

Cold Chain Management and Firm Performance: A Bibliometric Analysis and Future Research Direction

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ABSTRACT

The bibliometric analysis explores the field of research on cold chain management and its impact on firm performance, aiming to identify trends, gaps, and future research directions in the field. Leveraging on data from the Web of Science database, 155 articles published between 2015 and 2024 were analysed. The study reveals a growing interest in this area, with an increasing number of publications over the years, particularly, with notable spikes in 2022 and 2023. Key sources such as the Journal of Cleaner Production and Industrial Management and data Systems emerged as influential contributors to the literature. Prominent authors like Li, G. and Zhang, J. have made significant contributions, China leads in scientific production followed by India and the UK. The thematic evolution highlights shifting research streams from demand and logistics in cold chains to include topics like sustainability and impact on cold supply chains. Collaboration networks by countries and authors reveal central players like the USA and China, as well as influential authors such as Zhang, J. and Li, G. co-citation networks, identify seminar works driving the discus, including papers by Saif A and Wang S.Y. Overall, the study underscores the importance of effective cold chain management for firm performance and offers valuable insights for future research, emphasising the need for interdisciplinary collaboration and addressing emerging challenges in the field, such as sustainability and pandemic resilience. This analysis provides a foundation for scholars and practitioners to advance knowledge and practices in cold chain management, thereby enhancing operational efficiency, product quality, and market competitiveness.

Keywords: Cold supply chain, Management, Firm performance, Bibliometrics,



1.0 Introduction

Cold chain management involves the strategic orchestration of activities aimed at maintaining the quality and integrity of temperature-sensitive products throughout the entire supply chain network (Zhang, 2007; Bo & Danyu, 2009; Feyisa, 2021). This includes meticulous control of temperature conditions (Ramaa, Subramanya & Rangaswamy, 2012); utilisation of specialised storage and transportation facilities (Brzozowska & Brzeszczak, 2016; Karpova, 2017); implementation of monitoring and tracking technologies (Ottih, Cussen & Mustapha, 2018; Asghari & Sallstrom, 2019), and adherence to quality assurance standards (Mohammed, et al., 2021; Logmore, 2020). The primary objective of cold chain management is to ensure that perishable goods, such as pharmaceuticals, food products, and vaccines, are maintained within specified temperature ranges to prevent spoilage, degradation, or loss of efficacy (Zhang, 2007; Bo & Danyu, 2009; Adom, Kamil & Agyem, 2018). Hence, effective cold chain management is crucial for firms as it directly impacts performance metrics such as product quality, operational efficiency, customer satisfaction, and market competitiveness (Mavimbe & BJune, 2017). Given the importance of cold chain management, this study conducts a bibliometric analysis to examine the existing literature on cold chain management and its impact on firm performance. Thus, the primary objective is to identify key trends, themes, and research gaps, and to provide insights for future research directions in the field. Consequently, the research questions are:

- i. What is the current state of research on cold chain management and its impact on firm performance?
- ii. Who are the prominent authors contributing to this field in terms of research output and citations?
- iii. Which academic journals, countries, and institutions are leading the research efforts in cold chain management?
- iv. What are potential avenues for future research in this field, and how can they contribute to advancing our understanding of cold chain management's role in enhancing firm performance?

2.0 Methodology

This study deploys a bibliometric approach to examine the existing state of research on cold chain management and firm performance. Bibliometric analysis has shown its relevance in exploring similar research objectives within various domains, such as operations management, and humanitarian supply chain management (Fosso-Wamba, 2020). Additionally, it has been instrumental in investigating the evolution of resource-based theories (Zhang, et al., 2021); and the field of supply chain research (Fahimina, Sarkis & Davarzani, 2015). Consequently, to approach this study, the researchers applied search terms “cold chain management” OR “cold supply chain” OR “vaccine supply chain” OR “cold chain logistics” (topics) and “performance” (topics) on WEB of Science database, and 586 articles constitutes the initial search. For further screening, the researchers applied a filter by Citation Topics Meso limiting the search to areas such as supply chain and logistics, management, sustainability science, operations research and management science, and 167 articles remaining. Furthermore, the study limited the search by years (2015-2024) and 155 articles remained for the review. The remaining journal articles underwent further examination using a widely recognised bibliometric tools; Biblioshiny on Bibliometrix.

3.0 Results

In this section, the study outlines the significant findings from the analysis. Table 1 provides crucial details concerning the documents extracted from the Web of Science (WoS) database of cold chain management and firm performance. These documents were published between 2015 and 2024 and originated from 81 distinct sources. The documents in terms of articles comprises 124 document out of a total 155 document: constituting approximately 80.0 % of the total document.

Table 1: Primary information about the collected documents

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2015:2024
Sources (Journals, Books, etc)	81
Documents	155
Annual Growth Rate %	11.51
Document Average Age	3.21
Average citations per doc	25.78
References	8800
DOCUMENT CONTENTS	
Keywords Plus (ID)	446
Author's Keywords (DE)	684
AUTHORS	
Authors	470
Authors of single-authored docs	5
AUTHORS COLLABORATION	
Single-authored docs	5
Co-Authors per Doc	3.63
International co-authorships %	35.48
DOCUMENT TYPES	
Article	124
article; early access	10
Review	20
review; early access	1

Source: Authors Analysis on Bibliometrix

Table 2 and Figure 1 provide an overview of the annual distribution of production document related to cold chain management and firm performance. In terms of yearly distribution of number of articles produced each year from 2015 to 2024, trend reveals that there is a noticeable trend of increasing production over the years, with fluctuations in the number of articles. Production begins with a relatively low number of articles in 2015 and 2016, each accounting for 2% of the total. From 2017 onwards, there is a gradual increase in production, with 2018 marking a significant rise to 15 articles (10%). Notable spikes occur in 2022 and 2023, with 36 (23%) and 30 (19%) articles respectively, indicating heightened research activity during these years. Production in 2024 shows a slight decrease to 8 articles (5%) compared to the previous years. The trend suggests a growing interest in cold chain management and firm performance research, particularly in recent years. The fluctuations may be influenced by factors such as emerging issues, technological advancements, or shifts in research focus within the field.



