM,
- b) Social capital (both internal and external) influences on Circular Supply Chain Management (CSCM),
- c) BDA in Supply Chain Ambidexterity,
- d) Intelligent Food Supply Chain (iFSC),
- e) Impact of Healthcare 4.0 technologies—specifically Big Data Analytics (BDA), Artificial Intelligence (AI), and Blockchain—on hospital supply chain processes and performance, etc.

Platform-Enabled Big Data Analytics (PEBDA) leverages cloud platforms and data lakes to collect, process, and analyse large-scale data in real-time, integrating AI and machine learning to enhance visibility, efficiency, and decision-making in SCM. Tools like SAP Integrated Business Planning demonstrate its practical application (Antwi & Avickson, 2024). Social capital, both internal (within firms) and external (with suppliers, customers, and partners), has a positive influence on CSCM, which in turn supports sustainable performance (Zhou et al., 2024). Big Data Analytics Capabilities (BDAC) strengthen the impact of external social capital on CSCM but have minimal impact on the role of internal social capital. In sum, digital capabilities and external collaboration are critical for advancing sustainability.

Future research is likely to explore how BDA, in combination with other digital technologies, supports Supply Chain Ambidexterity—balancing the exploitation of current capabilities with the exploration of new innovations, enabling supply chains to remain both efficient and adaptable. In Food Supply Chains (FSC), this may involve optimizing logistics with BDA while adopting blockchain and AI for enhanced traceability (Xu & Wang, 2024; Mehdikhani et al., 2024). Although blockchain and IoT are gaining traction, the full potential of intelligent FSCs lies in integrating advanced analytics into enterprise resource planning systems, a process that is still in development (Sharma et al., 2024). Similarly, in Healthcare 4.0, digital technologies, specifically BDA, AI, and Blockchain, enhance efficiency, innovation, and risk management, with tailored strategies critical to organizational success (Saha & Rathore, 2024).

Third, this paper highlights its methodological contribution by introducing a novel integration of BNA and SLR, providing a balanced and comprehensive perspective that captures both overarching trends and specialized insights. To the best of our knowledge, **this is the first study to combine BNA with SLR in the domain of big data applications in supply chain management, offering a more comprehensive and nuanced understanding of big data analytics in SCM for the past 15 years.**

Section 2 outlines the research methodology and presents descriptive statistics, including the most active journals publishing BDA-SCM articles as of January 1, 2023. Section 3 presents the bibliometric analysis results. Section 4 demonstrates the network analysis of co-authors, words, and citations. Section 5 on SLR results elucidates the emerging topics at the intersection of big data analytics, supply chain management, and sustainability and provides a critical discussion of trending research fields. Finally, Section 6 concludes the paper by highlighting its theoretical contributions and providing managerial implications with future research directions.

2 Research methodology and descriptive statistics

BNA and SLRs are methods used in academic research to analyse existing literature, but they have distinct purposes, methodologies, and focuses. BNA is used when the dataset is too large for in-depth review, whereas SLRs use a dataset that is small and manageable enough for in-depth review.

BNA was performed for the 851¹ articles published as of January 1, 2023, retrieved from the Web of Science (WoS). To mitigate the limitations of BNA, we complemented it with an SLR of 194² articles published in 2023-2024. By conducting an SLR, new and evolving themes in the "big data in supply chain management" domain that might not be apparent through bibliometric and network analysis alone are uncovered. Integrating quantitative (BNA) and qualitative (SLR) approaches provides a well-rounded perspective on the field's current state and future directions.

¹ A full list of papers with full reference information will be available from the authors upon request

² A full list of 194 papers with full reference information will be available from the authors upon request

Data collection

We searched articles published in journals indexed in the WoS core collection based on keywords that can be categorized into two groups: 1) big data analytics, big data business analytics, big data supply chain analytics, business analytics, and big data; 2) supply chain, supply chain management, and the acronym SCM. These terms were searched using the database's title, abstract, author keyword, and keyword plus fields. The logical operator “OR” connected the terms within each group, and the logical operator “AND” connected the groups within each field. Finally, the fields were connected by “OR”. Table 1 shows this search query.

Table 1. Search query

((((TI=((“Big Data Analytics” OR “Big Data Business Analytics” OR “Big Data Supply Chain Analytics” OR “Business Analytics” OR “big data”) AND (“Supply chain” OR “Supply chain management” OR SCM))) OR AB=((“Big Data Analytics” OR “Big Data Business Analytics” OR “Big Data Supply Chain Analytics” OR “Business Analytics” OR “big data”) AND (“Supply chain” OR “Supply chain management” OR SCM))) OR AK=((“Big Data Analytics” OR “Big Data Business Analytics” OR “Big Data Supply Chain Analytics” OR “Business Analytics” OR “big data”) AND (“Supply chain” OR “Supply chain management” OR SCM))) OR KP=((“Big Data Analytics” OR “Big Data Business Analytics” OR “Big Data Supply Chain Analytics” OR “Business Analytics” OR “big data”) AND (“Supply chain” OR “Supply chain management” OR SCM)))

The field tags: TI=Title, AB=Abstract, AK=Author Keyword, KP=Keyword Plus

The beginning of publication years was unrestricted as the topic is relatively new. This decision was justified as the search results indicated that the earliest article was published in 2010 (Trkman et al., 2010).

2.1 Search results

The search query yielded 1482 results published as of January 2023. Four of these manuscripts, not published in English, were excluded. Additionally, after excluding 264 more manuscripts categorized as book chapters, proceedings papers, or editorial materials, we were left with 1214 articles. We then carefully examined the titles, abstracts, and introduction sections of these

remaining articles and screened out articles with irrelevant or unclear topics or those falling outside the study's scope. After this refinement, 851 articles remained.

We used the WoS portal's export feature, saved the records, and cited references of the final list of articles. We exported the data in two file formats. The first was a plain text file that BibExcel and VOSviewer (the visualization of similarities viewer for network analysis) software could analyse. The second format was an Excel file used for the spreadsheet analysis.

2.3 Descriptive analysis

We used a Microsoft Excel spreadsheet and BibExcel toolbox to analyse and illustrate the frequency of the articles in terms of publication year, journal, paper type, WoS category, research area, index, author, affiliation of the author (such as country and institution), keyword, title word, and citation time.

Among the 851 articles, the earliest publication was "The Impact of Business Analytics on Supply Chain Performance" by Trkman et al. (2010), published in the *Journal of Decision Support Systems*. Two articles were published in 2012, and three articles were published in 2013. As seen in Figure 1, there was an increasing trend of articles published on BDA-SCM between 2010 and 2022. The most significant jump was from 2020 to 2021. The number of articles published in 2021 increased by over 100% from 2020. There were similar increases between 2016 and 2018, though the base number from 2016 was much lower than the number of articles published in 2020. About 62% of the articles were published between 2021 and 2022.

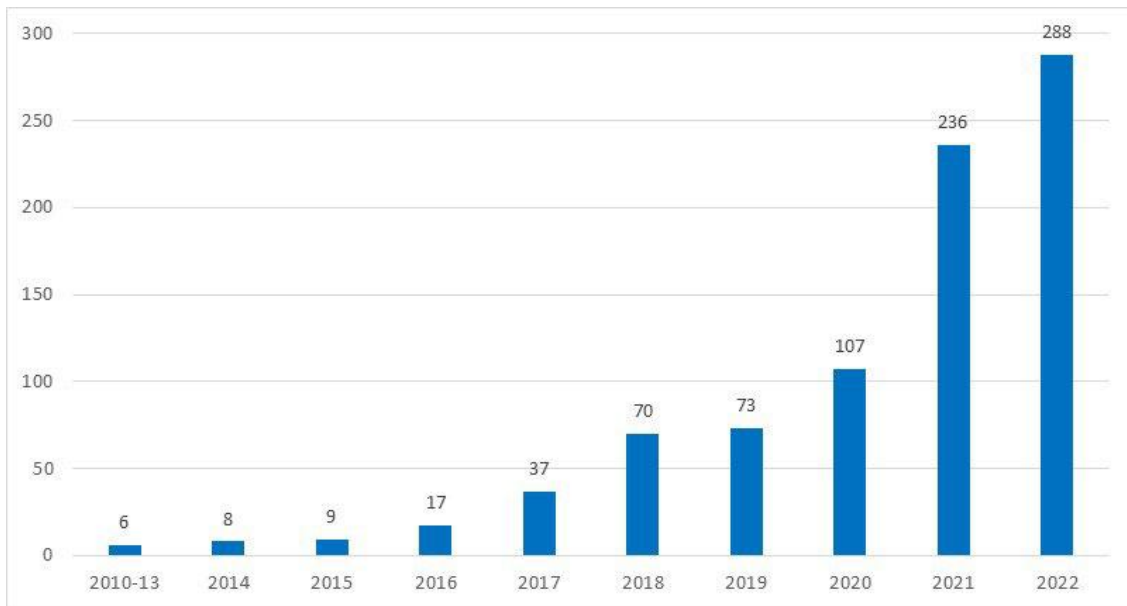


Figure 1. Frequency of articles published between 2010-2022

The 851 articles on the final list were published in 295 different journals. About 32% of these articles (269) were published in 10 journals, each of which published at least 15 BDA-SCM articles, as illustrated in Figure 2. As can be seen in Figure 2, the top journal publishing BDA-SCM articles (61 articles) is *Sustainability*, which is a category Quartile Q2 journal with an impact factor of 3.9 (in 2022) and indexed in SCIE and SSCI. It is followed by the *Annals of Operations Research* (39 articles), with an impact factor of 4.8 (in 2022), the *Journal of Cleaner Production* (JCP; 29 articles), with an impact factor of 11.1 (in 2022), and *Computers and Industrial Engineering* (25 articles), with an impact factor of 7.9 (in 2022). Among the most active journals, all are high-impact Quartile Q1 journals and indexed in SCIE except *Sustainability*.

