Mapping and Visualization Research Trend of Supply Chain Digital Twin: A Bibliometric Review

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Abstract

Since its inception, the concept of a digital twin has been used in a broad range of fields, including product life cycle management, product development, manufacturing, logistics, and process control, to mention a few. As technology advances, physical objects and virtual worlds are being integrated and interconnected in a real-life context. However, the Supply Chain Digital Twin publishing is confined to a few topics. This study uses bibliometric analysis to graphically map scientific publications and research trends in the Digital Twin Supply Chain sector worldwide. The Scopus database was used to collect information for this study, and online analysis using the Scopus website and VOSViewer was used to demonstrate bibliometric network mapping. We use an article selection procedure starting with the searched keywords and year constraints and then exporting the database to RIS and CSV format files. We retrieved 179 scientific publications published between 2017 and 2021 from the Scopus database over the last five years. We also use VOSViewer to map the network. According to the database, researchers in Germany had the most published papers indexed by Scopus among the most prolific authors (N=30), with the United States coming second (N=27) and the United Kingdom third (N=16). This study recommends combining the research subjects of IoT for Sustainability in Agriculture: Digital Twin Concept, Impact, Disruption, Internet, abbreviated as DTCIDI research themes.

Keywords
Bibliometric, supply chain, digital twin, research trend, research mapping

1. Introduction

Industry 4.0 is a technology framework that enables the implementation of cyber-physical integration concepts in manufacturing, logistics, and supply chains (SC). Various viewpoints (Liao et al. 2017; Strozzi et al. 2017; Tang and Veelenturf 2019) have emphasized on how digitalisation and data analytics skills might be expressed in forecasting future and recognizing real-time events (Fosso Wamba et al. 2017; G. Wang et al. 2016). According to some academics, there is a tendency toward digital twins, which are computerized simulations that mimic a physical thing in real time (Ait-Alla et al. 2019; Frank, Dalenogare, and Ayala 2019; Negri, Fumagalli, and Macchi 2017). SC disruption risks is one of the important areas of data analytics and digital twin applications. SC risk managers want decision-making support to identify disruption scenarios, understand the vulnerability of specific parts of the network and fortify them, monitor and recognize disruptions in real time, and choose actions for disruption and recovery (Hosseini, Ivanov, and Dolgui 2019; X. Wang, Tiwari, and Chen 2017). The existing optimisation and simulation models help decision-making for stress-testing existing SC systems as well as the deployment of contingency and recovery plans. These models require historical data on disruptions to build disruption scenarios, as well as real-time data on disruptions to detect bottlenecks and execute recovery plans (Dmitry Ivanov et al. 2017). Recent study revealed new options for controlling SC disruption threats using data-driven techniques.

According to(Dunke et al. 2018), digitalization and Industry 4.0 may have a substantial impact on optimization strategies in the SC sector, as well as disruption propagation impacts on SC performance. Current study creates new knowledge regarding the impact of interruption propagation on SC output performance by taking into account disruption location, duration and propagation, and recovery strategies using optimization and simulation methodologies. New digital technologies pose new problems for the use of quantitative analytic methodologies to SC ripple effect analysis, as well as new avenues and issue statements.

Simulation and optimization have played important roles in tackling complicated issues throughout the last few decades. To mention a few, successful examples are production planning and scheduling, SC design, and route optimization. Many issues, however, remain difficult due to their complexity and huge scale, as well as uncertainty and stochastic character. Furthermore, in recent decades, the primary use of optimization and simulation approaches has been in decision support, which requires decision makers to manually supply model input and analyze model output. On the other hand, the fast emergence of business analytics opens up new prospects for Operations Research and the reexamination of these difficult optimization issues. The trend toward the use of digital technology extends beyond the industrial industry. To make the whole SC I continuous delivery adaptable, the supplier network, customer network, and logistics service providers must all install and develop digital technology. As a result, in the case of more frequent crises like as natural disasters or supplier interruptions, the emphasis must be on risk management for all SC actors.