Table 2: Annual distribution of production documents

Year	Articles	%
2015	3	2%
2016	3	2%
2017	8	5%
2018	15	10%
2019	10	6%
2020	22	14%
2021	20	13%
2022	36	23%
2023	30	19%
2024	8	5%
Total	155	100%

Source: Authors Analysis on Bibliometrix

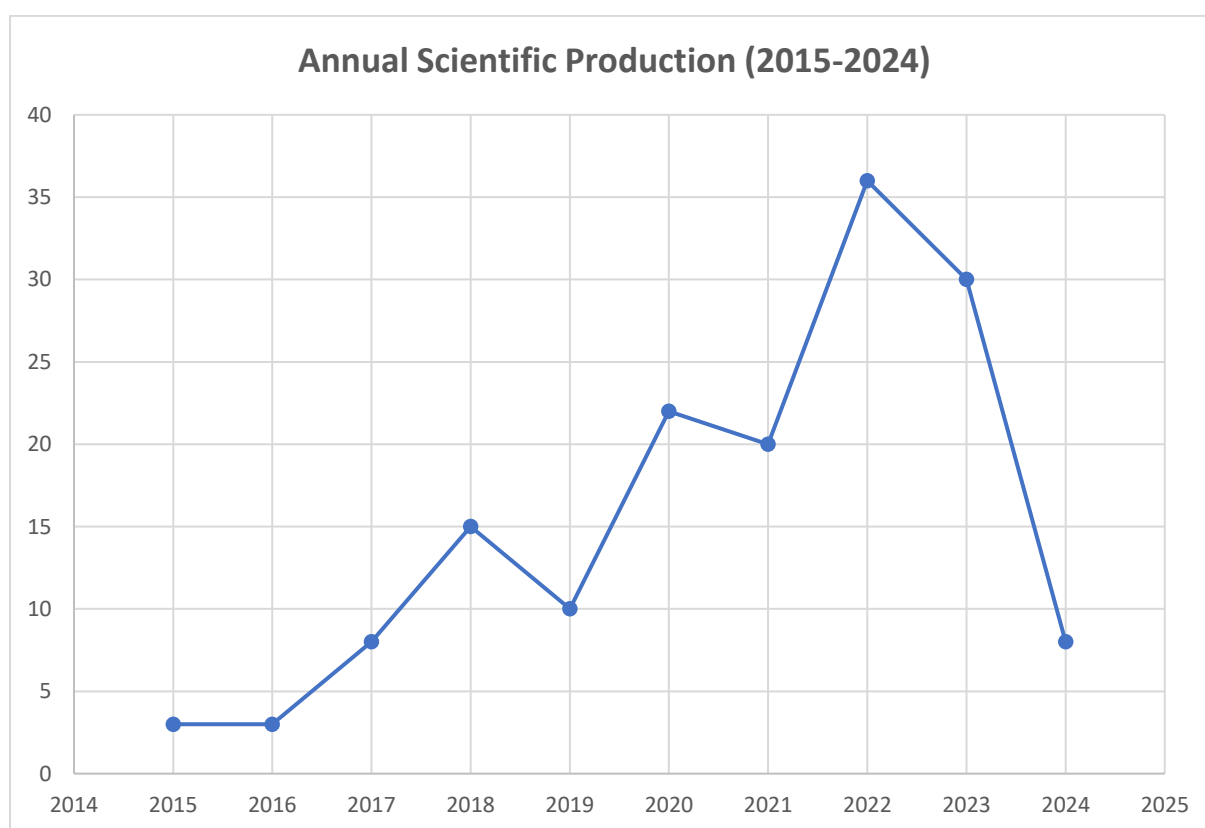


Figure 1: Annual Scientific Production

Table 3: Top 10 most relevant sources

SOURCES	Rank	Freq	cumFreq	Zone
JOURNAL OF CLEANER PRODUCTION	1	11	11	Zone 1
INDUSTRIAL MANAGEMENT \& DATA SYSTEMS	2	9	20	Zone 1
SUSTAINABILITY	3	9	29	Zone 1
COMPUTERS \& INDUSTRIAL ENGINEERING	4	7	36	Zone 1
INTERNATIONAL JOURNAL OF LOGISTICS MANAGEMENT	5	7	43	Zone 1
ANNALS OF OPERATIONS RESEARCH	6	5	48	Zone 1
JOURNAL OF ADVANCES IN MANAGEMENT RESEARCH	7	5	53	Zone 1
EXPERT SYSTEMS WITH APPLICATIONS	8	4	57	Zone 2
TRANSPORTATION RESEARCH PART E-LOGISTICS AND TRANSPORTATION REVIEW	9	4	61	Zone 2
ENERGIES	10	3	64	Zone 2

