

A Bibliometric Analysis of Digital Twin Applications in Supply Chain Management: Evidence from Scopus (2015–2025)

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Abstract:

The rapid adoption of digital twin (DT) technologies has significantly transformed supply chain management (SCM), yet the intellectual structure of DT research remains fragmented. This study aims to map the evolution, trends, and collaborative networks of DT applications in SCM. A dataset of 443 documents published between 2015 and 2025 and indexed in the Scopus database was analyzed using bibliometric methods. Performance analysis examined contributions of authors, countries, and journals, while science mapping identified co-citation, co-authorship, and keyword co-occurrence patterns using Biblioshiny and VOSviewer. The results indicate strong growth in research output, the emergence of key themes such as Industry 4.0 and supply chain resilience, and increasing international collaboration. This study provides a structured understanding of DT research in SCM and offers insights to support future research and the effective implementation of digital twin technologies in supply chain systems.

Key Words: Digital Twin, Supply Chain Management, Digital Transformation, Bibliometric Analysis, Industry 4.0

JEL Classification: M11, L23, C88

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Introduction:

Over the past decade, many industries have become highly competitive and fast-evolving, often described as “red oceans” (Caballero-Morales, 2021). Shorter product lifecycles and increased consumer empowerment require firms to innovate rapidly, delivering high-quality products and services while responding to constantly changing market demands (Reddy. K et al., 2019; Shekarian et al., 2022). Companies must design, test, and deliver offerings efficiently, minimizing errors and production faults that could compromise performance and customer satisfaction (Reddy. K et al., 2019).

Digital twin (DT) technology provides a powerful solution by creating virtual representations of physical systems that continuously update in real-time to reflect the actual process or object (Attaran & Celik, 2023). It enables the simulation and monitoring of supply chain processes, allowing firms to identify risks, improve decision-making, and optimize operations (Abideen et al., 2021; Kuo et al., 2021).

Furthermore, DT can integrate financial, logistical, and environmental data to optimize end-to-end supply chain operations (Lv et al., 2023).

In addition to operational improvements, DT supports scenario planning and risk assessment, enabling organizations to respond more effectively to disruptions. Beyond efficiency gains, DT facilitates sustainability and resilience initiatives by modeling environmental impacts, optimizing energy usage, and reducing waste across the supply chain (Fu et al., 2023; Zhu et al., 2019). Moreover, the combination of DT with emerging Industry 4.0 technologies, such as artificial intelligence, machine learning, and cloud computing, enhances the scalability, flexibility, and intelligence of supply chain operations (Kirchhof et al., 2020).

Despite growing interest, research on DT in supply chain management remains fragmented. Existing studies often examine isolated aspects, such as manufacturing, transportation, or design, without providing a comprehensive overview of research trends, collaborations, and emerging topics (Kuo et al., 2021).

To address this gap, this study conducts a bibliometric analysis of 443 documents published between 2015 and 2025 and indexed in the Scopus database. Using Biblioshiny and VOSviewer, the study examines publication trends, influential contributors, and emerging research themes in digital twin applications in supply chain management.

This study is guided by the following research questions:

- **RQ1:** What are the trends in Digital Twin technologies research in supply chain management from 2015 to 2025?
- **RQ2:** Which countries, authors, and journals have contributed most significantly to the development of Digital Twin technologies, and what collaborative networks exist among them?
- **RQ3:** What are the key research themes and emerging technological topics related to Digital Twins in supply chain management?

Based on these questions, the study hypothesizes that:

- **H1:** The number of publications on Digital Twin technologies in logistics has significantly increased over the past decade, reflecting growing academic and industrial interest.
- **H2:** Research collaborations are concentrated among a few leading countries, authors, and institutions, indicating an uneven distribution of expertise.
- **H3:** Emerging research themes increasingly integrate Industry 4.0 technologies such as IoT, AI, and CPS, highlighting the technological evolution of the field.

I. Literature Review:

1. Digital Twin in Logistics and Supply Chain Management:

The synergy between the Internet of Things (IoT) and Cyber-Physical Systems (CPS) is crucial in the development and deployment of Digital Twin technologies in logistics. IoT devices collect vast amounts of data from sensors embedded in physical systems, which are then used to create accurate and real-time digital representations. IoT-enabled Digital Twin applications improve supply chain resilience by enabling predictive maintenance, reducing downtime, and improving resource allocation in real time (Wang et al., 2022).

Moreover, Digital Twins facilitate end-to-end visibility across the supply chain, allowing managers to track goods, monitor equipment performance, and analyze operational bottlenecks in real time. The integration of DT with Industry 5.0 concepts, which emphasize human-centric systems and collaborative automation, fosters more sustainable, adaptive, and resilient supply chains capable of responding to sudden market fluctuations and disruptions (Zhou et al., 2024).

2. Challenges and Adoption of Digital Twin Technologies:

Despite numerous benefits, the adoption of Digital Twin technologies in supply chain management is not without challenges. High implementation costs, integration complexity with legacy systems, and data security concerns remain major obstacles (Maheshwari & Kamble, 2022). Additionally, there is a limited understanding of how Digital Twin technologies can be scaled across industries, particularly in dynamic and complex supply chains (Groshev et al., 2021). Several studies have emphasized that successful integration of Digital Twins requires careful coordination of IoT devices, CPS infrastructure, and data analytics capabilities, as well as training personnel to interpret and act on insights generated from virtual models. The adoption of Digital Twins also demands organizational change, as companies must realign processes and establish cross-functional teams to fully exploit the technology (Cimino et al., 2024).

