



# Digital Collaboration in Supply Chain: A Bibliometric Analysis from 2000 to 2022

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## **Research purpose:**

*The purpose of research is to examine the research trend on the topic of digital collaboration in supply chains. This study focuses on solving problems related to the topic: overall volume, growth pattern, geographical distribution, the most important source (journals or conferences), authors and research groups (through number of published documents and citations), documents (through number of citations and number of citations per year) and topics (through frequency of keywords)*

## **Research motivation:**

*Digital technology is booming and has the potential to help eliminate the trust barrier in supply chain collaboration. However, this topic is still new in terms of theory, and more general research is needed to identify the foundation research studies, research trends, research gap, and the most influence authors. This is the main motivation of this study.*

## **Research design, approach, and method:**

*This article used Bibliometric analysis to examine trends in the literature regarding digital collaboration in supply chains. The samples are selected from the Scopus database. VOS viewer tools are used to process the data and extract the map.*

## **Main findings:**

*The study focuses on four main aspects: (i) overall volume, growth pattern and geographic distribution of the extant publications on digital collaboration in supply chains, (ii) Scientific collaboration network analysis, (iii) the most important outlets, research groups and publications on digital collaboration in supply chains, (iv) the most important research topics on digital collaboration in supply chains.*

## **Practical/managerial implications:**

*Bibliometric methods for operations research literature analysis can avoid subjective bias in subject preference. Therefore, this article help identify the main concerns and focus of the digital collaboration topic in supply chain, then, help researchers find the right direction and identify valuable insights from fundamental research, outstanding authors and research groups, and important topics.*

**Keywords:** Digital Collaboration, Supply Chain, Bibliometric, Literature Review, Research trend

## 1. INTRODUCTION

In a volatile business environment, supply chain collaboration is essential to mitigate risk, reduce uncertainty, and optimize the value chain (Can Saglam et al., 2020; Guo et al., 2022). The Fourth Industrial Revolution has enabled businesses to collaborate more effectively, even building trustless collaboration platforms, which can further enhance

supply chain performance (Huang et al., 2023; Liu et al., 2022; Ghadge et al., 2020).

The successful implementation of these principles and practices will support system integration, the ability to adapt and respond flexibly to customer needs (Smit et al., 2016; Xu et al., 2018). In particular, blockchain technology will provide a unified, immutable data system, and decentralized data sharing on a network, providing value through transparency and consensus, thereby building trust and efficiency (Kamble et al., 2019), improving traceability, dispute resolution, integrity, digitization, and compliance between participants in the chain (Kamble et al., 2021; Lennert and Rao, 2021). With such flexibility, close integration, and transparency, technology-enabled collaboration, also known as digital collaboration, promises to be an important factor in helping businesses improve their adaptability, respond to unexpected disruptions, and deal with the unpredictable challenges of the business environment (Al-Omouh et al., 2023; Messabia et al., 2022). Al-Omouh (2023) referred to supply chain collaboration that is enhanced by these communication and digital technologies as digital collaboration.

Despite the proven potential of digital collaboration to improve supply chains, recent studies have limited coverage of this area. Most studies only mention digital collaboration partially when discussing information and digital technologies in supply chains. For example: Tonellia et al. (2021) refer to digital collaboration when analysing the basic features of Cyber-Physical Systems, identifying service-oriented architecture and microservice components; Viriyasitavat et al. (2022) refer to digital collaboration when building architecture and framework systems in blockchain operations; Wisetsri (2022) studies how machine learning operates in linear collaboration in the modern technology world... Even empirical studies have only mentioned digital collaboration as an intermediary factor when considering the impact of implementing Industry 4.0 technologies on supply chain adaptability (Huang et al., 2023; Zhao et al., 2023).

To address these gaps in the existing digital collaboration research, this study conducts a bibliometric analysis and qualitative analysis of the literature to identify research hotspots and future development trends in this field. The study aims to answer the following questions:

RQ1: What is the overall volume, growth pattern, and geographical distribution of publications on digital collaboration.

RQ2: What is the most important outlets, authors, research groups, and publications on digital collaboration.

RQ3: What is the most important topics in the literature on digital collaboration.