Source: Authors Analysis on Bibliometrix

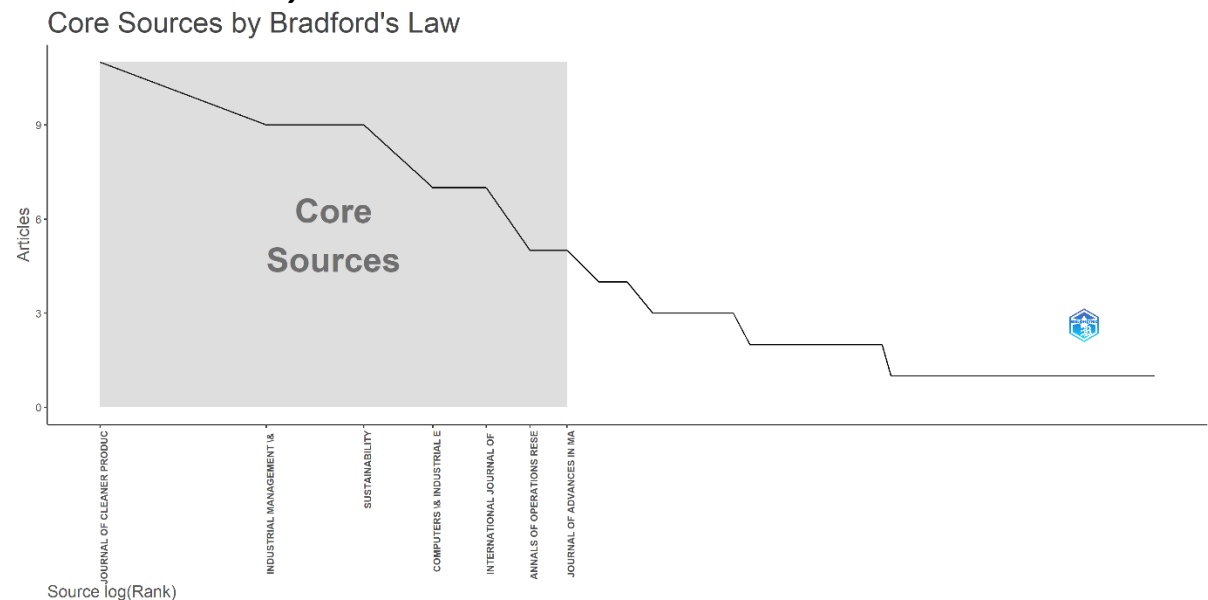


Figure 2: Bradford's Law

Table 3 outline the top 10 sources for cold chain management and firm performance research, based on frequency and cumulative frequency. Notably, the Journal of Cleaner Production leads with 11 citations, followed by Industrial Management and Data Systems and Sustainability, each with 9. Computers and Industrial Engineering and International Journal of Logistics Management are also prominent, each cited 7 times. According to the Bradford's law in Figure 2, these sources are core and they fall into Zone 1 category which includes highest quality and the most influential publications on cold chain management and firm performance. These sources span various disciplines, offering insights crucial for researchers. For those interested in the field, prioritising these journals ensures access to impactful literature, advancing knowledge in cold chain management and firm performance.

Table 4: Top 10 most local cited sources

Sources	Articles
INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS	492
JOURNAL OF CLEANER PRODUCTION	460
EUROPEAN JOURNAL OF OPERATIONS RESEARCH	367
INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	243
COMPUTERS AND INDUSTRIAL ENGINEERING	203
TRANSPORTATION RESEARCH PART E-LOGISTICS AND TRANSPORTATION REVIEW	191
THE INTERNATIONAL JOURNAL OF LOGISTICS MANAGEMENT	159
SUSTAINABILITY-BASEL	149
FOOD CONTROL	145
BRITISH FOOD JOURNAL	141

Source: Authors Analysis on Bibliometrix

Table 4 reveals the top 10 most locally cited sources in research on cold chain management and firm performance. Notably, the International Journal of Production Economics tops the list with 492 articles, followed closely by the Journal of Cleaner Production with 460 articles. These journals, along with others like the European Journal of Operations Research and Computers and Industrial Engineering, indicate the breadth and depth of scholarship in this domain, covering various aspects of production, logistics, and sustainability.

Table 5: Top 10 most relevant authors

Authors	Articles
LI G	7
ZHANG J	5
ZHAO Y	5
LENG L	4
LI Y	4
ZANONI S	4
CHANDRA D	3
HARIGA M	3
LIM MK	3
MARCHI B	3

Source: Authors Analysis on Bibliometrix

Table 5 presents the top 10 most relevant authors in this field. Researchers like Li G, Zhang J, and Zhao Y, have contributed significantly, with Li G leading with 7 articles. These authors' contributions underscore the richness and diversity of perspectives shaping discussions on cold chain management and firm performance.

Table 6: Top 10 countries based on scientific production.

Region	Freq
CHINA	208
INDIA	79
UK	36
IRAN	33
ITALY	25
USA	24
AUSTRALIA	21
SOUTH KOREA	17
CANADA	13
GERMANY	10

Source: Authors Analysis on Bibliometrix

Table 6 highlights the top 10 countries based on scientific production. China emerges as the leader with 208 articles, followed by India with 79 articles, the UK with 36 articles, and Iran with 33 articles among others. This distribution signifies the global interest and engagement in understanding and addressing challenges related to cold chain management and firm performance.

Table 7: Top 10 most cited countries

Country	TC	Average Article Citations
CHINA	1051	21.40
UNITED KINGDOM	720	102.90
INDIA	483	20.10
USA	387	48.40
AUSTRALIA	228	32.60
IRAN	208	20.80
ITALY	175	29.20
NETHERLANDS	147	49.00
U ARAB EMIRATES	143	35.80
BELGIUM	120	60.00

Source: Authors Analysis on Bibliometrix

Table 7 provides insights into the top 10 most cited countries in research on cold chain management and firm performance. It lists the countries along with their Total Citations (TC) and average article citations. China leads with 1051 total citations, averaging 21.4 citations per article. The United Kingdom follows closely with 720 total citations but boasts a significantly higher average article citation rate of 102.9. The table showcases the global impact of research originating from these countries and highlights the varying citation patterns across different nations, reflecting the diverse contributions to the field.

Table 8: Top 10 most global cited documents

Paper	Total Citations
CUCCHIELLA F, 2015, RENEW SUST ENERG REV	499
BAI Q, 2019, INT J PROD ECON	155
MOOSAVI J, 2022, INT J DISASTER RISK REDUCT	151
HARIGA M, 2017, J CLEAN PROD	113
TSANG YP, 2018, IND MANAGE DATA SYST	101
SHASHI S, 2018, INT J LOGIST MANAG	96
YU Y, 2017, COMPUT IND ENG	96
MENEGHETTI A, 2015, INT J PROD RES	93
KUMAR A, 2020, BUS STRATEG ENVIRON	83
LEMMENS S, 2016, CHEM ENG RES DES	83

Source: Authors Analysis on Bibliometrix

Table 8 identifies the top 10 most globally cited documents in the realm of cold chain management and firm performance research. Each entry includes the paper's author(s), publication year, journal, and the total number of citations received. For instance, "CUCCHIELLA F, 2015, RENEW SUST ENERG REV" has amassed 499 citations, making it the most cited document in the list. The table provides a glimpse into the influential works that have significantly contributed to the literature in this field, reflecting their impact and relevance among researchers and practitioners alike.