3. Key Challenges and Future Trends in Digital Twin Adoption:

Looking forward, several trends are emerging in the Digital Twin space. Artificial intelligence (AI), machine learning, and big data analytics are expected to heavily influence future Digital Twin applications, allowing for more predictive insights, faster decision-making, and enhanced operational visibility across complex supply chains, enabling smarter and more autonomous decision-making processes. Sustainability is becoming a key driving force, as Digital Twin technologies are increasingly applied to optimize green supply chains, reduce environmental impact, and minimize waste while also supporting circular economy initiatives and promoting resource efficiency across all logistics processes (Galkin et al., 2025). Future research is expected to focus on interoperability, data standardization, cybersecurity, and the economic impact of Digital Twin adoption across supply chain networks (Groshev et al., 2021).

4. Bibliometric Analysis of Digital Twin Research:

Several bibliometric studies have examined the growth of Digital Twin research in supply chain management. Barykin et al. (2020) conducted a comprehensive

bibliometric analysis to map the evolution of Digital Twin technologies and their applications in various sectors, including logistics and SCM. Their findings revealed that the number of publications on Digital Twin has grown significantly over the past decade, with the highest concentration of research occurring in the (2019-2023) period. A similar study by Lam et al. (2023) focused on the impact of Digital Twin in smart cities, providing insights into its role in urban logistics and infrastructure management.

Despite these advances, adoption challenges and fragmented research highlight the need for comprehensive analyses to better understand the intellectual structure and evolution of the field.

II. Research Methodology:

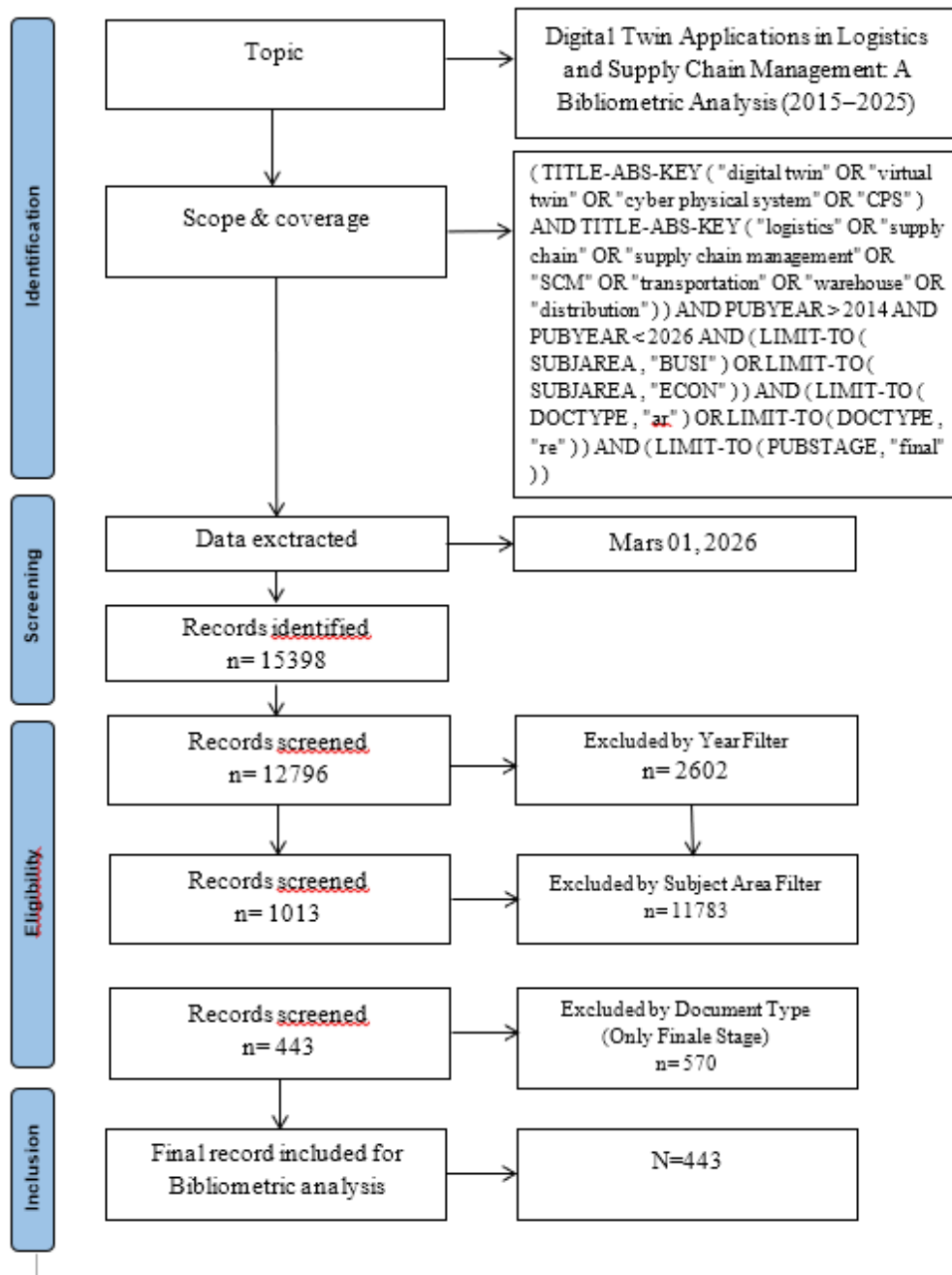
The data for this bibliometric analysis was retrieved from the Scopus database, a widely recognized and comprehensive source for scholarly articles, books, and conference papers in various disciplines. A targeted search query was employed to gather documents related to digital twin applications in logistics and supply chain management. The search query was:

(TITLE-ABS-KEY ("digital twin" OR "virtual twin" OR "cyber-physical system" OR "CPS")) AND TITLE-ABS-KEY ("logistics" OR "supply chain" OR "supply chain management" OR "SCM" OR "transportation" OR "warehouse" OR "distribution")) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (PUBSTAGE, "final")).