The findings of this study will help researchers find the right direction and identify valuable insights from fundamental research, outstanding authors and research groups, and important topics in digital collaboration in supply chains.

## 2. METHODOLOGY

### 2.1 Bibliometric

Bibliometric analysis is a quantitative research method that uses statistical and mathematical tools to analyse patterns and trends in large datasets of written documents, such as academic publications, books, and patents (Broadus, 1987; Pritchard, 1969). This method can be used to track the evolution of research topics and trends over time, and to provide insights into the historical development of a research field. In this section, we use bibliometric analysis to provide a general overview of the research progress on digital collaboration in supply chains. We explore the development trends of research themes, journals, and keywords in digital collaboration (He et al., 2017; He et al., 2017; Zhao, 2017).

### 2.2 Data retrieval

We used the Scopus database to collect data on digital collaboration in supply chain management. Because, Scopus is a popular choice for bibliometric reviews because it has wider coverage than Web of Science, is more widely cited by academics, and offers more advanced capabilities for exporting bibliographic data (Zhu & Liu, 2020; MartínMartín et al., 2018). Additionally, Scopus uses a consistent standard to select documents for inclusion in its index (Hallinger & Nguyen, 2020).

The search query is: TITLE-ABS-KEY ( digital AND ( integrat\* OR collaborat\* OR cooperat\* OR connect\* ) AND "Supply Chain" ) AND ( LIMIT-TO ( SUBJAREA , "BUSI" ) OR LIMIT-TO ( SUBJAREA , "DECI" ) OR LIMIT-TO ( SUBJAREA , "SOCI" ) OR LIMIT-TO ( SUBJAREA , "ECON" ) OR LIMIT-TO ( SUBJAREA , "ARTS" ) OR LIMIT-TO ( SUBJAREA , "MULT" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( EXCLUDE ( PUBYEAR , 2023 ) ).

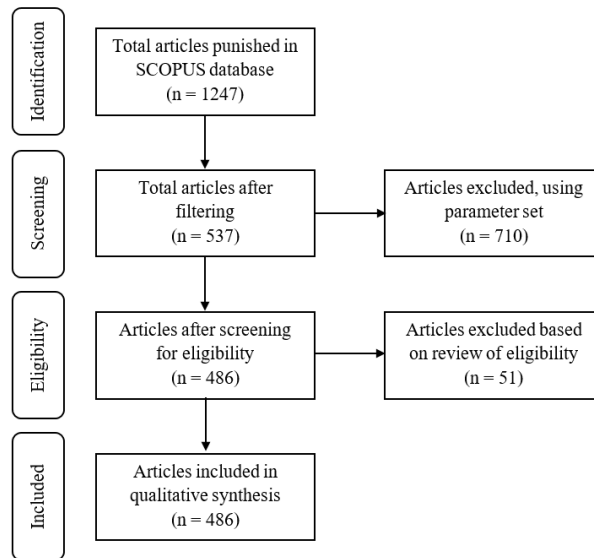
To ensure thoroughness and consistency across reviews, we followed the PRISMA protocol for conducting systematic reviews. Figure 1 illustrates the literature screening process carried out using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach. PRISMA is a systematic approach to reviewing the literature that involves identifying all relevant studies, selecting studies for inclusion, extracting data from studies, and synthesizing the findings. (Pahlevan-Sharif et al., 2019).

The initial search results yielded 1247 papers published in the SCOPUS database. We extracted data from the selected

papers, including authors, titles, keywords, abstracts, sources, organizations, countries, years, and references in tab-delimited Win (UTF-8) format (Kuhzady et al., 2020).

Next, according to PRISMA guidelines, the criteria used to narrow the search scope include document type, language, time period, and subject area. Specifically, the search was limited to articles published in English in relevant fields (Business, Management and Accounting, Economics, Econometrics and Finance, Science Decision Studies, Social Sciences, Arts and Humanities, Multidisciplinary) up to the end of 2022. There were 537 eligible articles used for the next steps.

We then conduct an initial filtering through parameter set. Following (Gümüş et al., 2020)'s suggestion, we scanned the titles and abstracts of articles to assess the suitability of each article. If we disagreed on the inclusion/exclusion of an article, we discussed it until they reached an agreement. Eventually, we obtained 486 publications that fulfil the criteria from the 537 collected papers. The data includes authors, titles, keywords, abstracts, sources, organizations, countries, years, and references of each paper. We use the data from the 486 papers for bibliometric analysis in the following sections.