Table 9: Top 10 most relevant affiliations

Affiliation	Articles
ZHEJIANG UNIV TECHNOL	12
UNIV TEHRAN	10
UNIV BRESCIA	9
CHONGQING UNIV	8
DR BR AMBEDKAR NATL INST TECHNOL	8
SOUTH CHINA UNIV TECHNOL	8
BIRLA INST TECHNOL AND SCI	7
HONG KONG POLYTECH UNIV	7
AMER UNIV SHARJAH	6
BEIJING TECHNOL AND BUSINESS UNIV	6

Source: Authors Analysis on Bibliometrix

Table 9 presents the top 10 most relevant affiliations based on their contribution to research in cold chain management and firm performance. Each entry includes the name of the institution and the number of articles produced by researchers affiliated with the institution. For instance, "ZHEJIANG UNIV TECHNOL and UNIV TEHRAN "have produced 12 and 10 articles respectively. Other notable affiliations include UNIV BRESCIA and CHONGQING UNIV. This indicates their significant involvement in this research domain. The table offers insights into the institutions that have been actively engaged in producing scholarly work on this topic, highlighting their role in advancing knowledge and understanding within the field.

Table 10: Co-occurrence Network Using Keywords.

Node	Cluster	Betweenness	Closeness	PageRank
cold chain	1	169	0.015151515	0.090864556
Optimization	1	173	0.01369863	0.069806334
Logistics	1	120	0.014705882	0.054005074
Management	1	0	0.010752688	0.014341859
distribution network	1	0	0.010752688	0.014341859
heterogeneous fleet	1	0	0.010752688	0.014341859
Metaheuristics	1	0	0.01	0.014576731
Transportation	1	0	0.01	0.014576731
Sustainability	2	153	0.011904762	0.046604062
literature review	2	179	0.014084507	0.048498243
India	2	0	0.009009009	0.013490489
Asia	2	0	0.010204082	0.013848279
vaccine supply chain	3	78	0.010869565	0.070171537
supply chain management	3	27	0.010638298	0.04388785
vehicle routing problem	3	0	0.008264463	0.015345978
covid-19 pandemic	3	0	0.008403361	0.015532192
sustainable development	3	0	0.008403361	0.015532192
balanced scorecard	3	0	0.008403361	0.015532192
supply chain	4	62.85714286	0.009708738	0.056320169
cold supply chain	4	0	0.007692308	0.013391526
covid-19	4	37.34285714	0.009615385	0.047085004
Vaccine	4	1.8	0.007874016	0.042563416
Performance	4	0	0.007692308	0.013391526
Vaccines	4	0	0.007692308	0.020731707
food supply chain	5	27	0.010989011	0.028690777
energy efficiency	5	0	0.008474576	0.01688108
vehicle routing	6	53	0.010989011	0.045124661
Problem	6	0	0.008474576	0.021125769
multi-objective optimization	6	0	0.008474576	0.015646346
cold chain logistics	7	1	0.5	0.045608108
location-routing problem	7	0	0.333333333	0.024070946
agricultural products	7	0	0.333333333	0.024070946

network, followed by Cluster 2 and Cluster 3. These clusters likely represent core research themes in the field, with implications for prioritising research efforts and understanding key concepts.

Table 11: Thematic Evolution

From (2015-2020)	To (2021-2024)	Weighted Inclusion Index	Inclusion Index	Occurrences	Stability Index
demand.	blockchain.	0.33	0.33	3	0.13
demand.	demand.	0.53	0.25	6	0.11
	supply chain				
demand.	management.	0.29	0.33	5	0.13
distribution					
centers.	demand.	0.25	0.25	2	0.14
distribution					
centers.	facility location.	0.25	0.25	2	0.13
emissions.	performance.	1.00	1.00	3	0.02
genetic	memetic				
algorithm.	algorithm.	0.33	0.33	2	0.17
information.	demand.	0.20	0.25	3	0.09
information.	performance.	0.50	0.13	4	0.02
logistics.	algorithm.	0.29	0.14	5	0.07
logistics.	delivery.	0.09	0.14	2	0.07
logistics.	performance.	0.42	0.11	8	0.02
optimization.	performance.	0.43	0.17	10	0.02
performance.	algorithm.	0.09	0.14	3	0.02
performance.	performance.	0.70	0.03	19	0.01