2. Research Method

A systematic and clear bibliometric review technique that focuses on the limitations of knowledge (Purnomo et al. 2021). For the purposes of bibliometric analysis, the search and selection criteria are shown in Figure 1. Scopus, one of the most extensively cited archives, was used to acquire the data. Search terms for this study were Supply Chain Digital Twin to avoid picking papers that were irrelevant to the study's purpose.

Only those terms are considered to maximize relevant search results. We used various specialty publications in the last ten years, from 2017 to 2021. On May 13, 2022, a search was conducted. Total retrieved documents were 226, but this was reduced to 180 when publications limit to 2017 until 2021 from the analysis. We restrict the source type to Journal, dan Conference Proceeding, then the result of the document reduces to 144. Then, we choose the language English only, and the documents reduce to 138. A total of 138 publications were studied for their bibliometric data. The procedure of selecting an article is shown in Figure 1.

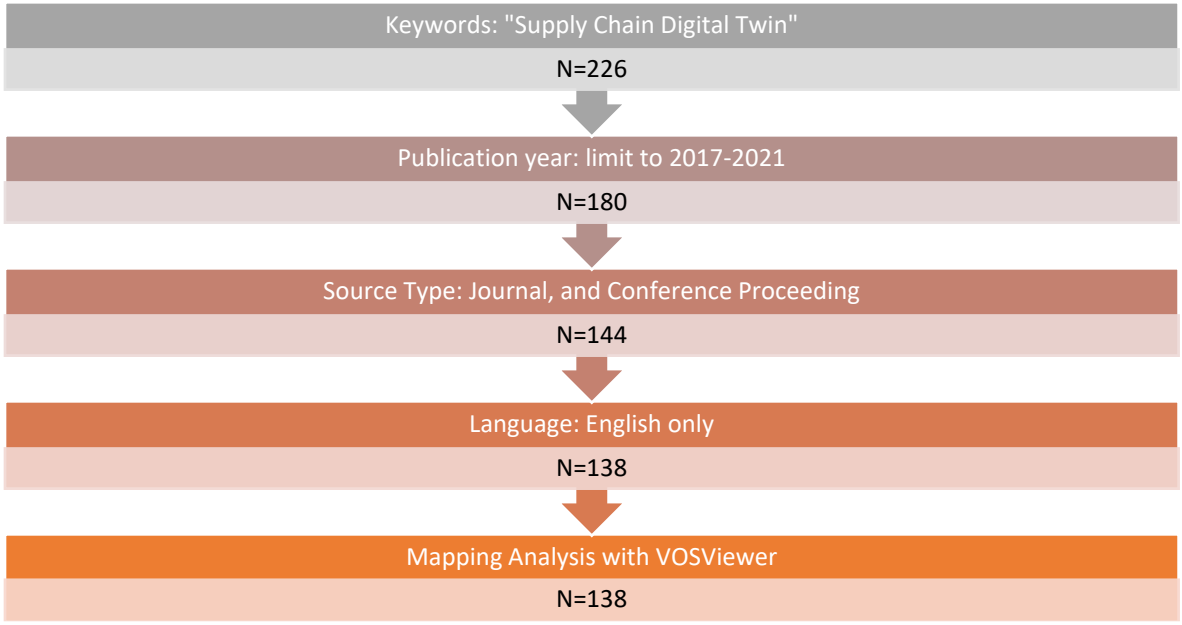


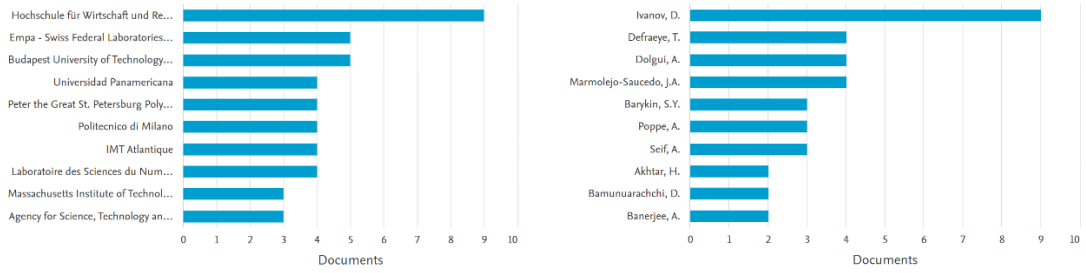
Figure 1. Research method to selection of the documents