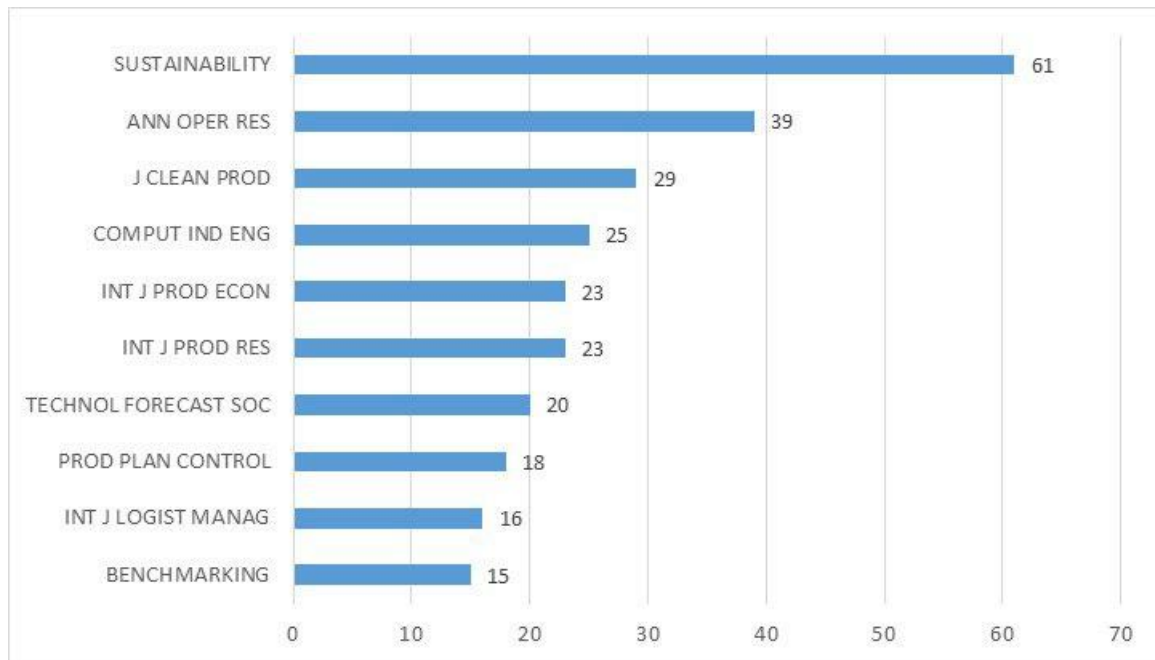


Figure 2. Most active journals publishing BDA-SCM articles

When we examined the publications in these journals by year, we found the results depicted in Figure 3.

Journal name	2010-16	2017	2018	2019	2020	2021	2022	Total
<i>Sustainability</i>		2	1	3	7	24	24	61
<i>Annals of Operational Research</i>			10	3	3	11	12	39
<i>Journal of Cleaner Production</i>		4	5	4	6	4	6	29
<i>Computers & Industrial Engineering</i>	4		3	3	2	4	9	25
<i>Int. Journal of Production Research</i>	1	3	1	2	3	10	3	23
<i>Int. Journal of Production Economics</i>	4	1		1	7	2	8	23
<i>Technological Forecasting & Soc. Change</i>			1	2		11	6	20
<i>Production Planning & Control</i>	1	5			4	5	3	18
<i>Int. Journal of Logistics Management</i>			8		1	3	4	16
<i>Benchmarking</i>		1	1	2	4	3	4	15

Figure 3. Number of publications in most active journals by year

Among the most active journals by year, there were no articles published until 2017 for quite a few of them. *Sustainability* was one of the journals with no publications before 2017; however, the number of articles in this journal tripled from 2020 to 2021. *Annals of Operations Research* secured the second position with a special issue published in 2018 (Wamba et al., 2018) and 11 and 12 articles on BDA in SCM-related topics in 2021 and 2022, respectively.

The *JCP* had a steady number of publications, around five per year from 2017 until 2022, and ranked third among the most active journals by year.

We classified the articles based on their WoS category and research area. The most popular WoS categories and research areas are illustrated in Figure 4. The top WoS categories are management, operations research, and management science, followed by industrial engineering. In contrast, the top research area categories are business and economics, engineering, and computer science.

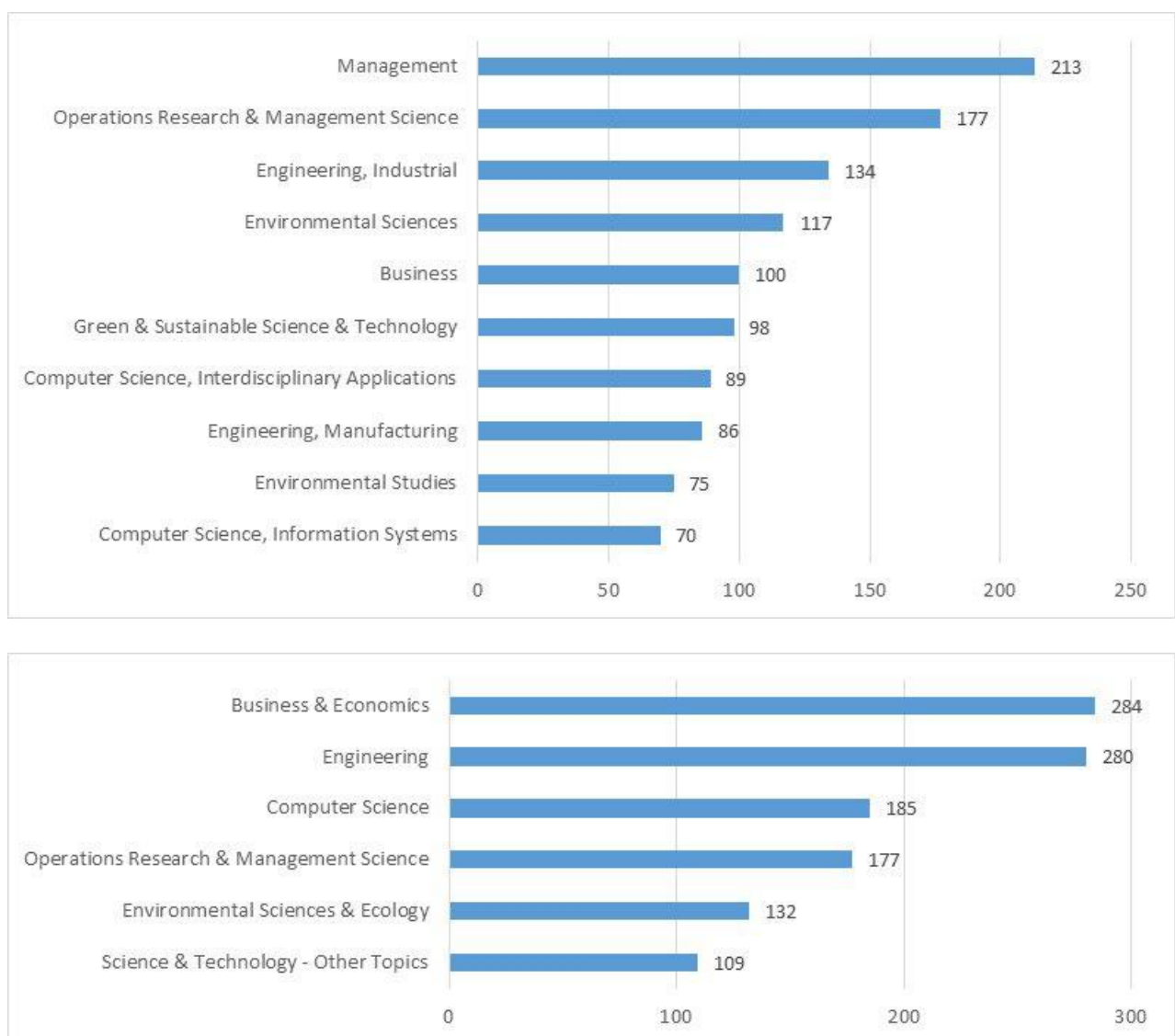


Figure 4. Top WoS Categories (*above*) and Top Research Areas (*below*)

3 Bibliometric analysis

Bibliometric analysis employs a quantitative approach to systematically incorporate all relevant studies within a specific research field (Eghtesadifard and Jozan, 2022). Bibliometric analysis interprets the cumulative scientific knowledge. Large volumes of unstructured data summarize a field's bibliometric and intellectual structure by analysing the social and structural relationships between different research constituents (e.g., author, country, institution, topic) (Donthu et al., 2021).

In this study, BibExcel was utilized as a tool for bibliometric analysis due to its extensive capabilities for retrieving, extracting, and analysing data from citation databases such as the WoS. This tool helps identify patterns and trends in scholarly literature, such as the most cited authors or journals in a particular field. Additionally, VOSviewer was employed to generate visual representations of the analysed bibliometric data. It can be used to create maps that show the relationships between different authors, institutions, or keywords in a particular field of study. By combining these two tools, researchers can gain a deeper understanding of the scholarly landscape in their field of study. They can use the data retrieved through BibExcel to perform bibliometric analysis and then use VOSviewer to create visual representations of this data that can be easily understood and interpreted to visualize the evolution of a research field over time.

3.1 Author influence

According to our findings, 1925 unique authors contributed to the BDA-SCM field. There were 2943 authorships in 851 articles. Table 2 shows the frequency of the number of authors per article.

Figure 5 shows the researchers who published ten or more articles in the BDA-SCM field. Angappa Gunasekaran is the top researcher by the number of published articles, with 21; Ankush Kumar and Pan Liu follow with 13 and 12 articles, respectively.