The query was designed to focus on recent academic contributions from 2015 to 2025, ensuring the dataset represents the latest developments in the field. This yielded a dataset of 443 documents, including journal articles and review papers, that met the specified criteria.

The study selection process is summarized in Figure 1, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. The initial search yielded 15,398 records. After screening for duplicates, publication type, subject area, and final publication stage, the final dataset of 443 documents was retained. This flowchart provides a clear overview of the identification, screening, and selection process, ensuring transparency and reproducibility of the bibliometric dataset.

Fig. 1 : « PRISMA Flow Diagram of the Data Selection Process »



Source : Authors' elaboration following the PRISMA framework.

The analysis was carried out using the Bibliometrix R package and VOSviewer software. Bibliometrix was employed to perform descriptive analyses of the dataset, including publication trends, authorship patterns, citation metrics, and keyword analysis. VOSviewer was used to visualize co-occurrence networks and to identify clusters of related research topics.

To examine the structure and evolution of digital twin research in supply chain management, several bibliometric indicators were applied, including publication growth, authorship characteristics, collaboration networks, citation analysis, and keyword trends. These indicators provide a comprehensive overview of research dynamics and facilitate the identification of key themes and emerging topics.

III. Results:

1. Descriptive analysis of the dataset:

1.1. Main Information:

Table 1 : « Main bibliometric indicators of the dataset (2015–2025) »

MAIN INFORMATION ABOUT DATA	
Timespan	2015:2025
Sources (Journals, Books, etc)	191
Documents	443
Annual Growth Rate %	36.34
Document Average Age	3.7
Average citations per doc	45.91
References	52314
DOCUMENT CONTENTS	
Keywords Plus (ID)	2120
Author's Keywords (DE)	1540
AUTHORS	
Authors	1417
Authors of single-authored docs	41
AUTHORS COLLABORATION	
Single-authored docs	46
Co-Authors per Doc	3.52
International co-authorships %	32.96
DOCUMENT TYPES	
article	405
review	38

Source : Authors' elaboration based on Biblioshiny (Bibliometrix R package)

This study analyzes 443 documents published between 2015 and 2025, retrieved from the Scopus database. The publications are distributed across 191 sources, reflecting a relatively wide dispersion of research output in the field of digital twin (DT) applications in supply chain management.

The dataset shows a high annual growth rate of 36.34%, indicating rapid expansion. The average document age is 3.7 years, confirming that the field is recent, while the average of 45.91 citations per document reflects notable academic impact.

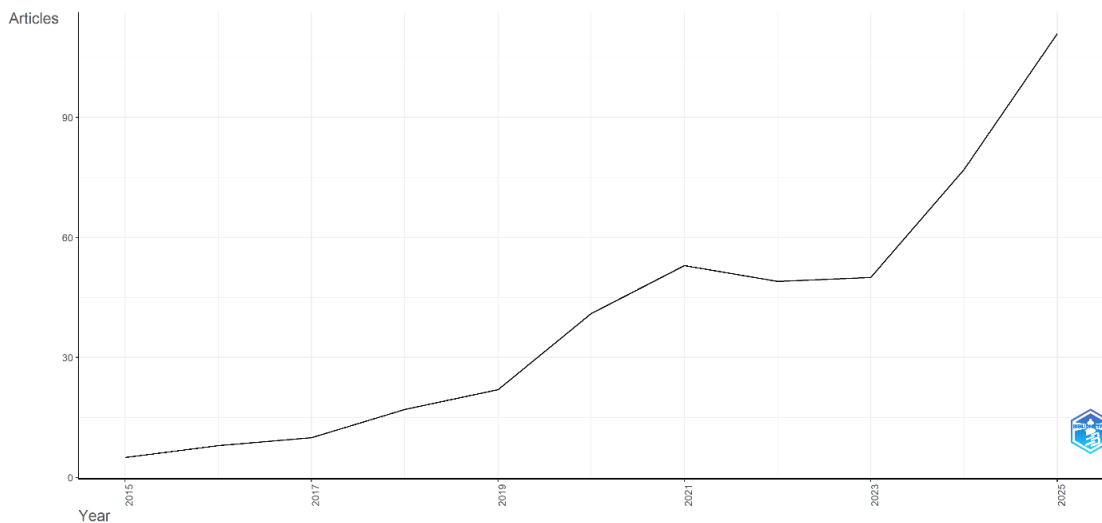
The dataset includes 2,120 Keywords Plus and 1,540 author keywords, highlighting diverse research themes and interdisciplinary connections.

A total of 1,417 authors contributed to the dataset, with only 41 single-authored documents, indicating strong collaboration. This is supported by an average of 3.52 co-authors per document and an international collaboration rate of 32.96%.

Most documents are journal articles (405), followed by 38 review papers, indicating a balance between empirical and review-based research.

1.2. Annual Scientific Production

Fig. 2 : « Annual Scientific Production (2015–2025) »



Source : Authors' elaboration using Biblioshiny (Bibliometrix R package)

Building on the descriptive analysis of the dataset, the temporal evolution of publications provides insight into how research activity in digital twin applications within logistics and supply chain management has developed over the past decade. The results reveal a clear and sustained upward trend in the number of publications from 2015 to 2025, confirming growing academic interest in this emerging domain. In the early stage (2015–2018), the number of publications remained relatively low, with only a limited number of studies addressing digital twin concepts in logistics contexts. This reflects the nascent stage of the field, where digital twin technology was primarily associated with manufacturing and engineering applications rather than supply chain systems.

A noticeable increase appears from 2019, marking a transition toward broader adoption in supply chain management, driven by advances in Industry 4.0 technologies such as IoT, big data, and cyber-physical systems.