3. Result and Discussion

From the search results using the keyword Supply Chain Digital Twin on the Scopus website, it was found that 138 articles had been published during the last 5 years from 2017 to 2021. The data obtained was then processed based on several information needs such as Annual Publication, the highest citation based on journal sources, the most productive organization and author, Scientific Source with SJR, to map using VOSviewer software to map the theme network and author network.

3.1 The Most Productive Organizational Affiliations and Productive Author of Supply Chain Digital Twin Research

In this research we get 286 affiliated organizations have researched Supply Chain Digital Twin like in figure 2. The ten most prolific research affiliates in Supply Chain Digital Twin research are Hochschule für Wirtschaft und Recht Berlin (N = 9); Empa - Swiss Federal Laboratories for Materials Science and Technology (N = 5); Budapest University of Technology and Economics (N = 5); Universidad Panamericana (N = 4); Peter the Great St. Petersburg Polytechnic University (N = 4); Politecnico di Milano (N = 4); IMT Atlantique (N = 4); Laboratoire des Sciences du Numérique de Nantes (N=4); Massachusetts Institute of Technology (N = 3); Agency for Science, Technology and Research, Singapore (N = 3) as shown in Figure 2 (a). They are all affiliates who have made a significant contribution to the researched Supply Chain Digital Twin.



(a) (b)

Figure 2. The top ten lof Productive Organizational Affiliations (a) and ProductiveAuthor (b) of Supply Chain Digital Twin Research

425 individual researchers have researched Supply Chain Digital Twin. As shown in Figure 2 (b), the most prolific Supply Chain Digital Twin author may be identified (Table 1).

Table 1. The author with the most publications in the field of Supply Chain Digital Twin

No	Author	Affiliation	Documents
1	Ivanov, D.	Hochschule für Wirtschaft und Recht Berlin, Berlin, Germany	9
2	Defraeye, T.	Empa - Swiss Federal Laboratories for Materials Science and Technology, Dubendorf, Switzerland	4
3	Dolgui, A.	IMT Atlantique, Nantes, France	4
4	Marmolejo-Saucedo, J.A.	Universidad Panamericana, Ciudad de Mexico, Mexico	4
5	Barykin, S.Y.	Peter the Great St. Petersburg Polytechnic University, Saint Petersburg, Russian Federation	3
6	Poppe, A.	Budapest University of Technology and Economics, Budapest, Hungary	3
7	Seif, A.	A-Star, Advanced Remanufacturing and Technology Centre, Singapore City, Singapore	3
8	Akhtar, H.	A-Star, Advanced Remanufacturing and Technology Centre, Singapore City, Singapore	2
9	Bamunuarachchi, D.	Swinburne University of Technology, Melbourne, Australia	2
10	Banerjee, A.	Swinburne University of Technology, Melbourne, Australia	2

3.2 The Most Document Cited of Supply Chain Digital Twin Research

From the research topic Supply Chain Digital Twin, we mapped the five highest document citations. From various sources along with the titles which we then attach in table 2.