Table 2. Frequency of the number of authors per article

# of authors	Frequency
1	79
2	186
3	190
4	205
5	102
6	55
7	19
8	10
9	2
10	2
11	1

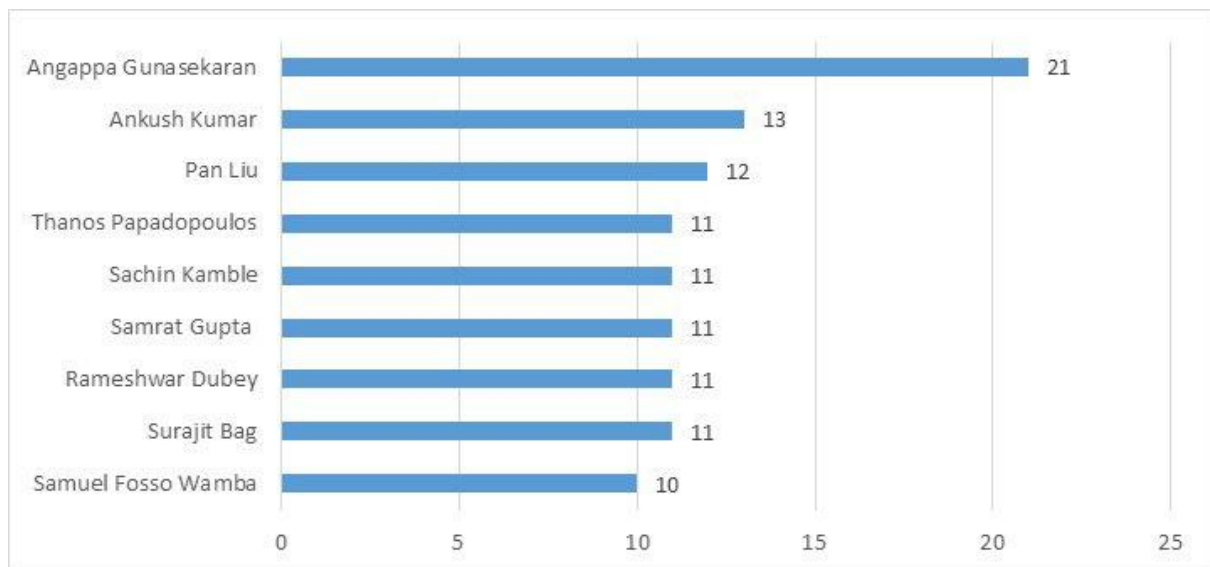


Figure 5. Top researchers by number of published articles

3.2 Affiliation statistics

We analysed the authors' affiliations and revealed the statistics for institutions and countries. The frequency of the number of institutions per article is shown in Table 3. As given in Table 2, 79 articles were published by one author. For an additional 211 articles, the co-authors are affiliated with one institution, bringing the frequency of the number of institutions per paper to

290 for papers coming from a single institution in Table 3. Authors from different institutions published the remaining 561 articles. The latter statistic highlights the importance of institutional cooperation.

Table 3. Frequency of the number of institutions per article

Number of institutions per paper	Frequency
1	290
2	246
3	148
4	80
5	55
6	20
7	8
8	2
9	1
10	1
Total	851

Table 4 provides information on the institutions with the most publications. Hong Kong Polytechnic University, the University of Kent, the NEOMA Business School, and Montpellier Business School are the top contributors to the research area of big data in SCM, and the last three have a high collaboration rate of 100% with other institutions.

Table 4. Information on institutions with the most publications

Institution	Total publications	Number of cooperations	Cooperation rate	Country
1 Hong Kong Polytechnic Univ.	28	22	78.57%	China
2 University of Kent	17	17	100.00%	UK
3 NEOMA Business School	16	16	100.00%	France
4 Montpellier Business School	15	15	100.00%	France
5 Indian Inst. of Tech. Delhi	14	9	64.29%	India
6 University of Johannesburg	13	9	69.23%	S. Africa
7 National Inst. of Ind. Eng.	13	11	84.62%	India
8 Henan Agricultural University	12	5	41.67%	China
9 University of Wollongong	11	10	90.91%	Australia
10 Cal. State Univ. Bakersfield	10	10	100.00%	US

Almost all of these institutions mentioned have a high cooperation rate, indicating a willingness to collaborate and share knowledge within the research community. The only exception is Henan Agriculture University from China, which has a lower cooperation rate. It might be worth investigating why this is the case and if any barriers exist that prevent collaboration.

Table 5 shows the frequency of the number of countries per article. In addition to the 79 articles published by one author, 432 articles have co-authors affiliated with one country. The remaining 340 articles were published by co-authors from more than one country. The latter statistic highlights the existence of networks conducive to international cooperation.

Table 5. Frequency of the number of countries per article

Number of countries per paper	Frequency
1	511
2	202
3	83
4	37
5	12
6	6
Total	851

Based on Table 6, China has the highest number of publications in the given area, followed by the U.S>. However, it is also evident that the level of international cooperation in China-based papers is lower than in US-based papers. This may suggest that China relies more on domestic research in this area while the U.S. is more engaged in international collaboration. Nevertheless, U.S. international cooperation is much lower than in France, Australia, and the UK. Moreover, the lower level of international cooperation observed in Germany, Italy, and Iran also implies that these countries may rely more on their domestic research efforts. On the other hand, France, Australia, and the UK have higher levels of international cooperation, indicating that these countries may be more engaged in collaborative research. It is essential to note that the analysis is limited to publications in English, and this may only reflect part of the research output of a specific country. Additionally, it is essential to consider other factors that

may affect a country's research output, such as funding availability, infrastructure, and scientific culture.

Table 6. Information on countries exhibiting the most international cooperation

	Country	Total publication	Number of articles with international cooperation	International cooperation rate
1	China	249	102	40.96%
2	USA	143	85	59.44%
3	UK	138	111	80.43%
4	India	119	72	60.50%
5	France	74	65	87.84%
6	Italy	47	23	48.94%
7	Germany	42	21	50.00%
8	Australia	39	32	82.05%
9	Iran	30	17	56.67%
10	Taiwan	28	21	75.00%

3.3 *Keyword analysis*

We conducted a keyword analysis to find the most frequently used keywords in the selected 851 articles. Table 7 shows the keywords that have a frequency of at least 15.

Table 7. Most frequently used keywords

Keywords	Frequency	Keywords	Frequency
Big Data	212	Machine Learning	38
Industry 4.0	178	Logistics	34
Supply Chain Management	115	Systematic Literature Rev.	29
Big Data Analytics	110	Business Analytics	26
Supply Chain	75	Literature Review	26
Internet of Things	67	Bibliometric Analysis	20
Sustainability	64	Data Analytics	20
Artificial Intelligence	53	Digitalization	20
Circular Economy	47	Supply Chain Resilience	19
Blockchain	46	Digital Transformation	17

As expected, big data is the most frequently used keyword, followed by Industry 4.0. Though there is no unique and concise definition of Industry 4.0, it is not surprising that it is the second most used keyword since Industry 4.0 covers a variety of digital technologies, with big data being a significant component. Since we are investigating big data in SCM, it is unsurprising

to find that "supply chain management" is the third most used keyword in the investigation of big data in SCM.

3.4 Citation analysis

We conducted citation analyses to derive the number of citations of each article by publications indexed in the WoS core collection. Then, we computed the adjusted time cited (average number of citations per year). The top three highly cited literature review articles and research papers are given in Table 8.

Table 8. Most highly cited articles

	Literature Review	Times Cited	Average
1	Oztemel and Gursev, 2020	619	206.33
2	Zhong et al., 2017	1083	180.5
3	Wolfert et al., 2017	944	157.33
	Research Paper	Times Cited	Average
1	Ivanov et al., 2019	601	150.25
2	Fragapane et al., 2022	140	140
3	Belhadi et al., 2021	255	127.5

Oztemel and Gursev (2020) reviewed Industry 4.0 and related technologies in the context of manufacturing and supply chain management. They highlighted the growing emphasis on cyber-physical systems, cloud systems, machine-to-machine communication, smart factories, augmented reality, data mining, and intelligent robotics. Zhong et al. (2017) prepared the second most highly cited article examining technologies such as BDA, IoT, cyber-physical systems (CPSs), cloud computing, and information and communications technology (ICT), which are employed to facilitate intelligent manufacturing. Subsequently, the authors gave details of global trends in intelligent manufacturing, encompassing strategic initiatives from various countries and major international corporations. Lastly, they discussed existing challenges and proposed avenues for future research. An avenue for future research involves exploring the concept of "human-in-the-loop" machine learning, facilitating efficient

interaction between humans and decision-making models. This approach utilizes data-enabled machine learning mechanisms to incorporate human domain expertise or knowledge, enhancing collaboration. For instance, traditional machine learning systems or algorithms can be augmented with human insights, thereby leveraging real-world sensing systems to enhance interactions and communication between humans and machines. The third most highly cited paper by Wolfert et al. (2017) is another review paper where the big data application in smart farming was analysed. The authors proposed that big data applications would impact the entire food supply chain and change the roles and power relationships among the different actors in this network. They highlighted that the fundamental challenges that should be analysed in the future are the critical issues related to data ownership, data quality, sustainable integration of big data sources, business models that provide a fair share among the shareholders, and openness of the platforms.

After determining the number of times each article was cited, the authors of the articles were matched with the articles to compute how many times each author was cited in both sources. The most highly cited authors with the most citations by publications indexed on WoS core collection are given in Table 9. Gunasekaran is the top researcher with 21 articles (see also Figure 5) cited 4021 times, followed by Dubey with 11 articles cited 2075 times, and Papadopoulos with 11 articles cited 1984 times.

Table 9. Most highly cited authors (WoS core collection)

	Author	Times Cited
1	Gunasekaran A	4021
2	Dubey R	2075
3	Papadopoulos T	1984
4	Zhong RY	1865
5	Childe SJ	1628
6	Hazen BT	1498
7	Newman ST	1358
8	Klotz E	1083
9	Xu X	1083
10	Wamba SF	1041

4 Network analysis

VOSviewer allows researchers to visualize relationships between nodes in the network using various visual cues such as node colour, size, spatial distance, and link thickness. Node colour is used to group nodes that belong to the same cluster or group. Node size indicates the prominence of a particular node in the network. The spatial distance between nodes indicates the dissimilarity between them, with nodes that are closer together being more alike. Link thickness indicates the strength of the relationship between nodes, with thicker links indicating a more robust relationship. Using the VOSviewer for network analysis, one can gain insights into the relationships between authors, their affiliations, country, keywords, or co-authorship, and identify attractive clusters within nodal networks.

4.1 *Co-authorship analysis*

Co-authorship analysis can provide insights into the social interactions and relationships among authors and their impact on the development of the research field. By analysing co-authorship patterns, researchers can identify key players in a research community, the degree of collaboration among authors, and the influence of social and institutional factors on scientific productivity. Co-authorship analysis can also reveal the emergence of new research topics and the evolution of research communities over time. In addition, it can be used to track the impact of specific individuals or groups on the development of the field, as well as to identify potential collaborations and areas for future research. Overall, co-authorship analysis is a valuable tool for understanding the social dynamics of scientific research and its impact on the development of the field (Zhang et al., 2021b).