After 2020, publication output rises sharply, reaching its peak in 2025, highlighting the growing importance of digital twin technologies for supply chain visibility and real-time decision-making.

Overall, these trends confirm that digital twin research in supply chain management is rapidly evolving and becoming a central area within digital transformation.

2. Source Analysis:

2.1. Most relevant sources:

The distribution of publications across the most relevant sources highlights the central role of a limited number of high-impact journals in advancing research on digital twin applications in supply chain management. As shown in Table 2, the International Journal of Production Economics emerges as the most productive source, contributing 39 publications (8.80%), followed by Logistics and the International Journal of Production Research, with 19 (4.29%) and 17 (3.84%) publications, respectively.

A notable observation is that the majority of the leading journals belong to the first quartile (Q1) according to the SCImago Journal Rankings, including International Journal of Production Economics, International Journal of Production Research, Journal of Cleaner Production, and Industrial Management and Data Systems. This indicates that research in this field is predominantly published in high-impact and well-established journals, reflecting both the scientific relevance and the growing maturity of the topic.

Furthermore, the presence of journals such as Internet of Things and IEEE Transactions on Engineering Management demonstrates the strong integration of digital technologies and engineering perspectives into logistics and supply chain research. At the same time, journals like Journal of Cleaner Production and Frontiers in Energy Research highlight the increasing importance of sustainability and energy-related aspects within digital twin applications.

Overall, the distribution of publications across these sources confirms the interdisciplinary nature of the field, combining elements of operations management, information systems, engineering, and sustainability, and underscores the role of leading journals in shaping the development of digital twin research in supply chain management.

Table 2 : « Top 10 Most Relevant Sources in Digital Twin Applications in Logistics and Supply Chain Management (2015–2025) »

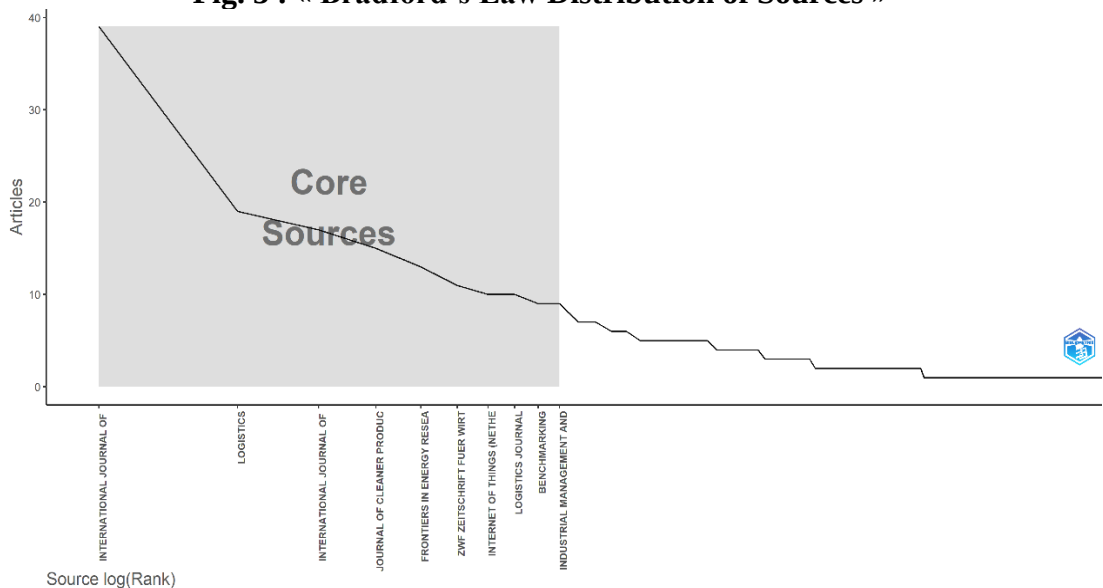
Sources	NP	H-index	SJR	Quartile	%
International Journal Of Production Research	39	201	2.242	Q1	8.80 %
Logistics	19	31	0.789	Q2	4.29 %
International Journal Of Production Economics	17	248	2.833	Q1	3.84 %
Journal Of Cleaner Production	15	354	2.174	Q1	3.39 %
Frontiers In Energy Research	13	75	0.553	Q2	2.94 %
ZWF Zeitschrift Fuer Wirtschaftlichen Fabrikbetrieb	11	19	0.271	Q3	2.48 %
Internet Of Things (Netherlands)	10	69	1.527	Q1	2.26 %
Logistics Journal	10	7	0.126	Q4	2.26 %
Benchmarking	9	89	1.102	Q1	2.03 %
Industrial Management And Data Systems	9	132	1.279	Q1	2.03 %

Source : Authors' elaboration using Bibliometrix (R package) and SCImago Journal Rankings.

2.2 .Bradford's Law

To examine the concentration and dispersion of publications across journals, Bradford's Law was applied. This law describes how scientific output on a given topic tends to be concentrated in a small number of core journals, followed by a progressively larger set of less productive sources (Hjørland & Nicolaisen, 2005). Applying this framework allows for the identification of core publication outlets and the assessment of source distribution patterns within the field.

Fig. 3 : « Bradford's Law Distribution of Sources »



Source: Authors' elaboration using Bibliometrix (R package).

As illustrated in Figure 3, the application of Bradford's Law reveals a clear concentration of publications within a limited number of core journals, followed by a progressive dispersion across a larger number of less productive sources. The initial segment of the distribution represents the core zone, where a small group of journals contributes a disproportionately high number of publications. Beyond this core, the number of journals increases substantially while their individual contributions decline, forming a hierarchical distribution of journals. This pattern reflects the presence of highly influential journals that dominate knowledge dissemination, alongside a broad range of peripheral sources contributing more modestly to the field.