**Fig. 1.** PRISMA flow diagram detailing steps in the identification and screening of sources for review of digital collaboration in supply chain

### 2.3 Analysis software

We exported bibliographic data (authors, titles, affiliations, citations, etc.) related to 486 papers from Scopus into a master Excel file. We used Excel to chart the landscape of digital collaboration (e.g., growth trajectory, geographical distribution) and to describe statistics (e.g., types of research papers, number of authors from a country).

We used VOSviewer software to support the export of visual maps to illustrate citation analysis and co-citation analysis. Authors widely used VOSviewer software in published reviews of research fields such as social sciences, business and management, medicine, and education.

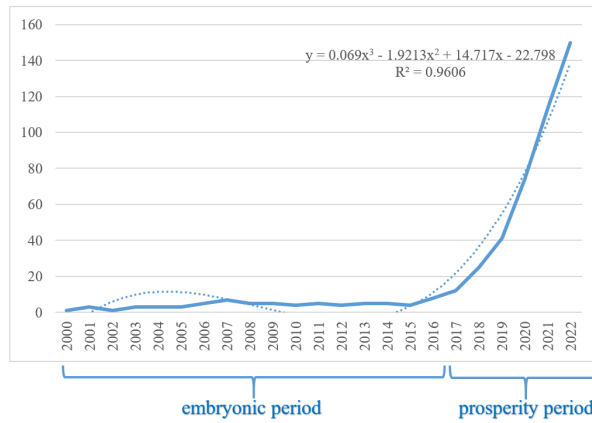
## 3. RESULTS AND DISCUSSION

In this section, we present the results of our bibliometric analysis of digital collaboration in supply chains, which address our research questions.

### 3.1 Annual growth of number of journal papers

The number of journal papers is an important indicator of scientific research output, quality, and contribution to the literature. It directly reflects the change in the amount of scientific knowledge, as the growth of knowledge is closely related to the number of journal papers (Hao et al., 2021; Zeng et al., 2021; Fahimnia et al., 2015).

This trend can be seen in the number of digital collaboration journal papers (Fig. 2). The field has attracted the attention of scholars since 2000, when there was only one publication. The number of annual journal articles was relatively low and did not fluctuate much in the first 17 years. Nevertheless, the ensuing timeframe, spanning from 2017 to 2022, witnessed a notable surge in scholarly articles pertaining to this subject matter, following a third-order ( $k = 3$ ) polynomial curve ( $R^2 = 0.9605$ ). This explosion of knowledge is likely due to the growing realization that digital collaboration technologies can help to eliminate the trust barriers that may prevent companies from sharing important information in the supply chain, thereby further enhancing supply chain operational capabilities.



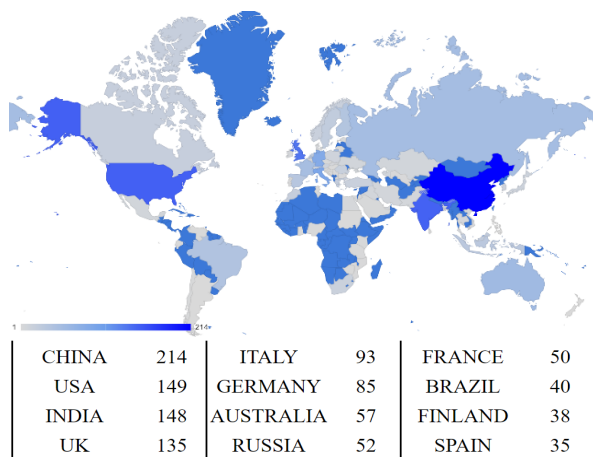
**Fig. 2.** The number of research journal papers on supply chain digital collaboration based on journal papers listed in the SCOPUS

Since 2017, the difference between the actual and theoretical values of the cumulative number of journal papers has increased year by year, indicating that digital collaboration research is developing rapidly. We can divide digital collaboration research development into two stages (Fig. 2). The first publication appeared in 2000. From 2000 to 2016, the number of journal papers grew slowly, reaching 8 in 2016. We call this the embryonic period of digital collaboration research. From 2017 to 2022, the number of journal papers increased rapidly, with an average annual growth rate of 64.7%. We describe this stage as the prosperity period.