Figure 6 illustrates the co-authorship relationships among authors who published at least five articles. Of the 2943 authors, 33 qualify for this threshold. As eight of the network's qualified authors are not connected, the most extensive set of connected items consists of 25 authors.

The VOSviewer cluster analysis tool generates five clusters. In Cluster 1 (red), Gunasekaran emerges as the author who collaborates the most, frequently collaborating with Dubey and Papadopoulos. Cluster 2 (green) is led by Bag and Gupta, who show a strong partnership and cooperation. Luthra and Mangla lead Cluster 3 (blue), with Luthra having notable joint publications with Kumar. In Cluster 4 (yellow), Kamble leads and shares a robust relationship with Gunasekaran. Cluster 5 (purple) comprises authors Singh, Mishra, and Dwivedi, who have an almost equal impact on big data in SCM research.

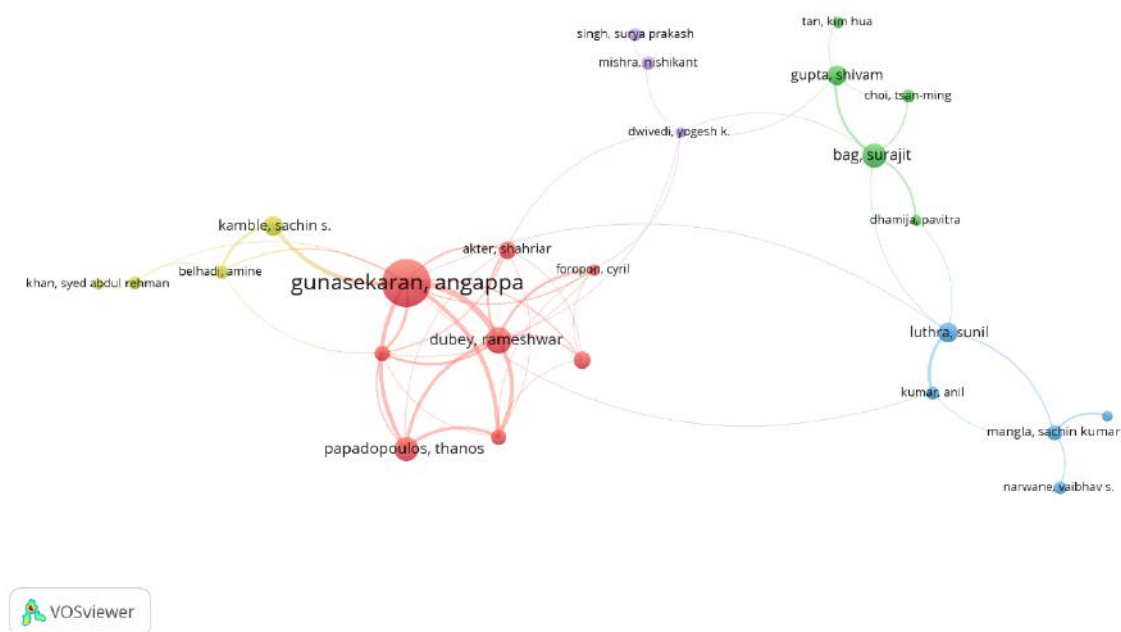


Figure 6. Cooperation network between authors

Figure 7 illustrates the co-authorship relationships among the affiliated institutions to at least seven articles. Of the 1173 institutions, 27 qualify for this threshold. As the two networks' qualified institutions are not connected, the most extensive set of connected items consists of 25 institutions. The VOSviewer cluster analysis tool generates five clusters. Hong Kong Polytechnic University leads Cluster 1 (red) and shows extensive cooperation within and across clusters, particularly with the University of Kent and Montpellier Business School. Cluster 2 (green) involves Neoma Business School, the University of Johannesburg, the Indian Institute

of Technology, and the University of Wollongong, which have strong partnerships within the cluster. In contrast, Neoma Business School has a particularly robust relationship with the South China University of Technology. Montpellier leads in Cluster 3 (blue) and shares a solid relationship with California State University Bakersfield in Cluster 5 (purple). Cluster 4 (yellow) comprises two institutions from the UK.

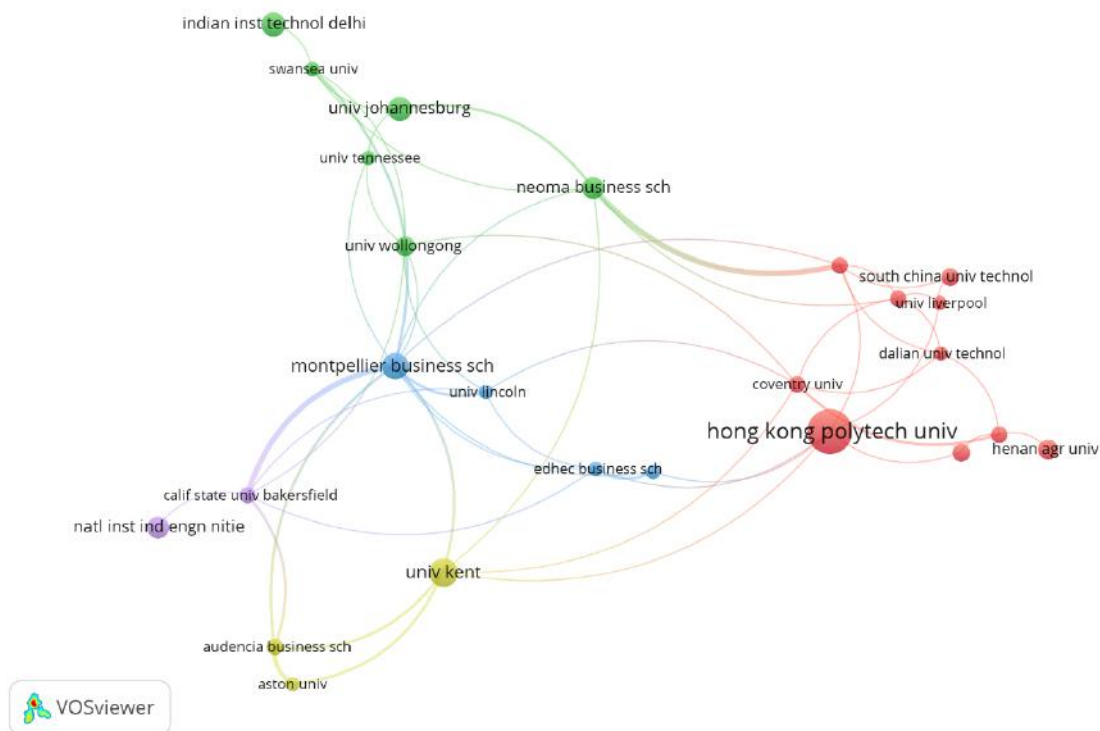


Figure 7. Cooperation network between institutions

Figure 8 illustrates the co-authorship relationships among the countries affiliated with at least ten articles. Among 83 countries, 30 qualify for this threshold. As all of the network's qualified institutions are connected, the most extensive set of connected items consists of 30 institutions. The nodal co-authorship network illustrates that most co-authorship relationships are in the People's Republic of China (PRC), followed by England, the US, India, and France. The network analysis reveals some exciting collaboration patterns regarding co-authorship relationships between countries. The VOSviewer cluster analysis tool generates five clusters.

The US leads the first cluster (red), and significant cooperation exists between the US and Germany. British authors primarily collaborate with Indian authors, followed by Australians within the second cluster (green). Authors from Italy mainly cooperate with authors from Malaysia and Pakistan (Cluster 3, blue). The fourth cluster (yellow) consists of authors from France, Brazil, and Morocco, with France having the most co-authorship relationships within this cluster. The PRC leads the fifth cluster (purple) and collaborates with authors from the Netherlands and Taiwan. Authors from the US publish jointly with British authors as well as French scholars. Overall, there is worldwide cooperation among authors.

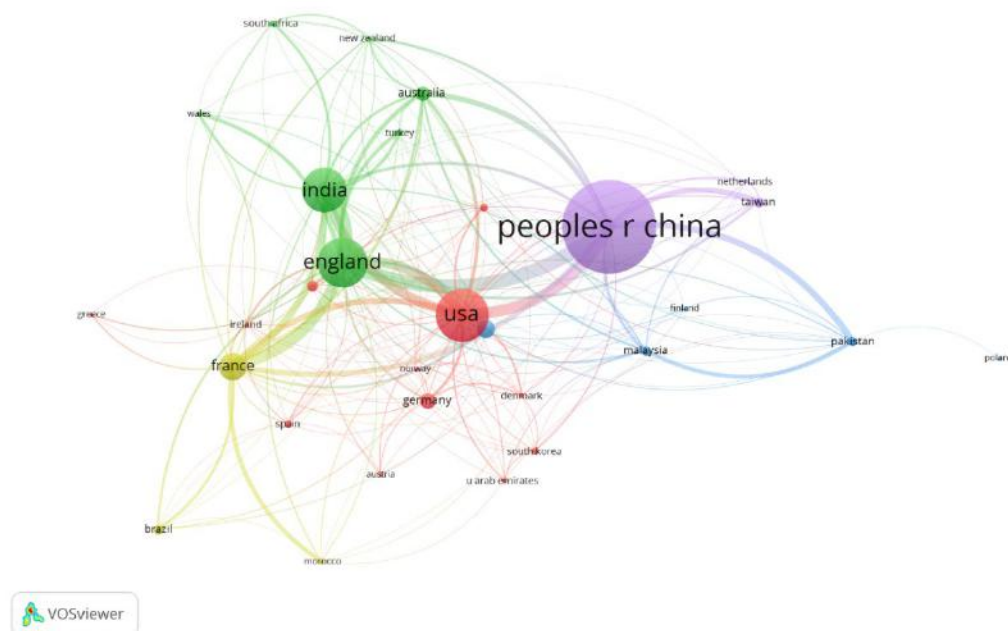


Figure 8. Cooperation network between countries

4.2 Co-word analysis

In co-word analysis, the focus is on analysing the actual content of publications rather than using citations. The unit of analysis is "words," which involves identifying and examining the relationships between words that appear together frequently within a set of documents. The words for analysis are often derived from "author keywords," which summarize the main

themes of the work. Words can also be extracted from other parts of the publication, such as titles, abstracts, or full texts. By analysing the co-occurrence patterns of words, researchers can identify thematic clusters, explore relationships between different research areas, and gain insights into the content and structure of a field of study. Co-word analysis provides a way to understand the underlying themes and concepts in the analysed documents. (Donthu et al., 2021).