These findings confirm that research on digital twin applications in supply chain management is both concentrated and widely distributed, aligning with Bradford's Law. This distribution highlights the role of leading journals while emphasizing the interdisciplinary expansion of the field.

3. Author Analysis:

3.1. Most Relevant Authors:

Table 3 : « Top 10 Most Relevant Authors in Digital Twin Applications in Logistics and Supply Chain Management (2015–2025) »

Authors	Articles	Fractional Publications	H index
IVANOV, DMITRY	16	10.23	85
DOLGUI, ALEXANDRE	7	2.73	75
HUANG, GEORGE Q	6	1.34	80
BAG, SURAJIT	4	1.41	50
GERLACH, BENNO	4	1.25	5
ANBANANDAM, RAMESH	3	1.33	17
BADAKHSHAN, EHSAN	3	1.5	11
BARYKIN, SERGEY Y	3	0.625	5
BELHADI, AMINE	3	0.56	40
GUNASEKARAN, ANGAPPA	3	0.61	133

Source : Authors' elaboration using Bibliometrix (R package).

Note: The H-index values were retrieved from Semantic Scholar.

The distribution of the most relevant authors highlights a concentration of research contributions among a limited number of highly productive scholars. As shown in Table 3, Dmitry Ivanov stands out as the most influential author, with 16 publications and a high H-index of 85, reflecting both productivity and academic impact.

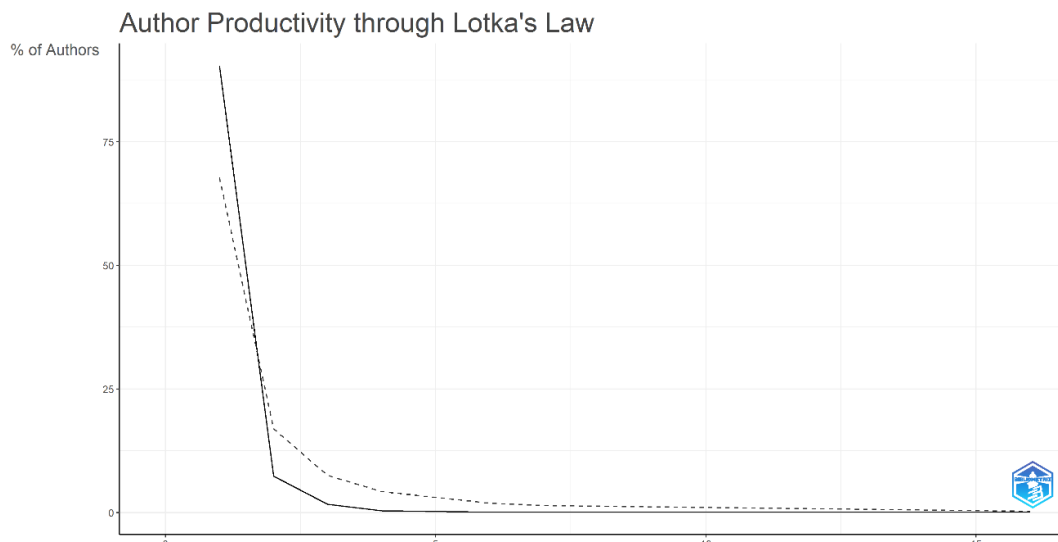
Other notable contributors include Alexandre Dolgui and George Q. Huang, who demonstrate strong research activity and citation influence. Additionally, authors such as Angappa Gunasekaran exhibit exceptionally high H-index values, indicating long-standing contributions and significant recognition within the field.

Overall, these findings suggest that digital twin research in supply chain management is shaped by a core group of leading researchers, supported by a broader base of emerging contributors.

3.2. Lotka's Law:

To examine the distribution of author productivity in the field, Lotka's Law was applied. This law describes the frequency of publications by authors, suggesting that the number of authors producing n publications is inversely proportional to n^2 , meaning that a large proportion of authors contribute only a single publication, while a small number of authors are highly productive.

Fig. 4 : « Author Productivity Distribution According to Lotka's Law »



Source: Authors' elaboration using Bibliometrix (R package).

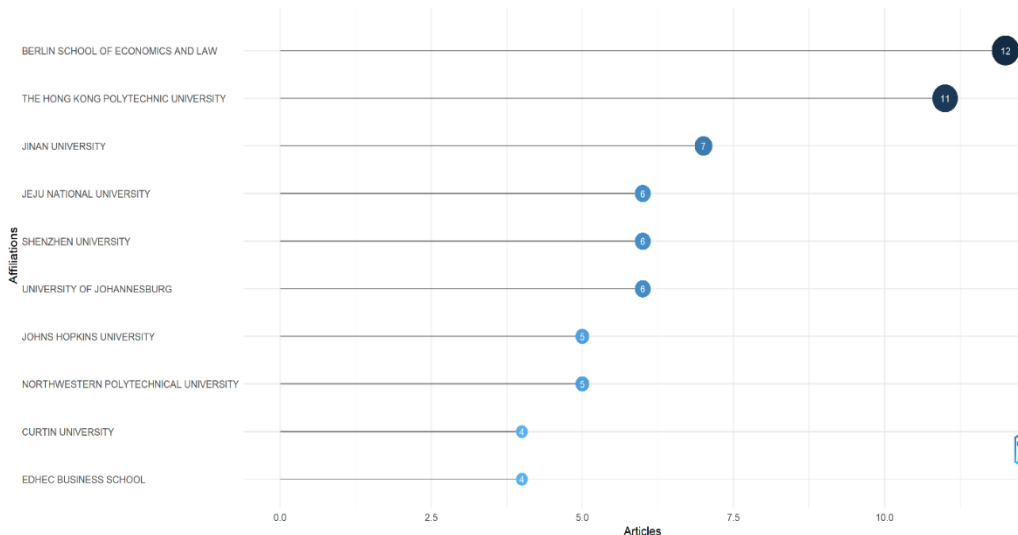
As illustrated in Figure 4, the empirical distribution of author productivity closely follows the theoretical Lotka curve. The results show that the majority of authors contributed only one publication, whereas the number of authors declines rapidly as the number of publications increases. This indicates a highly skewed distribution, where a limited group of researchers accounts for a significant portion of the total scientific output.