**3.2 Collaboration in research**

After extracting data from Scopus, of the 76 countries that contributed to the study, the top four (China, the United States, the United Kingdom, and India) accounted for 39.68% of the articles (Fig. 3). This suggests that these countries are leading the way in supply chain collaboration research.

Researchers have explained that global companies are increasingly investing in developing countries to implement new technologies in their supply chains. This is why, in addition to the United States and the United Kingdom, developing countries are also paying attention to implementing digital and communication technologies to improve supply chain collaboration.



**Fig. 3.** Country-wise Publication

**3.3 Top Authorship with country and affiliation**

The top 10 most productive authors in digital collaboration research, ranked by h-index, are shown in Table 1. (Donthu et al., 2021). Belhadi A has the highest h-index due to his high number of publications and citations. He published 6 articles related to digital collaboration from 2021 to 2022, with a total of 548 citations. His most cited paper, "Manufacturing and service supply chain resilience to the COVID-19 outbreak: Lessons learned from the automobile and airline industries", has 334 citations (Belhadi et al., 2021).

Ivanov D ranks second in terms of h-index and is the most productive author, with 5 papers published from 2019 to 2022. His most cited paper, "The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics", has 800 citations (Ivanov et al., 2019).

This research framework combines the results from two isolated areas: the impact of digitalization on supply chain management (SCM) and the impact of SCM on the ripple effect control and analyses perspectives and future transformations that can be expected in the transition towards cyber-physical supply chains.

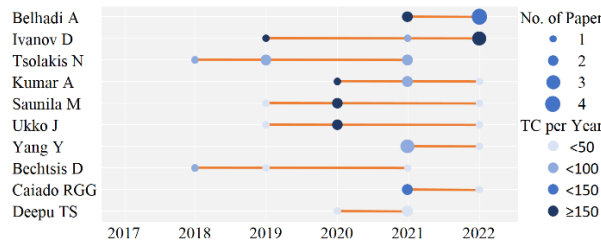


Fig. 4. Topmost 10 Authors – Affiliation & Country

Belhadi A and Ivanov D are considered consistent authors, as they still contribute to the field. Figure 4 shows the productivity of the authors per year with citation count. A larger circle indicates more articles, and a denser circle indicates more citations.

### 3.4 The most influencing Journal on digital collaboration

Analysis of the Scopus sample shows that there is no clear concentration of digital collaboration journal papers in any particular publication source. Among the 237 journals that published at least one paper on this topic, 199 only published one or two papers. The remaining 38 journals accounted for the majority of the digital collaboration journal papers.

The top 10 journals and proceedings for current research are shown in Table 2. These top 10 sources, which represent only 4.22% of the 237 total sources, published 114 articles on digital collaboration in supply chains, accounting for 23.41% of the total 487 articles. The Journal Citation Report partitions of the journal citation report database for these journal papers were Q1 and Q2, which represent the top journals in various fields.

The International Journal of Production Economics is the leading journal in the field with 19 articles and the highest citation of 1082, starting in 2014. However, the journal Sustainability (Switzerland) had the highest number of publications at 34, starting in 2017.

Table 2. Top 10 Journals and Proceedings in digital collaboration in SCM area

No	Journal Name	Total citations	No. of Paper	Year_start
1	International Journal Of Production Economics	1082	19	2014
2	International Journal Of Production Research	1067	12	2009
3	Technological Forecasting And Social Change	784	8	2017
4	Journal Of Cleaner Production	743	12	2008
5	Annals Of Operations Research	742	7	2018
6	Sustainability (Switzerland)	710	34	2017
7	Management Science	414	2	2003
8	Production Planning And Control	380	9	2008
9	Business Process Management Journal	331	3	2019
10	Supply Chain Management	306	8	2014

### 3.5 The most influencing documents on digital collaboration

Citation analysis reveals the five most influential documents in the field of digital collaboration, as shown in Table 3. These five documents, all published in high-ranking journals, represent only 1.03% of the total sample of 487 documents, but they account for 22.28% of the total citations.