Figure 9 illustrates the co-occurrence of the author keywords that exist at least 13 times. Of the 2296 keywords, 25 qualify for this threshold. We excluded literature reviews, systematic literature reviews, and bibliometric analyses from further consideration. The VOSviewer cluster analysis tool generates four clusters for the remaining 22 terms. The majority of the authors use big data as a keyword. Big data co-appears with supply chain and supply chain management; most of the time, more authors use supply chain management than supply chain. Industry 4.0 is the second most used keyword, and as expected, it appears quite a few times with big data. As we know, Industry 4.0 covers a variety of digital technologies, and among these, big data is an essential component. These findings reinforce Table 7; however, they illustrate additional relationships. Big data analytics and the emerging discipline of supply chain resilience are closely interlinked. Articles about Industry 4.0 are often associated with the topics of sustainability and circular economy. Therefore, there is a connection between Industry 4.0 initiatives and considerations of social, environmental, and economic sustainability and circular economy principles.

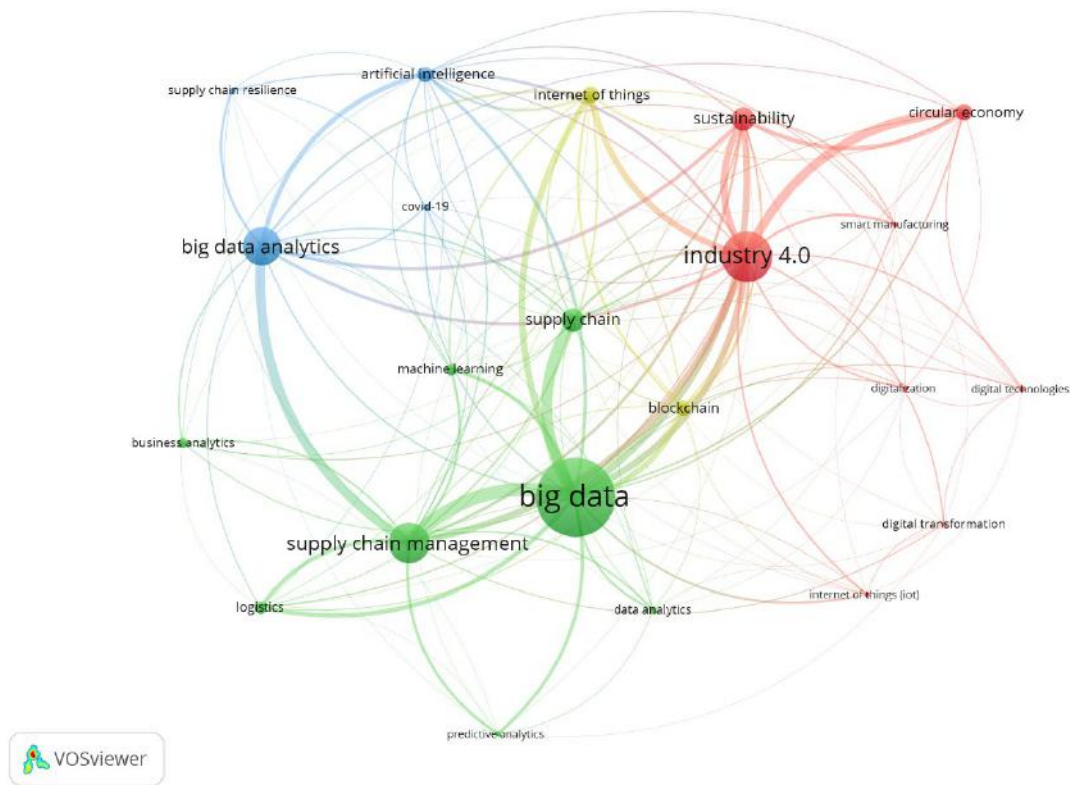


Figure 9. Co-occurrence of keywords

4.3 Co-citation analysis

Co-citation analysis relies on the assumption that publications frequently cited together are likely to be thematically similar or related. This method helps identify connections and patterns among scientific articles by analysing citation patterns. The basic premise is that if many other articles cite two articles together, this suggests they share similar concepts, ideas, or research topics. Co-citation analysis is valuable for various purposes, including identifying influential publications, mapping research fronts, detecting emerging trends, and exploring the intellectual structure of a scientific field. It gives researchers insights into the relationships and associations among research articles, authors, and research areas based on co-citation patterns (Donthu et al., 2021).

Figure 10 illustrates the co-citation relationships among articles cited together at least 70 times. Fifteen articles qualify for this threshold. The VOSviewer cluster analysis tool generates two clusters.

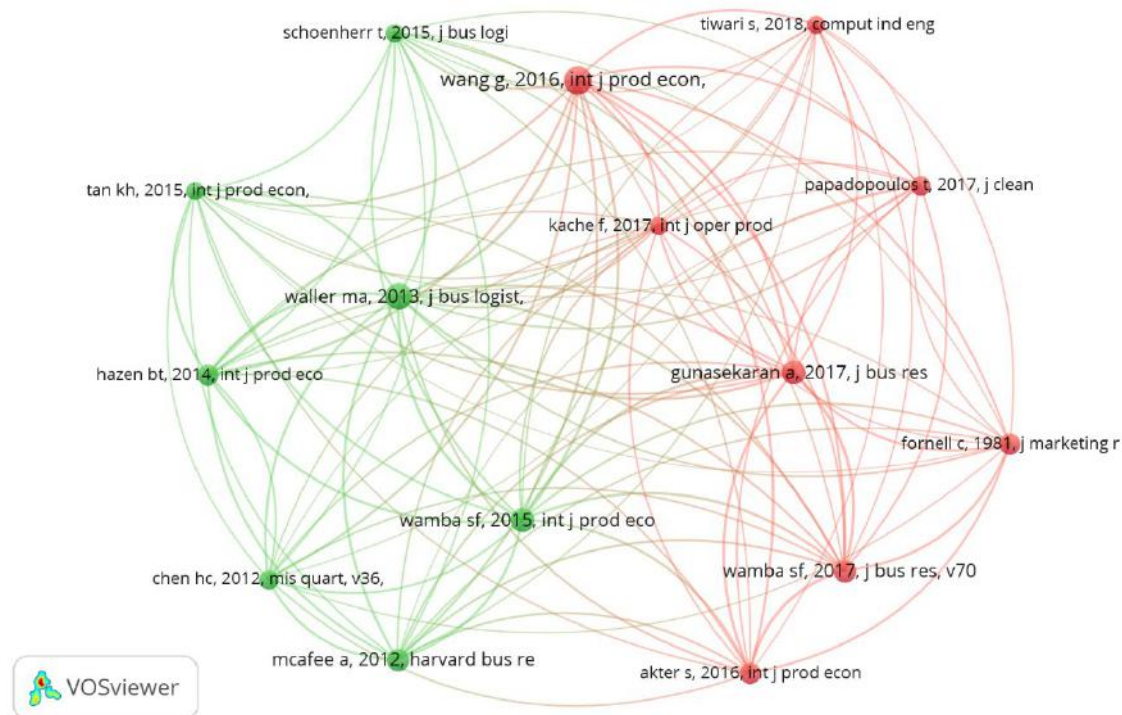


Figure 10. Co-citation of articles

Figure 11 illustrates the co-citation relationship among journals cited together at least 500 times. Twenty-two journals qualify for this threshold. The VOSviewer cluster analysis tool generates three clusters. Cluster 1's most co-cited journal is the *International Journal of Production Economics (IJPE)*. In contrast, Cluster 2's International Journal of Production Research (IJPR) and Cluster 3's JCP are the leading journals. Since this research is a bibliometric and network analysis of "big data in supply chain management," it is not surprising that these three production journals are the most co-cited.