The alignment between the observed and theoretical distributions confirms the applicability of Lotka's Law in the context of digital twin applications in supply chain management. This pattern suggests that the field is characterized by a broad base of occasional contributors and a small core of highly productive authors, which is typical of emerging and interdisciplinary research fields.

4. Affiliation and Country Analysis:

4.1. Most Relevant Institutional Affiliations:

Fig. 5 : « Most Relevant Institutional Affiliations in Digital Twin Applications in Supply Chain Management (2015–2025) »



Source: Authors' elaboration using Bibliometrix (R package).

The analysis of institutional affiliations provides insights into the leading research organizations contributing to the field of digital twin applications in supply chain management. As illustrated in Figure 5, the Berlin School of Economics and Law ranks as the most productive institution with 12 publications, followed by The Hong Kong Polytechnic University with 11.

Other prominent affiliations include Jinan University with 7 publications, as well as Jeju National University and Shenzhen University, each contributing 6 publications.

4.2. Country Contributions:

The analysis of country contributions provides insight into the global distribution of scientific production in the field of digital twin applications in supply chain management. As presented in Table 4, China leads the way with the highest number of publications (183 articles), followed by India (142 articles) and the USA (110 articles). These three countries account for a substantial share of global research output.

In addition to the sheer number of publications, Table 4 also presents data on the international collaboration rate (MCP %) for each country. It is noteworthy that China, despite its high number of articles, has a lower percentage of international collaborations (24.04%) compared to other countries like Canada (60.61%) and Germany (54.46%). This highlights the importance of international cooperation in enhancing the global impact of research.

Table 4 : « Country Scientific Production and International Collaboration (2015–2025) »

Country	NA	A%	SCP	MCP	MCP %
CHINA	183	9,92	139	44	24,04
INDIA	142	7,70	82	60	42,25
USA	110	5,96	96	14	12,73
GERMANY	101	5,47	46	55	54,46
UNITED KINGDOM	87	4,72	68	19	21,84
FRANCE	58	3,14	35	23	39,66
ITALY	53	2,87	41	12	22,64
AUSTRALIA	41	2,22	29	12	29,27
CANADA	33	1,79	13	20	60,61
SOUTH KOREA	32	1,73	23	9	28,12

Source : Authors' elaboration based on *Biblioshiny* (R package).

5. Citation Analysis:

The table below presents the most cited documents in digital twin applications in logistics and supply chain management, based on total citations, citations per year, and normalized citations. Ivanov D.'s papers, particularly from 2020 and 2021, lead the list with the highest citation impact.

Table 5 : « Most Cited Documents in Digital Twin Applications in Supply Chain Management (2015–2025) »

Paper	Total Citations	TC/ Year	Normalized TC
IVANOV D, 2020, TRANSP RES PART E LOGIST TRANSP REV	1768	252,57	15,66
KUSIAK A, 2018, INT J PROD RES	1173	130,33	7,74
IVANOV D, 2021, PROD PLANN CONTROL	1119	186,50	12,28
WINKELHAUS S, 2020, INT J PROD RES	601	85,86	5,32
FATORACHIAN H, 2021, PROD PLANN CONTROL	553	92,17	6,07
IVANOV D, 2016, INT J PROD RES	476	43,27	6,04
TANG CS, 2019, TRANSP RES PART E LOGIST TRANSP REV	412	51,5	6,97
IVANOV D, 2020, INT J INTEGR SUPPLY MANAGE	409	58,43	3,62
IVANOV D, 2021, INT J PROD RES	400	66,67	4,39
DOLGUI A, 2020, INT J PROD RES	392	56	3,47

Source : Authors' elaboration based on *Biblioshiny* (R package).

Overall, the most cited documents are primarily authored by a small group of influential researchers, particularly Ivanov, whose work dominates the field. This

highlights the significant role of key contributors in shaping the development and direction of digital twin research in supply chain management.