Table 2. The Most Document Cited of Supply Chain Digital Twin Research

No	Cites	Title	Source	Year
1	672	Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) (D Ivanov 2020)	Transportation Research Part E: Logistics and Transportation Review	2020
2	178	A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0 (D Ivanov and Dolgui 2021)	Production Planning and Control	2021
3	144	A supervised machine learning approach to data-driven simulation of resilient supplier selection in digital manufacturing (Cavalcante et al. 2019)	International Journal of Information Management	2019
4	142	Coronavirus (COVID-19/SARS-CoV-2) and supply chain resilience: A research note (D Ivanov and Das 2020)	International Journal of Integrated Supply Management	2020
5	119	Reconfigurable supply chain: the X-network (Dolgui, Ivanov, and Sokolov 2020)	International Journal of Production Research	2020

3.3 Supply Chain Digital Twin Research Sector's Annual Publications

Figure 3 shows a graph of the annual trend of increasing publications in the last ten years, from 2017 to 2021. From the Supply Chain Digital Twin publication database published in 2017, starting with 1 document in 2017, then there was a significant increase in the number of publications year in years from 2018. In year 2018 (N=6), 2019 (N=23), 2020 (N=49), until 2021 the publications have increase of up to 59 documents.

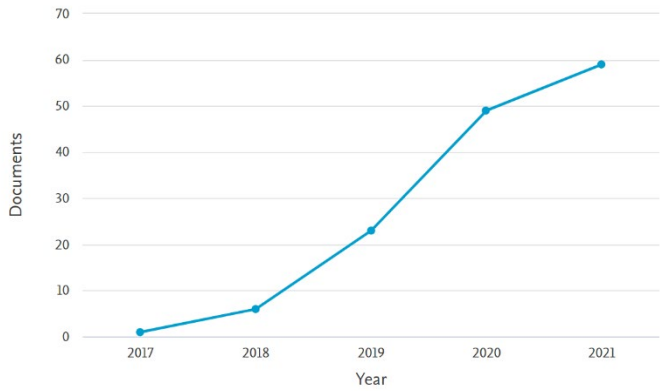


Figure 3. Chart documents per year on Supply Chain Digital Twin literature

3.4 Supply Chain Digital Twin Research from Scientific Source with SJR

A total of 138 sources of study have been published on the topic of Supply Chain Digital Twin Research. The Sustainability Switzerland, SJR 2021 (N = 6) publishes the most articles each year in the field of Supply Chain Digital Twin research. The details are shown in Table 3.

Table 3. The Most Document Cited of Supply Chain Digital Twin Research

Scientific Source	SJR 2021	Article
Sustainability Switzerland	0.664	6
Applied Sciences Switzerland	0.507	4
IFAC Papersonline	0.308	4
IEEE Access	0.927	3
International Journal Of Production Research	2.780	3

Over a three-year period prior to the reporting year, each journal's SCImago Journal Rating (SJR) is determined by the average number of papers published in each journal during the reporting year that were referenced. SJR 2021 indicators ranging from 0.308 to 2.780 are found in the most prolific Supply Chain Digital Twin research publications.

3.5 The Subject Area of Supply Chain Digital Twin Research

Found 138 documents published by Supply Chain Digital Twin in the last ten years, from 2017 to 2021. The most knowledge is in the field of Engineering, with 23.6% academic documents (N=76). Then the second is Computer Science with 21.7% academic documents (N=70), and the third is Business, Management and Accounting with 9.6% academic documents (N=31). Then, Decision Sciences with 8.7% academic documents (N=28), Energy with 5.3% academic documents (N=17), Social Sciences with 5.0% academic documents (N=16), Environmental Science with 4.7% academic documents (N=15), and others with 10.6% academic documents such as images of Supply Chain Digital Twin publication documents (Figure 4).