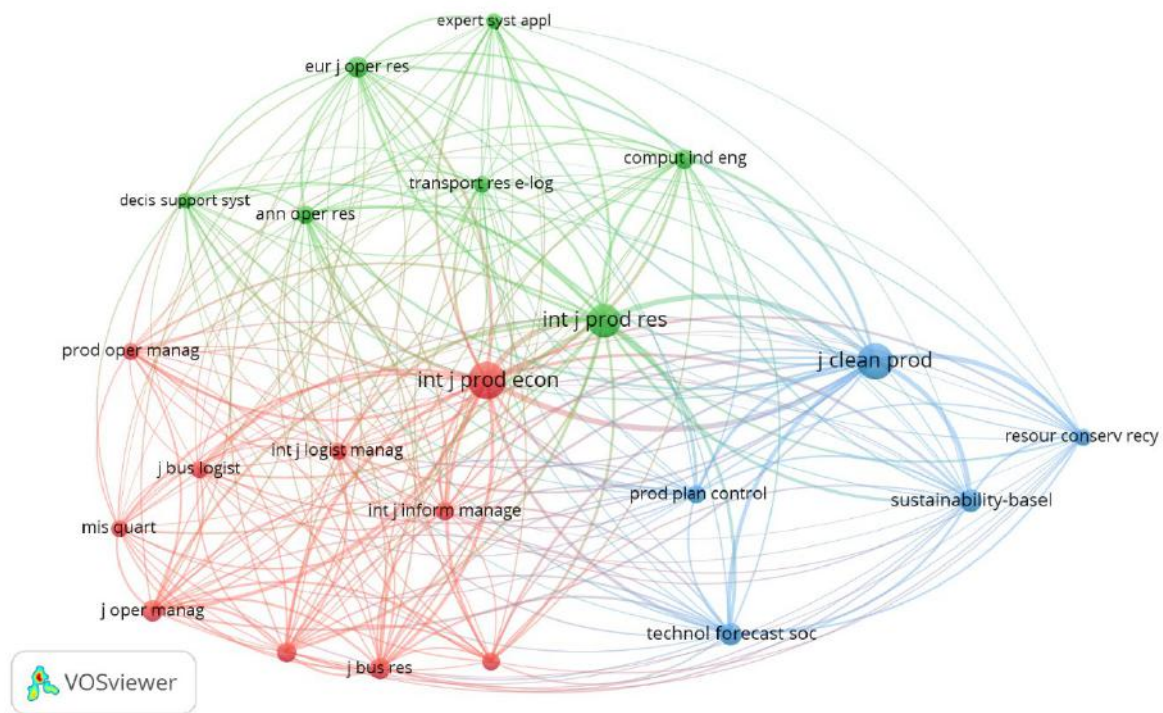


Figure 11. Co-citation of journals

Figure 12 illustrates the co-citation relationships among authors cited together at least 120 times. Twenty-one authors qualify for this threshold. The VOSviewer cluster analysis tool generates four clusters. In a co-citation network, two authors are connected if the same publication cites them. In Cluster 1 (red), the most co-cited authors are Wamba and Dubey. There is a strong relationship between Wamba and Dubey; they likely work on thematically similar or related research areas. Wamba is often co-cited with Zhong as well, the most cited author in Cluster 4 (yellow). In contrast, Dubey is mostly co-cited with Gunesakaran, followed by Hair, Mikalef, Teece, and Akter. Gunesakaran, Cluster 2 (green) 's most co-cited author, is often co-cited with Dubey and Wamba. Almost all the authors in Cluster 2 are co-cited equally, except Gunasekaran. All authors in Cluster 3 (blue) are equally co-cited except Ivanov, the most cited author in this cluster. Cluster 4 only has two authors co-cited together, Zhong and Dobrzanski. Zhong is also co-cited with Gunasekaran and Wang in Cluster 1 and Ivanoff in Cluster 2.

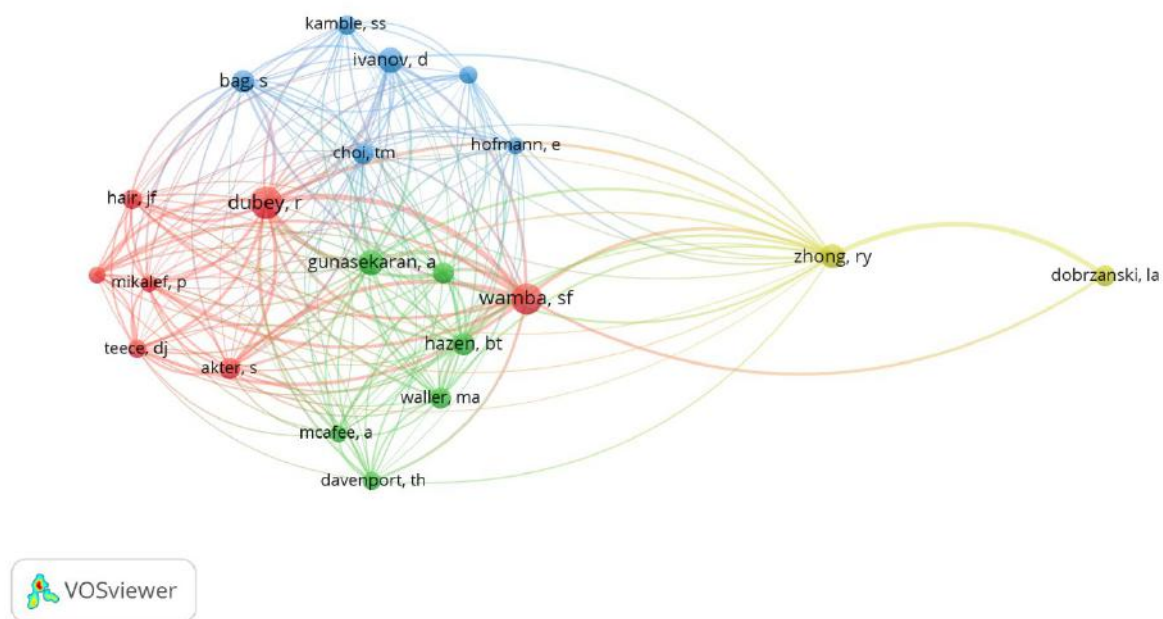


Figure 12. Co-citation of authors

5 Emerging topics in big data-enabled supply chain management

As mentioned in the introduction, bibliometric and network analyses, while valuable, have their limitations. These methods tend to prioritize highly cited publications, which can lead to the oversight of less cited or newer contributions that may be equally important. This bias often excludes recent publications that focus on niche topics or emerging areas that have not yet gathered significant citations (Donthu et al., 2021).

To mitigate the limitations of bibliometric and network analysis, we conducted an SLR of 194 articles in 2023-2024, identifying new themes in the "BDA in SCM" field that are not evident through bibliometric and network analysis alone. In this section, we explore the existing literature to identify research opportunities in supply chains enhanced by big data. We performed a thorough search in the WoS database, identifying 194 relevant articles published in 2023-2024. We utilized the search strings outlined in Table 1. The search query for publications from January 1, 2023, to December 31, 2024, returned a total of 565 results. After

removing one Turkish-language publication, the dataset was reduced to 564 manuscripts.

Further exclusions included:

- 31 conference proceedings
- 6 editorial materials
- 4 book chapters
- 2 retractions
- 1 correction
- 1 retracted publication

This resulted in a refined dataset of 519 articles. Additionally, eight articles without full-text access were excluded, leaving 511 articles.

We then carefully reviewed the titles, abstracts, and introduction sections, screening out 317 articles that were irrelevant, unclear, or beyond the study's scope. Ultimately, 194 articles were selected for analysis.

For the SLR part of the study, we used a data extraction protocol (DEP). DEP is a systematic process used in research, especially in SLRs and meta-analyses, to gather and organize data from selected studies or sources in a consistent and structured manner. It helps ensure that the information retrieved from multiple studies is relevant, reliable, and comparable.

The protocol outlines the specific steps, criteria, and formats for extracting data from the studies. It is a critical component of the research methodology. The goal is to standardize the process to minimize bias and ensure that relevant data is accurately captured for analysis.

Our DEP included **Paper Type, Research Aim, Research Question, Theoretical Background, Method, Input, Output, Result, and Contribution to Knowledge.**

The Data Extraction Protocol enables researchers to agree on the type of information to be extracted from each paper. It also allows for assessing the quality of the paper by explicitly checking the theoretical foundation, methodology, and data sources. Where it is unclear how the results are obtained in an academic paper, this approach allows us to confidently exclude that paper from the review pool. By employing DEP, this study ensures a structured and unbiased review of papers, strengthening the reliability of insights into BDA's evolving role in SCM.

5.1 BDA and supply chain responsiveness and resilience

BDA can improve supply chain responsiveness (Zheng et al., 2023). Neural networks can detect patterns in-demand data and enable flexibility and responsiveness in supply chain production facilities. Deep learning algorithms can analyse vast amounts of data to identify patterns and trends that might be difficult for humans to detect. These insights can then be used to optimize production and inventory management. One crucial area for future research to focus on is utilizing big data to enhance the performance of green supply chains (Zheng et al., 2023). There is a strong link between supply chain flexibility and supply chain resilience. Lee et al. (2024) find that while big data analytics does not directly affect supply chain resilience, it improves it through improving supply chain flexibility. From a practical perspective, the findings suggest that firms should prioritize enhancing supply chain flexibility rather than expecting BDA to directly improve resilience. Additionally, investing in innovation-focused assets can amplify the benefits of BDA, further strengthening the adaptability and resilience of supply chains.

Critical enablers influencing the adoption and implementation of artificial intelligence (AI) in production systems also play a key role in enhancing supply chain resilience (Merhi & Harfouche, 2023). Among these factors, technology outweighs organizational and

environmental considerations in driving AI adoption, with project management emerging as the most essential enabler. In our view, focusing only on one aspect of digital technology, such as AI, limits our understanding of how various digital technologies contribute to supply chain resilience. Integrating other digital technologies, like the Internet of Things, big data analytics, cloud computing, and blockchain, into the study could provide a more comprehensive view of the digital landscape's impact on supply chain resilience.

The connection between Industry 4.0 and supply chain resilience, specifically in creating a "Resilient Supply Chain 4.0.", encompasses various advanced technologies, including the Internet of Things, cyber-physical systems, augmented reality, cloud computing, the Internet of Services, big data analytics, artificial intelligence, digital twins, blockchain, industrial robotics, and additive manufacturing (Marinagi et al., 2023).

5.2 BDA and sustainability of digital supply chain

Cloud computing, artificial intelligence, big data analytics, blockchain technology, and the Internet of Things are emerging technologies relevant to improving digital supply chain sustainability from a circular economy point of view (Liu et al., 2023). A comprehensive approach is needed to address the sustainability and vulnerabilities of networked enterprises (Tamym et al., 2023). BDA can be incorporated into sustainability proposals as sustainability analytics, representing a promising research area. BDA also plays a pivotal role in sustainable digital supply chains by enabling environmental monitoring, circular economy practices, and green supply chain integration. However, adoption is hindered by challenges such as governance policies, managerial knowledge gaps, and interoperability issues.

The relationship between BDAC and green supply chain integration (GSCI), as well as the role of supply chain visibility and organizational culture, can be examined through the lens of organizational information processing theory (Shi et al., 2023). However, empirical research

needs to be conducted to understand the relationships and the effects better. Research could involve collecting data from organizations operating in various industries and analysing the relationships between BDAC, supply chain visibility, GSCI, and the moderating effects of organizational culture.

When implementing BDA in sustainable supply chain management (SSCM), several issues and challenges associated with this transition should be considered (Tambuskar et al., 2023).

A positive relationship exists between BDA and sustainable manufacturing, with green practices and environmental performance identified as critical factors facilitating this transition. Therefore, implementing BDA in SSCM can benefit the environment and society.

Social capital refers to the resources derived from networks of relationships both within a firm and with external stakeholders (Chowdhury et al., 2024). Internal social capital includes the connections among employees and departments, while external social capital involves relationships with suppliers, customers, and partners. Both types of social capital positively influence CSCM, which in turn mediates the link between social capital and a firm's sustainable performance (Zhou et al., 2024). Notably, BDAC strengthens the effect of external social capital on CSCM but does not significantly impact the relationship between internal social capital and CSCM. By combining social capital theory with the resource-based view, the study offers a more comprehensive understanding of how firms can enhance sustainability. It highlights the role of digital capabilities in boosting external collaboration to support sustainable outcomes. These findings contribute to the broader discussion on digital transformation and supply chain sustainability. They also provide practical guidance for managers aiming to use social capital and big data to improve their sustainability performance. The emphasis on external networks and digital tools underscores their strategic importance in CSCM. Overall, the study advances knowledge in both theory and practice concerning SSCM.