6. Keyword and Trend Analysis :

6.1. Most Frequent Keywords :

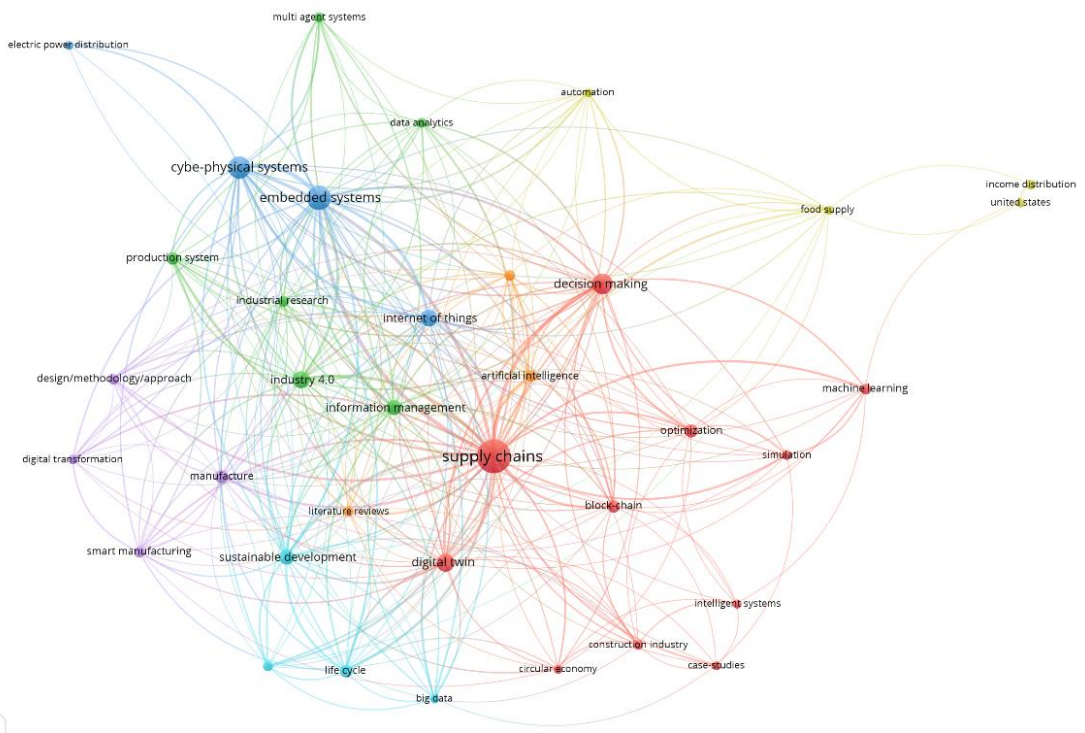
Table 6 : « Most Frequent Keywords and Their Metrics in Digital Twin Applications in Supply Chain Management (2015–2025) »

Keyword	Cluster	Links	TLS	Occurrences	Avg. citations
Supply chains	1	32	295	99	103.71
Embedded systems	3	28	175	49	113.77
Cyber-physical systems	3	28	129	42	68.23
Decision making	1	27	111	35	114.62
Digital twin	1	26	71	28	80.25
Internet of things	3	26	89	25	99.52
Industry 4.0	2	26	90	24	162.62
Information management	2	28	82	21	94.19
Sustainable development	6	25	87	21	119.54
Manufacture	5	20	50	15	174.13

Source : Authors' elaboration based on *Biblioshiny* (R package).

Table 6 presents the most frequently used keywords in supply chain research from 2015 to 2025. The table highlights key trends, with terms such as “supply chains”, “digital twin”, and “industry 4.0” emerging as central to the discourse. These keywords reflect the increasing emphasis on technological integration, sustainability, and supply chain resilience within the logistics field. The rising prominence of these keywords indicates the growing importance of digital transformations in optimizing supply chains and addressing challenges such as global disruptions and sustainability.

Fig. 6 : « Keyword Co-occurrence Network in Digital Twin Applications in Supply Chain Management (2015–2025) »



Source : Authors' elaboration using Biblioshiny (R package).

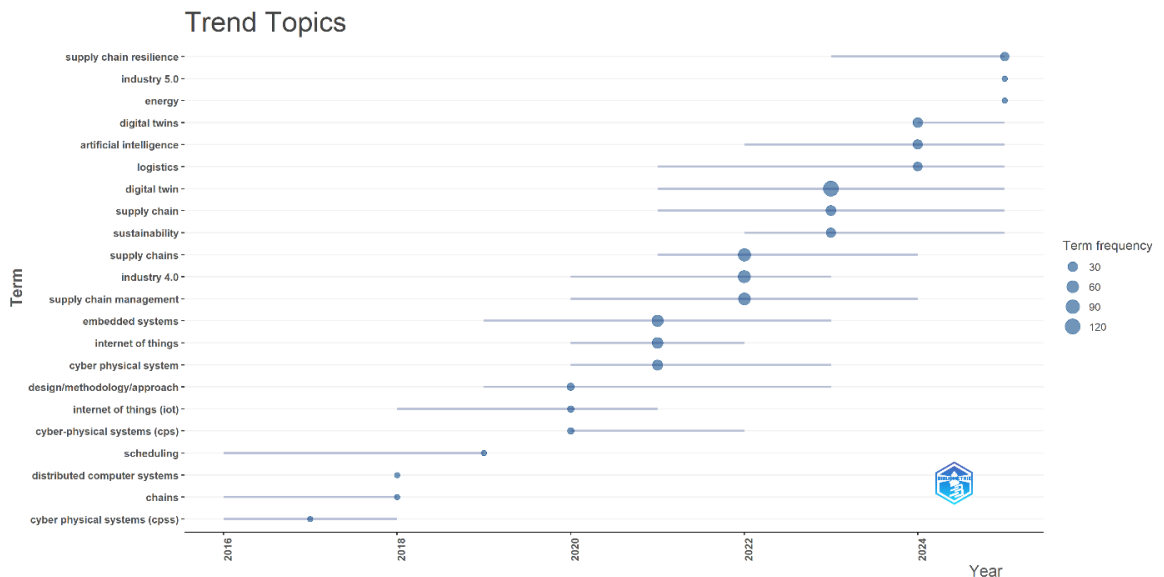
Figure 6 illustrates the keyword co-occurrence network, revealing the main conceptual structure of digital twin research in supply chain management. The network highlights strong interconnections between key technological and managerial concepts, with “supply chains” and “digital twin” positioned as central nodes. The visualization shows several distinct clusters representing major research themes. The red cluster is primarily associated with decision-making, optimization, and artificial intelligence, reflecting the increasing importance of data-driven approaches. The blue cluster focuses on cyber-physical systems, embedded systems, and Internet of Things, emphasizing the technological infrastructure supporting digital twin applications.

Additionally, the green and yellow clusters highlight themes related to data analytics, information management, and supply chain processes, while the presence of terms such as “sustainable development” and “circular economy” indicates a growing focus on sustainability.