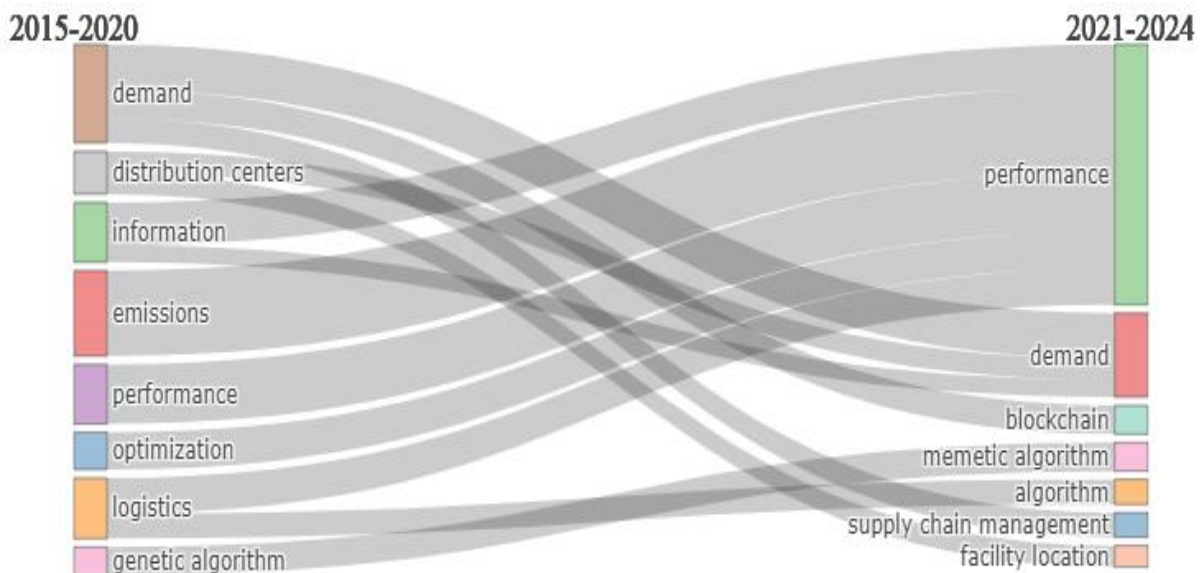


Figure 4: Thematic Evolution

Fig. 3. presents the thematic evolution of the study of cold chain management and firm performance. It can be identified from the figure that during the first phase, that is, between 2015 to 2020, studies concentrated on research eight streams such as demand,



distribution centres, information, emissions, performance, optimisation, logistics and genetic algorithm. The figure shows further that some of these research streams have evolved to include more topics in the second phase (i.e. between 2021 to 2024). For example, distribution centres and performance, information and performance, emissions and performance, performance optimisation, logistics and performance, information and demand, distribution centres, facility location, and supply chain management.

Table 11: Collaboration Network by countries

Node	Cluster	Betweenness	Closeness	PageRank
Iran	1	20.33214286	0.013888889	0.046976166
Italy	1	83.98545066	0.01369863	0.046165133
USA	1	112.9947561	0.015873016	0.080394559
Canada	1	49.74344664	0.014084507	0.055398351
Germany	1	16.01454036	0.012820513	0.034629745
Chile	1	0.80952381	0.009708738	0.01134432
Turkey	1	0.375	0.012195122	0.013562601
Netherlands	1	0	0.011627907	0.013881159
Mexico	1	0	0.009174312	0.007514674
France	1	9.949025974	0.011904762	0.018021864
Latvia	1	0	0.009708738	0.010785261
Finland	1	0.2	0.010638298	0.010377606
Oman	1	4.015353535	0.011904762	0.023480436
Spain	1	0	0.010989011	0.016590675
Serbia	1	0	0.011904762	0.016471115
China	2	242.9428977	0.01754386	0.115783048
India	2	38.30175602	0.013888889	0.050332901
united kingdom	2	209.3394641	0.016129032	0.103077429
Korea	2	36	0.012345679	0.026364676
Poland	2	0	0.012048193	0.017137904
Denmark	2	36	0.011904762	0.020891285
Pakistan	2	0.886904762	0.012658228	0.02361578
Singapore	2	0	0.010204082	0.007317207
Saudi Arabia	2	3.109737485	0.012658228	0.023997461
New Zealand	2	0	0.011111111	0.010313853
Australia	3	135	0.012987013	0.041637274
Bangladesh	3	0	0.008849558	0.007879778
Vietnam	4	0	0.009009009	0.018184102
Japan	4	0	0.009009009	0.018184102
Malaysia	4	0	0.009009009	0.018184102
Argentina	5	0	0.010204082	0.012266994
Indonesia	5	0	0.010204082	0.012266994
Ireland	6	0	0.010309278	0.012725578
Sweden	6	0	0.010309278	0.012725578
Belgium	7	0	0.010309278	0.012725578
Uganda	7	0	0.010309278	0.012725578
Sri lanka	8	0	0.008333333	0.008386767
Thailand	9	0	0.008547009	0.007682364