The field of BDA-based supply chain decarbonization is evolving, with research largely focused on specific regions (India, China) and industries (food, manufacturing). The authors contend that BDA enhances decision-making and improves decarbonization outcomes. (Kumar et al., 2023)

5.3 BDA and supply chain performance

In the relationship between BDAC and supply chain performance, supply chain innovation (SCI) plays a mediating role, and a data-driven culture's influence is a moderating factor (Al-Khatib and Ramayah, 2023). BDAC can enhance supply chain management capabilities (SCMC) by providing real-time visibility into supply chain operations, optimizing inventory management, improving demand forecasting, and enabling efficient logistics and transportation management (Riggs et al., 2023). These improvements in SCMC, in turn, can lead to reduced resource consumption, waste generation, and environmental impact, thereby promoting sustainable performance. Social sustainability should be explicitly considered in this respect since sustainable performance requires social, environmental, and economic sustainability.

Supply chain performance mediates the relationship between big data-driven supply chains and a firm's sustainable performance (Kamboj and Rana, 2023). Le (2023) found that big data-driven supply chains positively influence sustainable corporate performance. The author illustrates how a big data-driven supply chain impacts SSCM to enhance the sustainable corporate performance of small and medium-sized enterprises (SMEs) in the food value chain in an emerging economy like Vietnam.

On the other hand, SMEs face challenges in deriving value from their investments in BDA (Persaud and Zare, 2023). There is limited research available on this topic that is related explicitly to SMEs. Both the analytics culture and BDA-specific absorptive capacity play

crucial roles in amplifying the impact of technological and human capabilities on the strategic business value derived from BDA investments. Indeed, absorptive capacity plays a crucial role in maximizing the effectiveness of BDA in Purchasing and Supply Management. Companies with strong knowledge acquisition and transformation capabilities are better positioned to leverage BDA for strategic decision-making, leading to improved supply chain performance and more effective use of both new and existing knowledge sources. This strategic alignment enables firms to capitalize on data-driven insights, enhancing long-term procurement strategies and overall supply chain efficiency (Patrucco et al., 2023). Jum'a et al. (2023) contend that big data personal capabilities (BDPC) have a significant impact on supply chain innovation capabilities. Findings also illustrate that supply chain innovation capabilities are the most influential predictor of sustainable supply performance. Surprisingly, big data technological capabilities (BDTC) have had no significant effect on supply chain innovation capabilities.

5.4 BDA and SCM in healthcare management

Bag et al. (2023) conducted an empirical study examining the impact of a collaborative platform powered by BDA and AI technologies on the absorptive capacity of healthcare supply chain management. The researchers analysed various factors contributing to developing and implementing a BDA and AI collaborative platform in healthcare supply chain management. They also analysed the impact of BDA and AI-powered absorptive capacity on various healthcare outcomes, including patient satisfaction, quality of care, and operational efficiency.

Ziaee et al. (2023) explored the application of BDA in the pharmaceutical supply chain (PSC) from the perspective of the Information Processing View theory. The objective was to enhance business intelligence in the PSC using BDA. The researchers employed the Supply Chain Operations Reference (SCOR) model to identify and discuss the potential benefits of adopting BDA in five key processes: plan, source, make, deliver, and return. Overall, the study

emphasized the potential of BDA to enhance business intelligence and resolve critical issues within the pharmaceutical supply chain. By embracing BDA capabilities, pharmaceutical companies can make informed decisions, enhance efficiency, and effectively address supply chain challenges.

Despite the extensive research on BDA across various supply chains, its application in service supply chains remains underexplored. In particular, healthcare supply chains, which account for the second-highest operational expenditures, have yet to fully harness the potential benefits offered by BDA (Hussain et al., 2024). By enhancing information processing capabilities in uncertain environments, Healthcare 4.0 technologies foster improved operational efficiency, innovation, and risk management, ultimately enhancing supply chain performance. This study provides empirical evidence to guide healthcare professionals in leveraging digital technologies and highlights the importance of tailoring digital strategies to the specific type of healthcare organization (Saha and Rathore, 2024).

Benzidia et al. (2024) investigate the role of BDAC in enhancing environmental process integration and driving green process innovation in healthcare Operations and Supply Chain Management (OSCM). It demonstrates that green process innovation mediates the relationship between BDAC and environmental performance, emphasizing that BDAC alone is insufficient to achieve sustainability goals without the support of innovative green practices (Benzidia et al., 2024).

5.5 BDA and SCM in the agriculture value chain

Kumari et al. (2023) analysed the antecedents for sustaining quality control in understudied agriculture value chains. The research focused on understanding the factors contributing to maintaining consistent and high-quality control processes in these value chains. Since the agriculture value chains are understudied, the authors contend that limited research on this topic

makes the study valuable for filling the knowledge gap. This empirical study explored how traceability, collective action, big data predictive capability, and addressing behavioural uncertainties can contribute to sustaining quality in agriculture value chains.

Several research opportunities exist for operations management researchers in the farming sector (Gupta et al., 2023). While early articles focused on operational efficiency and effectiveness through optimization techniques, recent technological developments and changing priorities have expanded the scope of farming research. The proliferation of mobile communication devices, the Internet, information technology platforms, and social media have provided new avenues for exploration.

In the FSC, ambidexterity could mean using BDA to optimize current logistics (exploitation) and investing in Blockchain or AI-driven traceability systems to innovate and ensure future transparency (exploration) (Xu and Wang, 2024; Mehdikhani et al., 2024). Industry 4.0 technologies are reshaping FSC, with Blockchain and IoT currently leading adoption. However, the full potential of an iFSC lies in the integration of AI-driven systems, BDA, and advanced analytics — a step still in its early stages (Sharma et al., 2024). The often-overlooked intermediate stage of data management — the crucial phase between data collection and data analysis — which plays a vital role in enabling effective digital transformation (Wang et al., 2024).

Barriers to adopting BDA in circular agri-food supply chains (AFSC) are technical, economic, social, environmental, and organizational (Perçin, 2023). A lack of knowledge on the senior managers' part and weaknesses in governance policies are the most significant barriers to BDA adoption (Dehkhodaei et al., 2023). The identified barriers and proposed policy measures can guide senior managers and government bodies in promoting the successful adoption of BDA, ultimately enhancing supply chain analysis and improving manufacturing processes.

Food waste is a significant global issue with economic, social, and environmental consequences (Ahmadzadeh et al., 2023). IoT and big data technologies can be applied to food waste management in the various stages of the food supply chain. The challenges associated with implementing IoT and big data technologies in the food supply chain are data privacy and security concerns, interoperability issues, and standardized protocols. The potential opportunities for future research include exploring advanced analytics techniques, integrating emerging technologies like blockchain, and developing more comprehensive sustainability metrics for evaluating food waste reduction efforts.

5.6 *New research avenues*

As can be seen from the literature review on the new research directions of BDA use in SCM, the research is clustered around resilience and responsiveness, the green supply chain, supply chain performance, healthcare management, and the agriculture value chain. After comparing and summarizing the reviewed approaches, we identified the primary research opportunities where the deployment and use of 'big data' are likely to have a significant impact on SCM.

We anticipate that future studies will explore the expanding role of BDA, in combination with other digital technologies, in achieving Supply Chain Ambidexterity—the ability to balance exploitation and exploration. This balance enables supply chains to be both efficient and flexible, meeting current demands while adapting to future changes and fostering innovation.

By enhancing real-time business intelligence, BDA enables faster decision-making, improved supply chain visibility, and better risk management. Despite its potential, BDA adoption in the Australian PSC remains limited, hindered by technological, organizational, and regulatory challenges (Ziaee et al., 2023).

While both climate-neutral and carbon-neutral supply chains aim to reduce environmental impact, climate neutrality addresses a broader range of greenhouse gases (Guntuka et al., 2024).

In contrast, carbon neutrality focuses specifically on carbon dioxide emissions. The choice between the two approaches depends on the organization's goals, priorities, and the specific environmental challenges they seek to address. BDA plays a vital role in developing climate-neutral supply chains by enabling the monitoring of greenhouse gas emissions, optimizing logistics, supporting circular economy initiatives, and ensuring supply chain transparency. It helps track and manage, reduce where possible emissions, optimize transportation routes, reduce waste, and enhance compliance with sustainability regulations. Predictive analytics and AI-driven models improve climate risk management and resilience planning, allowing businesses to anticipate disruptions and adopt sustainable strategies.

Several factors continue to hinder the full impact of BDA on supply chain operations, limiting its transformative potential (Hasan et al., 2022). The proposed framework addresses this challenge by identifying key enablers and barriers to BDA adoption, while emphasizing its capacity to enhance decision-making and operational efficiency. Grounded in Task-Technology-Fit and Institutional Theory, the framework provides a robust theoretical foundation for examining BDA's role in supply chains. It not only guides future empirical research but also highlights the strategic value of BDA in navigating the increasing volatility and competitiveness of global supply networks.

Identifying barriers to adopting BDA in SCM in different industries, especially in circular and digital supply chains, is a new research opportunity. Additionally, societal sustainability poses challenges in its assessment due to the diverse regional conditions and local cultures. Establishing a consistent standard for societal sustainability takes time and effort. Still, the rapid and secure exchange of information, facilitated by big data, can benefit both customer satisfaction and employee well-being, and can be an area for further research.

Research on how big data can be utilized to encourage a large number of people to become highly involved in SSCM can be conducted. The use of big data in training workers with

specialized skills and forming knowledge and experience in computer science and mechanics is valuable in controlling and maintaining autonomous moving vehicles and drones and should be analysed in detail. Further research should explore how Big Data can enhance SCM and customer relationship management strategies to deliver tailored sales, services, and logistics solutions. Another future research direction may be to analyse how BDA can optimize the supply chain by examining demand, inventory, procurement, transportation, and production processes.