Overall, the network structure demonstrates that digital twin research in supply chain management is highly interconnected and interdisciplinary, integrating advanced technologies with operational and strategic decision-making.

6.2. Trend Topics

Fig. 7 : « Trend Topics in Digital Twin Applications in Supply Chain Management (2015–2025) »



Source : Authors' elaboration using Biblioshiny (R package).

Figure 7 presents the evolution of research topics in digital twin applications in supply chain management from 2015 to 2025. The graph highlights the increasing prominence of key keywords such as “digital twin,” “supply chain,” and “industry 4.0” in recent years.

As shown, “digital twin” emerges as a dominant topic after 2020, reflecting its growing relevance within the field. Other important themes include “supply chain management,” “sustainability,” and “cyber-physical systems,” which continue to gain attention over time.

Earlier topics such as “embedded systems” and “Internet of Things” appear in earlier years, indicating their foundational role in enabling digital twin applications. In contrast, more recent topics emphasize advanced analytics, decision-making, and system optimization.

Overall, the evolution of these topics demonstrates a clear shift from foundational technologies toward integrated, data-driven, and sustainability-oriented approaches in supply chain management.

7. Discussion

This study presents a bibliometric analysis of digital twin applications in supply chain management based on Scopus-indexed publications from 2015 to 2025. The findings reveal a strong increase in research output, particularly after 2018, highlighting the growing importance of digital twin technologies in enhancing supply chain performance and resilience.

The results also indicate a concentration of publications within a limited number of high-impact journals, such as the *International Journal of Production Research*, the *Journal Logistics*, *International Journal of Production Economics*, and *Journal of Cleaner Production*. This confirms their central role in shaping the field, while the broader distribution of publications reflects the interdisciplinary nature of digital twin research.

The application of Bradford's Law suggests that while a few journals dominate the field, the research is spread across a broad array of interdisciplinary sources, illustrating the expanding scope of digital twin applications across various sectors, from IoT to sustainability. However, this concentration of publications within a limited number of journals may also constrain the diversity of perspectives and limit the dissemination of alternative approaches within the field.

Author analysis based on Lotka's Law shows that a relatively small group of researchers contributes significantly to the field. Leading scholars such as Ivanov, Dolgui, and Huang play a central role, demonstrating high research productivity and academic impact. This concentration of influential authors, combined with a high level of international collaboration, highlights the global and cooperative nature of research in this domain.

Furthermore, keyword analysis reveals a clear shift in research focus from foundational topics toward advanced themes such as Industry 4.0, cyber-physical systems, and real-time data integration. The increasing prominence of concepts such as resilience and sustainability reflects the transition toward more adaptive and technologically driven supply chain systems. Nevertheless, the rapid emergence of new themes may also indicate a lack of theoretical consolidation within the field.

Despite these contributions, some limitations should be acknowledged. The reliance on the Scopus database may exclude relevant studies indexed in other sources such as Web of Science or Google Scholar. Future research could address this limitation by incorporating multiple databases and advanced analytical approaches to provide a more comprehensive perspective.

Overall, the findings provide a structured and data-driven understanding of digital twin research in supply chain management, offering valuable insights into its evolution, key contributors, and emerging themes.

Finally, the findings highlight the increasing strategic role of digital twin technologies in supporting decision-making processes and improving supply chain visibility in complex and dynamic environments. As supply chains continue to face disruptions and uncertainty, the integration of digital twins with advanced analytics is expected to further enhance predictive capabilities and operational efficiency.

Conclusion

This study provides a comprehensive bibliometric analysis of digital twin applications in logistics and supply chain management over the period 2015–2025. By examining publication trends, influential journals and authors, collaboration patterns, and thematic developments, the study offers valuable insights into the evolution and current state of research in this rapidly expanding field.

The findings highlight a significant growth in research output, particularly after 2018, reflecting the increasing recognition of digital twin technologies as a transformative tool in logistics and supply chain management. Key journals, such as the *Journal of Manufacturing Science and Engineering* and the *International Journal of Production Economics*, continue to play a central role in disseminating impactful research. The rise of emerging themes like Industry 4.0, cyber-physical systems, and supply chain resilience indicates the field's shift toward integrating advanced technologies for smarter, more resilient logistics systems.

The analysis also reveals a growing interdisciplinary collaboration, with increasing contributions from diverse fields like IoT, AI, and sustainability, illustrating the complex and interconnected nature of research in the domain. This trend underscores the growing importance of digital twin technologies in addressing contemporary challenges such as global disruptions, environmental concerns, and technological integration.

From a global perspective, the results demonstrate the globalization of research in digital twin applications, evidenced by the rising international collaboration and the dominance of a small group of highly influential authors. This further confirms the international and interdisciplinary nature of digital twin research, positioning it as a key player in shaping the future of logistics and supply chain management.

Future research could focus on the integration of artificial intelligence, blockchain, and machine learning with digital twin technologies to enhance predictive capabilities and optimize supply chain management. Additionally, expanding the bibliometric analysis to include alternative databases and considering altmetric indicators could provide a more holistic understanding of the research's societal impact and global reach.

Furthermore, the continued evolution of digital twin technologies is expected to support more intelligent and data-driven supply chain systems. As organizations increasingly adopt these technologies, their role in enhancing operational transparency, risk management, and decision-making will become more critical. From a practical perspective, this highlights the importance of implementing digital twins in real-world supply chain contexts and strengthening collaboration between academia and industry to accelerate innovation and effective adoption.

Overall, this study makes a significant contribution to the literature by offering a longitudinal and data-driven perspective on the development of digital twin applications in logistics. The findings provide valuable reference points for both scholars and practitioners who are interested in the intellectual structure, emerging trends, and future directions of this dynamic field.

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