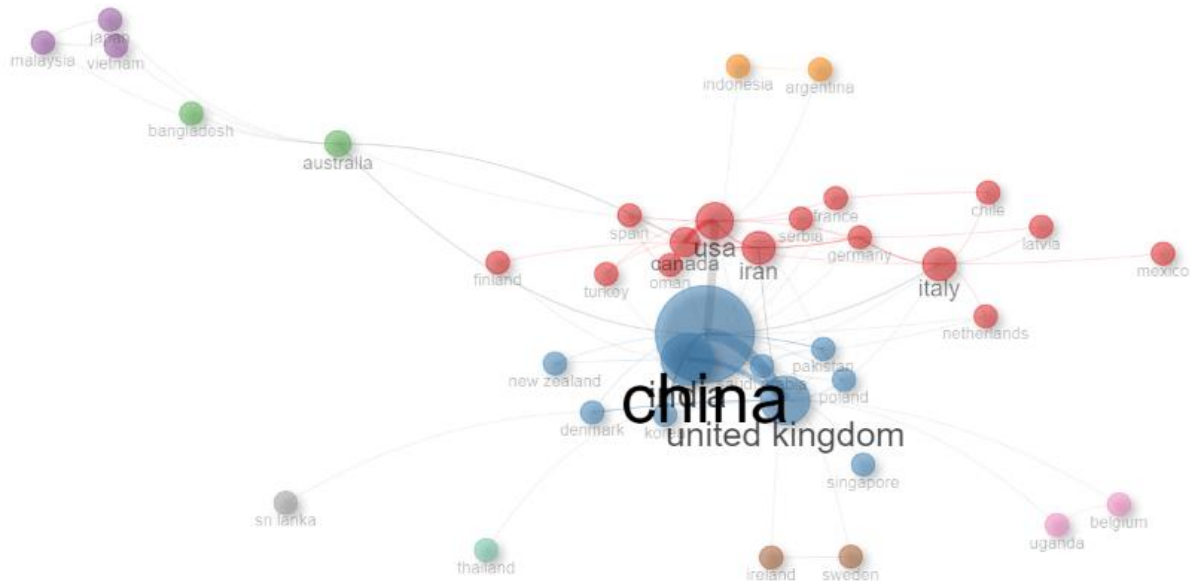


Figure 5: Collaboration network by countries

Table 11 and figure 4 describe the Collaboration Network by countries as displayed in nine clusters. Cluster 1 comprises countries such as Italy, USA, Canada, and Germany, with high betweenness and PageRank values. The USA stands out as the most influential node within this cluster, followed by Italy and Canada. These countries likely play central roles in international collaborations due to their high betweenness centrality, indicating their importance as intermediaries between other countries. Also, Cluster 2, China, India, and the United Kingdom form the core of this cluster, exhibiting high betweenness and PageRank values. China emerges as the most influential node, followed by the United Kingdom and India. These countries likely serve as major hubs for global collaborations in research and academia, given their high betweenness centrality. More so, in Cluster 3, Australia stands out as the sole member of this cluster, with significant betweenness and PageRank values. Despite being a single node cluster, Australia demonstrates considerable influence in international collaborations, potentially due to its strong research institutions and active participation in global research networks. Cluster 4 constitutes countries such as Vietnam, Japan, and Malaysia, albeit with lower betweenness and PageRank values compared to previous clusters. These countries may not play as central a role in international collaborations compared to clusters 1, 2, and 3, but they still contribute to global research networks. Lastly, Cluster 5, Cluster 6, Cluster 7, Cluster 8, and Cluster 9 consist of individual countries or small groups with minimal betweenness and PageRank values, indicating limited influence in international collaborations. However, each country still contributes to the global research field, albeit to varying degrees. On the overall, clusters 1 and 2 appear to be the most important and influential in the collaboration network by countries, with the USA and China serving as key nodes driving international collaborations. These clusters likely represent regions with strong research ecosystems and extensive international partnerships.



Table 12: Collaboration network by authors

Node	Cluster	Betweenness	Closeness	PageRank
li g	1	46.2	0.025641026	0.044445413
zhang j	1	86	0.03030303	0.03704414
zhao y	1	4.4	0.023809524	0.0401032
leng l	1	4.4	0.023809524	0.0401032
wang z	1	0	0.018867925	0.019579953
lau h	1	0	0.020833333	0.016727569
li x	1	0	0.018181818	0.007184418
nakandala d	1	0	0.020833333	0.016727569
han y	2	0	0.016949153	0.018856231
li j	2	42	0.022222222	0.024483851
liu l	2	16	0.017241379	0.028832258
liu y	2	0	0.013513514	0.01191914
tyagi m	3	2	0.333333333	0.035367769
bhardwaj a	3	0	0.2	0.009762521
kumar n	3	0	0.25	0.027434855
sachdeva a	3	0	0.25	0.027434855
kumar s	4	1	0.5	0.036486486
mangla sk	4	0	0.333333333	0.019256757
raut rd	4	0	0.333333333	0.019256757
zhang x	5	16	0.018867925	0.020010132
lam jsl	5	0	0.014492754	0.015089075
li y	6	82	0.028571429	0.037477286
lim mk	6	0	0.020408163	0.026972544
tseng ml	6	0	0.020408163	0.026972544
shi y	6	0	0.020408163	0.017471478
park k	7	0	1	0.025
su m	7	0	1	0.025
chandra d	8	0	1	0.025
kumar d	8	0	1	0.025
dulebenets				
ma	9	0	1	0.025
fathollahi-fard				
am	9	0	1	0.025
routroy s	10	0	1	0.025
priyadarshi r	10	0	1	0.025
zanoni s	11	0	0.333333333	0.027322404
marchi b	11	0	0.333333333	0.027322404
diaz f	11	0	0.333333333	0.022677596
romagnoli f	11	0	0.333333333	0.022677596
hariga m	12	0	0.5	0.025
as'ad r	12	0	0.5	0.025
shamayleh a	12	0	0.5	0.025