The most cited paper is by Rai et al. (2006). This seminal paper investigates the hierarchy of IT-related capabilities and their impact on firm performance in a supply chain management (SCM) context. It finds that integrated IT infrastructures enable firms to develop the higher-order capability of supply chain process integration, which results in significant and sustained firm performance gains, especially in operational excellence and revenue growth.

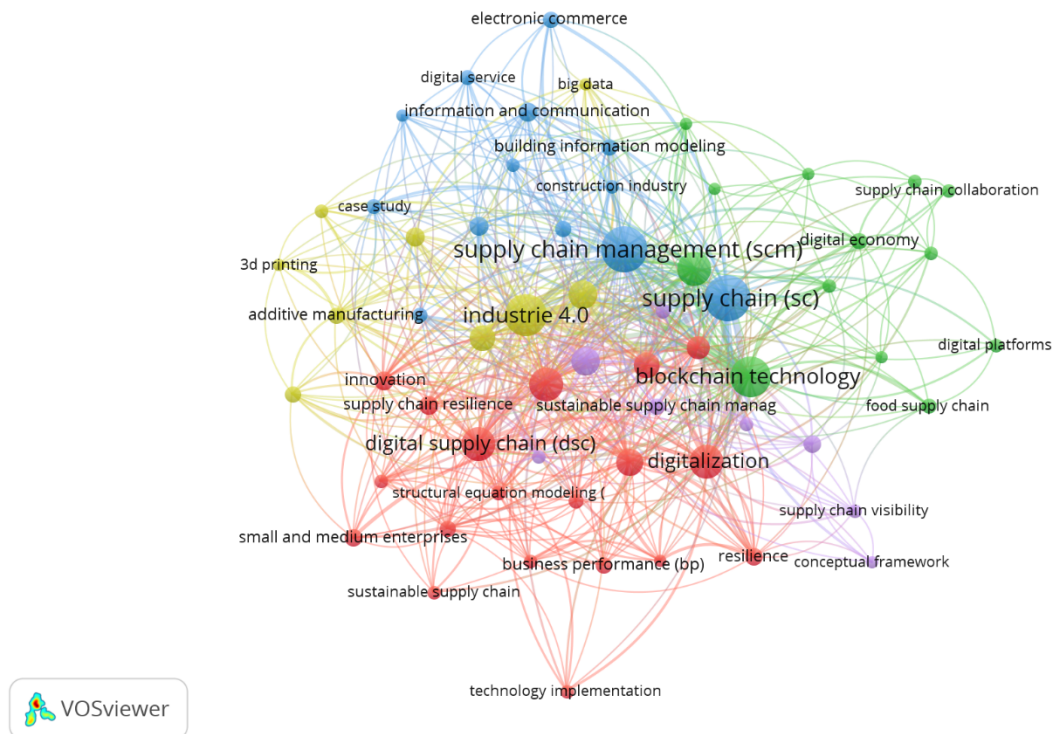
The second most cited paper is by Ivanov et al. (2019). This research framework combines the results from two isolated areas: the impact of digitalization on SCM and the impact of SCM on the ripple effect control and analyses perspectives and future transformations that can be expected in the transition towards cyber-physical supply chains.

### 3.6 Topical trends in the digital collaboration knowledge base

To explore the most important topics in digital collaboration literature, we investigated the keywords of digital collaboration documents. We conducted a co-keyword analysis, following van Eck and Waltman (2014); Zupic and Čater (2006), to identify the key themes.

Figure 5 represents our co-keyword analysis. It shows 62 keywords corresponding to 62 nodes with at least 6 occurrences. Each circle represents a keyword and indicates the sub-area of the Digital Supply Chain Collaboration theme. Larger circles indicate more occurrences of a keyword. Circles with similar colours show keywords that are distributed in the same region. The most frequently used keywords are "supply chain management (SCM)", "supply chain (SC)", "digital supply chain (DSC)", "blockchain technology", "Industry 4.0", and "digitalization".