6 Conclusions

This study accomplished four objectives. First, we provided an up-to-date overview of the existing literature in the field, incorporating the most recent studies available as of January 1, 2023. Second, we conducted a bibliometric analysis to quantitatively assess all relevant studies in the field, identifying influential authors, key institutions, and leading countries. Third, we performed a network analysis using VOSviewer to visualize relationships among researchers and institutions. We observed a global collaboration among authors (Figure 8). Our findings revealed strong collaboration between the U.S. and Germany, while British authors primarily partner with researchers from India and Australia. Academics from China collaborate closely with those from the Netherlands and Taiwan, whereas U.S. scholars frequently co-author with researchers from the United Kingdom and France. Finally, we proposed future research questions based on an in-depth systematic literature review of papers on big data analytics and supply chain management published between January 2023 and December 2024.

6.1 Theoretical Contributions

Big data analytics is context-specific and requires a tailored approach (Ali and Essien, 2025). Among technological, organizational, and environmental factors, the perceived benefits of using BDA in outbound retail logistics emerged as the strongest predictor of adoption, followed

by top management support. Environmental dynamics influence the adoption of BDA in decision-making in four distinct ways: (i) supply chain (SC) maturity and connectivity significantly affect BDA utilization, (ii) well-connected SCs enhance data accessibility and information exchange, (iii) the tangible benefits of BDA influence its adoption, and (iv) outsourcing complex analytical tasks to external experts enables firms to concentrate on core operations rather than building in-house IT infrastructure (Ali and Essien, 2025).

Articles about Industry 4.0 frequently intertwine with themes of social, environmental, and economic sustainability, as well as principles of the circular economy. This connection underscores the interplay between Industry 4.0 initiatives and conscientious considerations of principles associated with sustainability and the circular economy. To the best of our knowledge, previous bibliometric and network analyses focusing on big data in SCM have yet to discern the interconnection between Industry 4.0, sustainability, and the circular economy.

In the specified field, China leads in the number of publications, surpassing the US. However, the two countries exhibit notable differences in their levels of international collaboration. China's articles exhibit lower international cooperation than those from the US, implying that China relies more on domestic research efforts. At the same time, the US is more actively involved in international collaborative endeavours in this area.

Keywords play an essential role in characterizing the research landscape (Figure 9). In this study, the keyword “big data” emerged as the most frequently used term, strongly linked to Industry 4.0, supply chain and SCM, and machine learning, albeit with less intensity. Big data analytics and the emerging discipline of supply chain resilience are closely interlinked. Industry 4.0 followed closely, reflecting the broad scope of digital technologies encompassed by this term. Although the term Industry 4.0 lacks a unique and concise definition, its prominence in keyword usage aligns with its comprehensive coverage of various digital technologies, with big data being a significant component.

Regarding journal co-citations, the *IJPE* emerges as the most co-cited journal, indicating its central role in the academic discourse on big data in SCM. Additionally, the *IJPR* and the *JCP* are identified as leading journals, further emphasizing their impact and influence in the field.

We conducted an SLR of articles published between 2023 and 2024 to identify emerging topics in “big data in supply chain management.” **Future studies will likely examine** how BDA, alongside other digital technologies, supports Supply Chain Ambidexterity—the balance between efficiency and flexibility. By enhancing real-time intelligence, BDA improves decision-making, visibility, and risk management. Broader adoption faces barriers across industries, categorized as technological, organizational, and environmental (Hasan et al., 2022; Ali and Essien, 2023). Technological factors include data integration, system compatibility, and the lack of advanced analytical tools. Organizational challenges involve a limited data-driven culture, resistance to change, and inadequate skills or training among employees. Environmental factors encompass external pressures, including competitive dynamics, regulatory requirements, and market volatility.

A growing research focus on climate-neutral supply chains represents a significant and emerging study area. This research area delves into exploring and developing supply chain strategies and practices that aim to go beyond carbon neutrality to achieve a state of climate neutrality considering all greenhouse gas emissions. It is an essential field of study as organizations increasingly recognize the need to mitigate their environmental impact and align their supply chain operations with sustainability objectives.

Identifying barriers to the use of computer science and mechanics to control and maintain autonomous moving vehicles and drones effectively is also of great value. Additionally, research is needed to explore utilizing big data in developing customized sales, services, and logistics solutions for clients. A final potential avenue for future research could involve investigating the optimization of supply chains by utilizing BDA.

6.2 Managerial Implications

The future of supply chain management lies in the strategic integration of big data analytics, AI, and sustainable practices. Managers must focus on digital transformation, collaboration, and resilience to navigate the complexities of modern supply chains. By leveraging these technologies and aligning them with organizational goals, businesses can achieve competitive advantage, sustainability, and long-term success.

Managers should prioritize adopting BDA and AI technologies to enhance decision-making, improve forecasting accuracy, and optimize supply chain operations. These technologies can help reduce costs, improve efficiency, and enhance responsiveness to market changes (Goodarzian et al., 2024; Jahin et al., 2024; Wu et al., 2024). Investing in technologies and strategies can enhance supply chain resilience, especially during disruptions like COVID-19. This includes improving real-time data processing, predictive analytics, and collaboration across the supply chain (Jegan Joseph Jerome et al., 2024; Liu et al., 2024; Yan et al., 2024). Adopting Industry 4.0 technologies like IoT, blockchain, and cloud computing can improve supply chain visibility, traceability, and efficiency (Chauhan, 2023; Fu et al., 2023; Liu et al., 2023; Saha and Rathore, 2024; Wang et al., 2024).

From a practical perspective, organizations need to develop internal capabilities such as data literacy, advanced analytics integration, and knowledge management practices. These competencies are essential for fully harnessing the strategic potential of BDA in procurement and achieving sustainable supply chain performance improvements (Patrucco et al., 2023).

Managers should focus on integrating sustainability into supply chain operations by leveraging BDA and AI. This includes adopting green supply chain practices, reducing carbon footprints, and promoting circular economy principles (Rashid et al., 2024; Tavana et al., 2024; Sing and Joshi, 2024; Kumar et al., 2024). Fostering collaboration and coordination among supply chain

partners, especially in closed-loop and platform-based supply chains, can be achieved through cost-sharing contracts, revenue-sharing models, and integrated decision-making (Peng and Li, 2023; Ge et al., 2024; Wu and Lang, 2024). Circular economy principles can be adopted by designing closed-loop supply chains emphasizing recycling, remanufacturing, and waste reduction. BDA, BDAC, and AI can play a critical role in optimizing these processes (Song et al., 2024; Khan et al., 2024; Xiang and Dong, 2024; Zhou et al., 2024).

6.3 *Future Research Directions*

Future research could focus on developing precise assessment methods and criteria to evaluate the impact of information and digital technologies (IDT) in SSCM (Liu et al., 2023). These methods and criteria would help researchers and practitioners better understand how IDT influences various aspects of SSCM. Some potential areas for future research and development include:

- Creating frameworks for assessing risks associated with the adoption and implementation of IDT in SSCM
- PEBDA and its Impact on SCM
- Developing methodologies to assess the resilience of Digital Supply Chains (DSC).
- Investigating how SMEs can overcome challenges in deriving value from BDA.

By developing precise assessment methods and criteria, future research can provide valuable insights into the impact of IDT on SSCM and help organizations make informed decisions.

PEBDA leverages digital platforms such as cloud-based systems and data lakes to collect, process, and analyse large-scale data in real-time. These platforms integrate advanced analytics, including AI and machine learning, to enhance visibility, efficiency, and decision-making in SCM. Key features of PEBDA include scalability, real-time processing, data integration from multiple sources, advanced analytics, and visualization tools like dashboards.

A notable example in SCM is SAP Integrated Business Planning, which optimizes supply chain operations (Antwi & Avickson, 2024).

Supply Chain Resilience (SCRes) is a multi-dimensional construct encompassing absorptive, response, and recovery capabilities, all of which contribute significantly to supply chain performance, measured through cost efficiency, return on investment, lead time, and customer satisfaction (Zhao et al., 2023). While numerous antecedents to SCRes have been identified, they are often examined in isolation, overlooking their potential synergistic effects (Jiang et al., 2024). In this context, Supply Chain Digitalization—defined as the comprehensive digital management of products, services, operational processes, and business models—emerges as a critical enabler of SCRes. It enhances resilience by improving visibility, agility, and responsiveness across the supply chain, thereby positively influencing performance (Zhao et al., 2023). This highlights the growing need for developing robust methodologies to assess and enhance the resilience of DSC in an increasingly volatile and complex business environment.

SMEs can overcome challenges in deriving value from BDA (Persaud and Zare, 2023) by focusing on a few key areas:

1. **Identifying Barriers:** Explore why SMEs struggle with BDA — is it due to a lack of technical expertise, high costs, limited infrastructure, or data quality issues?
2. **Developing Frameworks:** Propose a tailored framework for BDA adoption in SMEs, considering their resource constraints and strategic goals.
3. **Building Capabilities:** Investigate how SMEs can develop data literacy, upskill employees, and create a data-driven culture.
4. **Collaboration and Support:** Examine the role of partnerships, government support, or industry alliances in helping SMEs access BDA tools and expertise.

5. **Measuring Impact:** Suggest metrics to track the tangible benefits of BDA for SMEs, like cost savings, operational efficiency, or customer satisfaction.

These emerging topics highlight the intersection of big data and SCM, offering valuable insights into both the benefits and challenges that organizations may face in these domains.

We acknowledge that bibliometric studies can only offer a short-term forecast of the research field. Therefore, scholars should refrain from making overly ambitious assertions about its long-term impact, as Donthu et al. (2021) suggest. We assert that integrating both quantitative (BNA) and qualitative (SLR) approaches can provide a well-rounded perspective on the current state of the field and its future directions.

This research has limitations, as it relied on articles retrieved from the WoS database. While WoS is known for its rigorous selection criteria and high-quality scholarly literature, future research could use data sources like Scopus to provide a more detailed and comprehensive field view. Non-English publications were excluded, potentially leading to a loss of valuable insights. Additionally, the study focused on analysing the publication of research constituents from academia, and we acknowledge that analysing publications from industry constituents may have yielded different results. Exploring industry contributions is another new direction for future research.

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.

Data availability statement

The full list of analysed articles is available to supplement this paper.

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