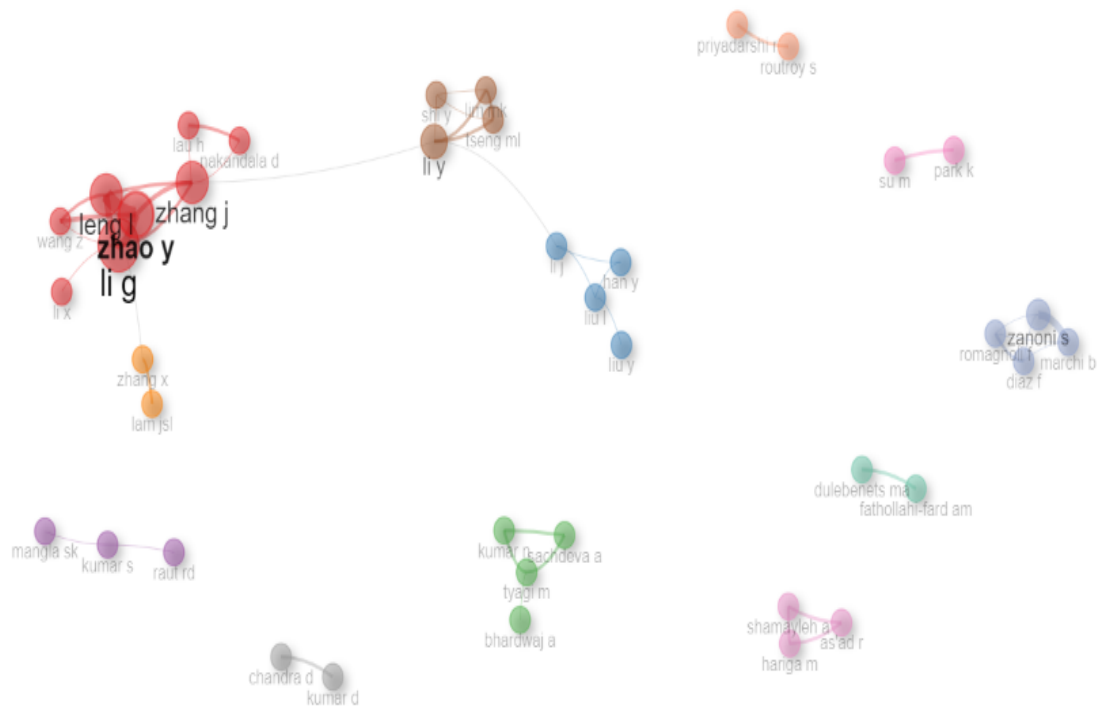


Figure 6: Collaboration network by authors

Table 10 and figure 6 describe the collaboration network by authors, providing insights into the centrality and influence of both individual authors and clusters. Cluster 1 includes authors like Zhang, J. and Li, G., who have high betweenness and PageRank values, indicating their importance in connecting different parts of the collaboration network and their prominence in terms of publication impact. Zhang, J. stands out with the highest betweenness and PageRank, suggesting significant influence and centrality in the network. Also, Cluster 2 authors such as Li, J. and Liu, L., exhibit moderate betweenness and PageRank values. While they may not be as central or influential as those in Cluster 1, they still contribute significantly to the network's cohesion and scholarly impact. In Cluster 3, Tyagi, M. stands out with high closeness centrality, suggesting that they are closely connected to other authors in the network. Despite having a lower betweenness and PageRank, high closeness indicates efficient communication and collaboration within this cluster. More so, in Cluster 4, Kumar, S. is the sole member of this cluster, but with notable betweenness and PageRank values. Despite being a single node cluster, Kumar S appears to be influential and well-connected within the network. Furthermore, Clusters 5, 6, 7, 8, 9, 10, 11, and 12 consist of individual authors or small groups with minimal betweenness, closeness, and PageRank values. While these authors may contribute to the network, they are not as central or influential as those in Clusters 1 and 2. On the Overall, authors in Clusters 1 and 2 appear to be the most important and influential in the Collaboration Network by authors, with Zhang, J. and Li, G. being particularly noteworthy. These authors likely play crucial roles in connecting different parts of the collaboration network and have a significant impact on scholarly publications on cold chain management and firm performance.



Table 13: Co-citation Network by Papers

Node	Cluster	Betweenness	Closeness	PageRank
saif a 2016	1	126.1001052	0.011235955	0.033581255
shashi 2018 2018	1	119.2923441	0.011494253	0.035735181
james sj 2010	1	62.00154259	0.010309278	0.031677695
mercier s 2017	1	41.47261341	0.010204082	0.030616664
hariga m 2017	1	70.97975068	0.010526316	0.034574945
govindan k 2014	1	82.62485744	0.010869565	0.019386413
aung mm 2014	1	14.91653733	0.009259259	0.020595893
meneghetti a 2015	1	114.6846953	0.010989011	0.023699828
ali i 2018	1	21.47783804	0.009433962	0.020796303
zanoni s 2012	1	41.56384641	0.00990099	0.018898697
chaudhuri a 2018	1	42.38167097	0.009803922	0.01723266
hsiao yh 2018	1	25.99419316	0.009708738	0.01542734
hsu ci 2007	1	1.825723168	0.007936508	0.008030258
osvald a 2008	1	15.27660637	0.009009009	0.011994434
raut rd 2019	1	0.677621954	0.007936508	0.01503257
ashok a 2017	1	21.77463837	0.009090909	0.016650248
bozorgi a 2014	1	0	0.006756757	0.015389232
coulomb d 2008	1	0	0.006578947	0.014567408
gallo a 2017	1	0.741699352	0.008064516	0.01758601
green kw 2012	1	5.291177686	0.008695652	0.008612725
wang sy 2018	2	72.07506986	0.011111111	0.033558721
leng ll 2020-1	2	31.16575928	0.00990099	0.025608495
hsiao yh 2017	2	4.473044368	0.009090909	0.019520682
li y 2019	2	17.32649744	0.009803922	0.019165931
qin gy 2019	2	3.632014434	0.008928571	0.020582463
xiao yy 2012	2	8.251969255	0.009345794	0.019300974
al theeb 2020	2	8.474339675	0.009174312	0.021328068
liu gk 2020	2	0	0.007194245	0.017384511
stellingwerf hm 2018	2	58.67670722	0.01	0.012955124
zhang ly 2019	2	2.166901707	0.008928571	0.018105632
babagolzadeh m 2020	2	13.74722844	0.010526316	0.016784865
deb k 2002	2	1.223695571	0.008547009	0.014959671
leng ll 2020-2	2	15.85981054	0.009009009	0.021078369
duijzer le 2018	3	0.565659794	0.00862069	0.014192338
ivanov d 2020	3	1.890221171	0.008695652	0.011033369
lin q 2020	3	3.831446533	0.009259259	0.010885533
rong ay 2011	4	31.06446704	0.01	0.019818424
kuo jc 2010	4	36.10118825	0.011111111	0.020810718
joshi r 2009	4	86.43372636	0.011363636	0.030256482
shukla m 2013	4	11.55608147	0.009803922	0.021924677
joshi r 2011	4	42.26918465	0.010638298	0.023138761
manzini r 2013	4	59.35626303	0.009615385	0.015688797
ahumada o 2009	4	3.42498028	0.00877193	0.016902321

bogataj m 2005	4	30.11773895	0.010638298	0.02385048
aiello g 2012	4	6.293673118	0.008849558	0.019506722
carter cr 2008	4	12.34949574	0.009803922	0.016224202
montanari r 2008	4	31.89903779	0.010869565	0.024553569
nakandala d 2016	4	45.71640779	0.011111111	0.023599015
kelepouris t 2007	4	1.260550288	0.008196721	0.020200481
salin v. 2003	4	0.719378435	0.008196721	0.016994845