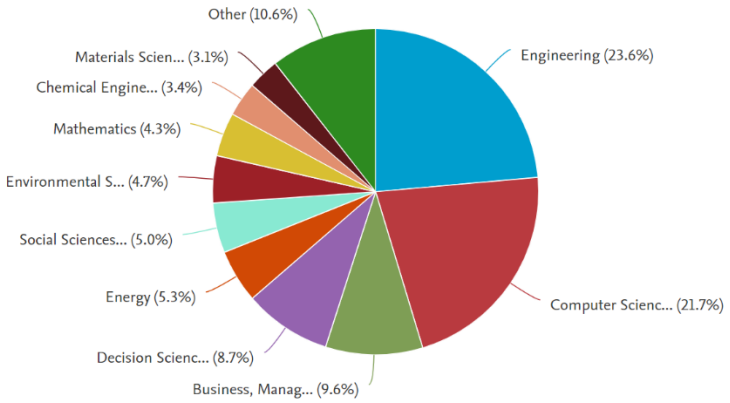


Figure 4. The Subject Area of Supply Chain Digital Twin Research

3.7 Theme Map of Supply Chain Digital Twin Research

Using the VOSViewer application, Supply Chain Digital Twin on keyword mapping networks, the following subject map investigation was conducted. In this inquiry, we'll be looking at the titles and abstracts of articles. A binary representation of the result is used in the calculation. We can see from Figure 5.

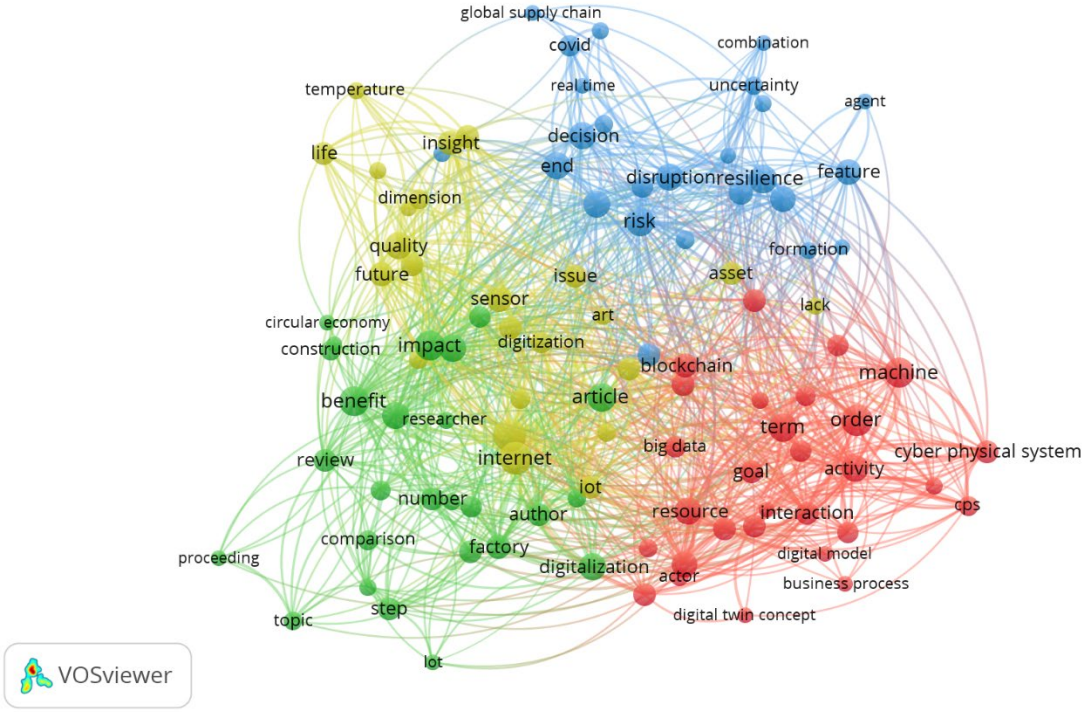


Figure 5. The coexistence of 99 of the most common terms (with at least four occurrences). The thickness of the lines reflects the severity of the link between terms, based on how often they appeared in articles together.

The data on the topic Supply Chain Digital Twin was processed using VOSviewer software and obtained 3994 terms, with 174 terms meet the threshold. By default, from each of the 104 terms, 60% of the relevant terms will be selected, making 104 terms selected. The 104 network terms will be mapped as in Figure 5 and divided into five clusters, Links is 2547, TLS (Total Link Strength) is 4091:

1. Cluster 1 has 29 items, which are red node color. In this network we choose terms Digital Twin Concept. This cluster with the word network like activity, actor, addition, aspect, behavior, big data, blockchain, business

process, capacity, cps, cyber physical system, digital model, digital twin concept, digital twin technology, effectiveness, goal, interaction, machine, order, organization, phase, production system, proof, resource, security, service, supplier, term, work.