The five clusters of keywords identified in Figure 5 represent the key themes in digital collaboration literature: Cluster 1 (red): Integration of digital technology in the supply chain, including keywords such as digital supply chain, digital technologies, digitalization, and supply chain integration. Cluster 2 (green): Drivers of digital collaboration, including keywords such as blockchain technology, digital economy, and digital transformation. Cluster 3 (blue): Supply chain in general, including keywords such as supply chain, supply chain management, information and communication technology, and logistics. Cluster 4 (yellow): Technologies of digital collaboration, including keywords such as 3D printing, additive manufacturing, Industry 4.0, and Internet of Things. Cluster 5 (purple): Analysis part of digital



**Fig. 5.** Keyword co-occurrence Visualisation

collaboration, including keywords such as artificial intelligence, big data analytics, and digital twin model.

VOSViewer can also help researchers identify the regency of topical themes. Temporal co-word analysis reveals when particular topics were most popular (Bhattacharya et al., 2019). In Figure 6, the purple nodes represent traditional topics (i.e., prior to 2017) in digital collaboration literature, such as supply chain, supply chain management, collaboration, and supply chain integration. The yellow nodes represent recent topics (i.e., 2021 onwards), such as digital supply chain, digital transformation, artificial intelligence, and supply chain resilience. The green nodes represent topics that first appeared between 2018 and 2020.

The combination of occurrence frequency and average publication year of keywords suggests scholars' interests in each period. In the early period (dark coloured nodes), scholarly interest focused on traditional and general economic issues, such as supply chain (71) (2019), supply chain management (72) (2018), collaboration (23) (2016), and supply chain integration (19) (2017). Next, the issues of concern focused on digital technologies (blockchain technology (57) (2020), Internet of Things (27) (2020)) and digital transformation (Industry 4.0 (62) (2020), digital technologies (40) (2020), digitalization (41) (2020)). Later on, scholars explored the depths of digital collaboration, building new concepts or values for integrating digital technologies into supply chain collaboration (digital supply chain (38) (2021), supply chain resilience (23) (2021)).

#### 4. CONCLUSIONS AND SUGGESTION FOR FURTHER RESEARCH

Despite growing scholarly interest, the overall picture of the digital supply chain collaboration literature remains unclear. To address this gap, we conducted a bibliometric analysis of the existing literature on digital collaboration in the supply chain domain using data from Scopus from 2000 to 2022. Our study identified 486 documents on digital collaboration

worldwide. We focused on five main aspects: (i) overall volume, growth pattern and geographic distribution of the extant publications on digital collaboration, (ii) top authorship with country and affiliation, (iii) The most influencing Journal and documents on digital collaboration, (iv) the most influencing documents on digital collaboration, and (v) topical trends in the on digital collaboration knowledge base.

One of the strengths of bibliometric analysis is its ability to explore the key authors and research groups of a given topic. In this study, we revealed that the most productive scholar on digital collaboration has only published six documents on the topic, suggesting that the knowledge base in this area is not comprised of truly productive and active scholars and research groups.

The analysis of co-citation networks showed that the topic of digital collaboration is emerging, as evidenced by the prevalence of topics of interest, including common interest of scholars from one country. This suggests an opportunity to increase research in this area in that country, as knowledge of the phenomenon is consolidating in academia.

This study has several limitations. One is that bibliometric analysis only works with metadata information without the content of digital collaboration studies. It is necessary to understand the content of the research, such as analysis of the thematic categories. (Lima & Carlos Filho, 2019). Finally, this study uses samples extracted from the Scopus database, which may be limited when studies on this topic are published in other databases.