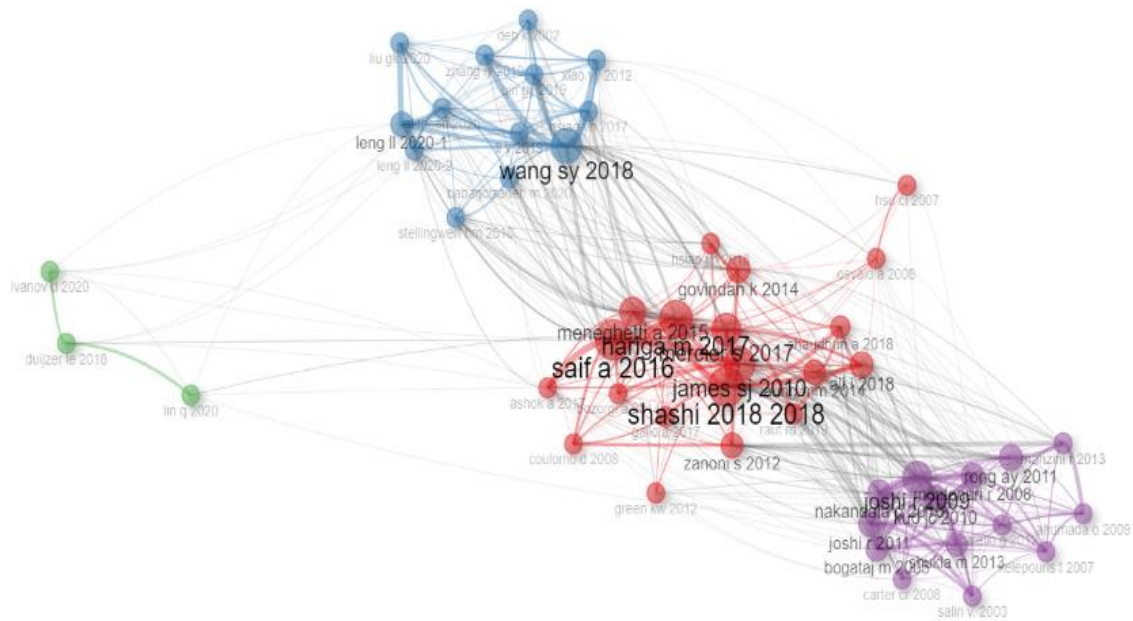


Figure 7: Co-citation Network by Papers

Table 13 and figure 7 describe the co-citation network by Paper offering insights into the importance and influence of individual papers and clusters. In Cluster 1, papers such as "Saif, A. in 2016" and "Shashi (2018)" exhibit high betweenness and PageRank values, indicating their centrality and influence within the cluster. These papers are likely highly cited and play crucial roles in connecting other papers in the network. Also in Cluster 2, papers like "Wang, S.Y. in 2018" and "Leng, L. L. 2020-2021" stand out in this cluster with significant betweenness and PageRank values. They are central and influential within the cluster, suggesting that they are frequently cited and contribute significantly to the network's cohesion. More so, Cluster 3 consists of papers with relatively lower betweenness, closeness, and PageRank values compared to Clusters 1 and 2. While they may not be as influential individually, collectively, they contribute to the network's diversity and knowledge dissemination. In Cluster 4, papers such as "Rong, A.Y. in 2011" and "Joshi, R. in 2009," demonstrate moderate to high betweenness and PageRank values, indicating their importance in connecting other papers and their overall influence within the network. Overall, papers in Clusters 1 and 2 appear to be the most important and influential in the co-citation Network by Papers, with notable examples like "Saif, A. in 2016" and "Wang, S.Y. in 2018." These papers likely represent seminal works or topics of high interest within the respective research domains on cold chain management and firm performance.

4.0 Discussion



The bibliometric analysis on cold chain management and firm performance provides valuable insights into the state of research, prominent contributors, key journals, countries, and institutions, as well as emerging trends and future research directions. The analysis reveals a growing interest in cold chain management and its impact on firm performance over the past decade, as evidenced by the increasing number of publications. This trend underscores the rising importance of effective cold chain management in various industries and its implications for firm competitiveness and performance. The study identifies key authors who have made significant contributions to the field, such as Li G., Zhang J., and Zhao Y. Their prolific output and high citation counts, indicating their influence and expertise in cold chain management research, shaping the discourse and advancing knowledge in the field. The analysis highlights journals like the Journal of Cleaner Production and Industrial Management and Data Systems as leading outlets for research on cold chain management and firm performance. Institutions such as Zhejiang University of Technology and the University of Tehran emerge as prominent contributors, indicating their active involvement in advancing scholarship in this domain. China emerges as a dominant force in cold chain management research, both in terms of scientific production and citation impact. Other countries like India, the UK, and Iran also make significant contributions, reflecting the global nature of research on this topic and the diverse perspectives shaping the discourse. The analysis identifies emerging research themes such as sustainability, vaccine supply chain, and the impact of COVID-19 on cold supply chains. These themes reflect current challenges and opportunities in cold chain management and provide directions for future research to address pressing issues and gaps in knowledge.

5.0 Conclusions

In conclusion, the bibliometric analysis provides a comprehensive overview of the research in cold chain management and firm performance. It highlights the increasing importance of effective cold chain management in ensuring product quality, operational efficiency, and customer satisfaction. Key findings suggest that research in this field is dynamic and multidisciplinary, drawing contributions from diverse authors, journals, countries, and institutions. Moving forward, future research should continue to explore emerging themes such as sustainability, digitalisation, and resilience in cold chain management. Collaborative efforts involving academia, industry, and policymakers are essential to address complex challenges and drive innovation in this critical area. By leveraging insights from bibliometric analyses, researchers can identify research gaps, prioritise areas for investigation, and contribute to the advancement of knowledge and practice in cold chain management and firm performance.

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