2. Cluster 2 has 26 items, which are green node color. In this network we choose terms Impact. This cluster with the word network like ability, article, author, benefit, bim, business, circular economy, comparison, construction, digitalization, evaluation, factory, idea, impact, literature, Iot, number, overview, perspective, proceeding, proposal, researcher, review, step, topic.
3. Cluster 3 has 25 items, which are blue node color. In this network we choose terms Disruption. This cluster with the word network like agent, combination, complexity, condition, covid, decision, disruption, effect, end, era, feature, formation, global supply chain, interest, machine learning, pandemic, real time, resilience, risk, role, software, support, uncertainty, validation, visibility.
4. Cluster 4 has 24 items, which are yellow node color. In this network we choose terms Internet. This cluster with the word network like art, asset, current state, digital transformation, digitalization, dimension, evolution, future, future research, improvement, insight, internet, iot, issue, lack, life, person, productivity, quality, sensor, stakeholder, sustainability, temperature, thing.

3.8 Authorship Network

A trend of collaborative research may be seen in figure 6 of a Supply Chain Digital Twin article. There are 425 authors in the Authorship Network; 4 of them fulfill the criterion, the authors with the greatest total link strength (TLS) will be selected. There are three distinct research teams, each of which is related to the others.

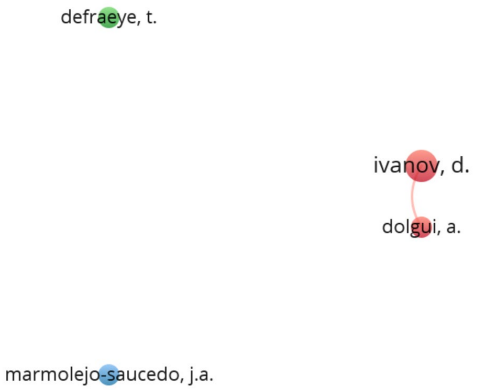


Figure 6. The network of 4 co-authors publishing in Supply Chain Digital Twin. Each node presents an author

4. Conclusion

From the search results using the keyword Supply Chain Digital Twin on the Scopus website, it was found that 138 articles had been published during the last 5 years from 2017 to 2021. In this research we get 286 affiliated organizations have researched Supply Chain Digital Twin like in figure 2. The ten most prolific research affiliates in Supply Chain Digital Twin research are Hochschule für Wirtschaft und Recht Berlin (N = 9); Empa - Swiss Federal Laboratories for Materials Science and Technology (N = 5); Budapest University of Technology and Economics (N = 5). 425 individual researchers have researched Supply Chain Digital Twin There was a significant increase in the number of publications year in years. From the Supply Chain Digital Twin publication database published in 2017, starting with 1 document in 2017, then there was a significant increase in the number of publications year in years from 2018. In year 2018 (N=6), 2019 (N=23), 2020 (N=49), until 2021 the publications have increase of up to 59 documents. The most knowledge is in the field of Engineering, with 23.6% academic documents (N=76). Then the second is Computer Science with 21.7% academic documents (N=70), and the third is Business, Management and Accounting with 9.6% academic documents (N=31). According to the contribution to knowledge, this study offers a categorization of the Supply Chain Digital Twin study may have to wait several years to find the important themes. So, new topics may be studied or researched in order to increase understanding in this area. Future evaluations of Supply Chain Digital Twin's contribution and influence should be based on the combination of Scopus information, WoS, or another database. This study recommends combining the research subjects of IoT for Sustainability in Agriculture: Digital Twin Concept, Impact, Disruption, Internet, abbreviated as DTCIDI research themes.

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