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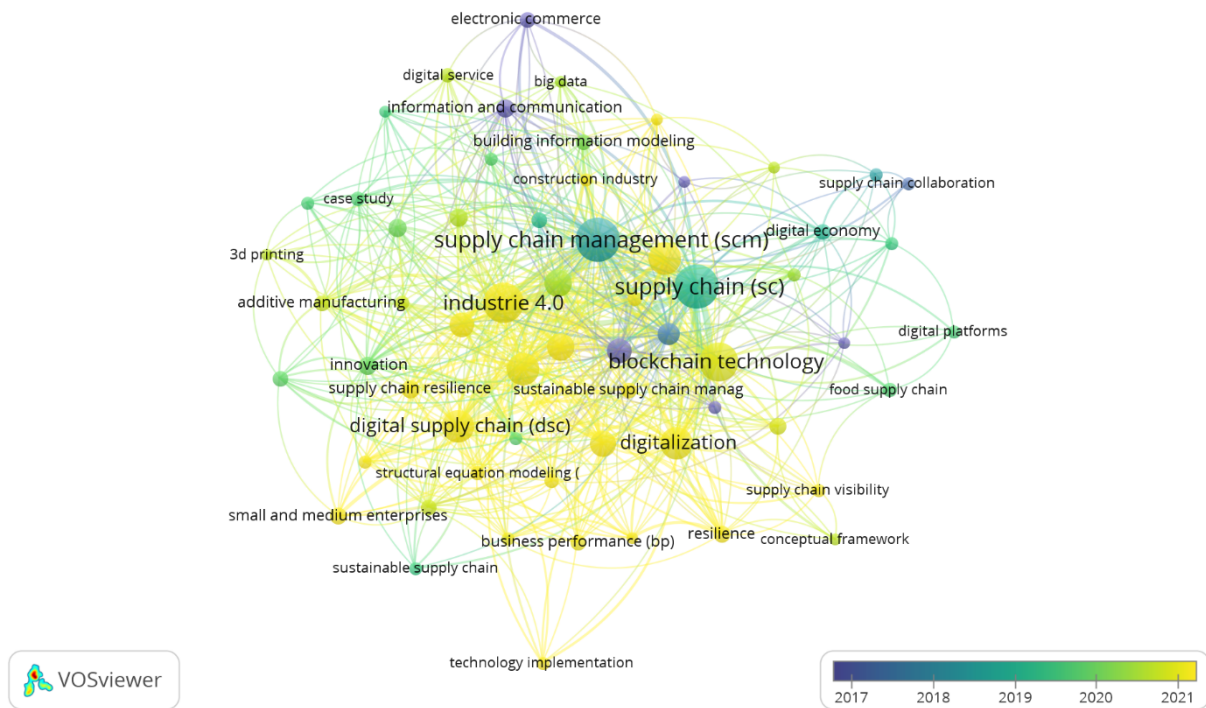
APPENDIX

**Table 1.** Productivity of Authors in digital collaboration in SCM area

No	Author	Affiliation	Country	h_index	Total citations	No. of Paper	Year_start
1	Belhadi A	Cadi Ayyad University	Morocco	6	548	6	2021
2	Ivanov D	Berlin School of Economics and Law	Germany	5	1097	5	2019
3	Tsolakis N	University of Cambridge	United Kingdom	4	250	5	2018
4	Kumar A	Institute of Management Technology	India	4	233	4	2020
5	Saunila M	LUT University	Finland	4	187	4	2019
6	Ukko J	LUT University	Finland	4	187	4	2019
7	Yang Y	Hong Kong Baptist University	Hong Kong	3	90	4	2021
8	Bechtsis D	Aristotle University of Thessaloniki	Greece	3	117	3	2018
9	Caiado RGG	Pontifical Catholic University of Rio de Janeiro	Brazil	3	159	3	2021
10	Deepu TS	Indian Institute of Space Science and Technology	India	3	56	3	2020

**Table 3.** Top 5 publications in digital collaboration, 2000-2022

No	Title	Authors	Source	Year	Total Citations
1	Firm performance impacts of digitally enabled supply chain integration capabilities	Rai A.; Patnayakuni R.; Seth N.	MIS Quarterly: Management Information Systems	2006	1375
2	The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics	Ivanov D.; Dolgui A.; Sokolov B.	International Journal of Production Research	2019	800
3	Industry 4.0 and the circular economy: a proposed research agenda and original roadmap for sustainable operations	Lopes de Sousa Jabbour A.B.; Jabbour C.J.C.; Godinho Filho M.; Roubaud D.	Annals of Operations Research	2018	582
4	Models for supply chains in e-business	Swaminathan J.M.; Tayur S.R.	Management Science	2003	377
5	Manufacturing and service supply chain resilience to the COVID-19 outbreak: Lessons learned from the automobile and airline industries	Belhadi A.; Kamle S.; Jabbour C.J.C.; Gunasekaran A.; Ndubisi N.O.; Venkatesh M.	Technological Forecasting and Social Change	2021	334



**Fig. 6.** Overlay Network of keyword co-occurrence

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