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RESEARCH ARTICLE **Open Access**

Managing Perishable Goods Supply Chain Disruptions during the Covid-19 Pandemic (Systematic Approach)

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Abstract

The current article examines the trends and performance of research on the types of effects of the COVID-19 epidemic and the different management strategies of perishable goods supply chain disruptions during 2 years (2020-2022) using bibliometric and network analysis based on the data set from the Scopus database using VOSviewer software. The analysis designates that Kumar A. has been the most influential author in perishable goods supply chain research during the COVID-19 pandemic, and India has contributed the most in this field. The most repeated keywords were resilience, food supply, and perishable food supply chain. Citation analysis indicated that resilience and sustainability are the mainstream of research in articles with high citations. The network analysis also disclosed that resilience and sustainability are the key themes in the clusters. Furthermore, strategies for managing disruption during the COVID-19 pandemic were extracted from the highly-cited articles, which are presented in this article.

Keywords: *Disruption management, Supply chain of perishable goods, COVID-19, Systematic approach, Bibliometric and network analysis*

Introduction

In recent years, supply chains have experienced certain disturbances that have endangered their operational performance and the existence of each member. There are different types of supply chain disruptions, and they can be categorized as general and specific disruptions. General disruptions in the supply chain may be instigated by lack of communication, excess inventory, runaway demand, etc., and specific disruptions as well may be caused by catastrophic events (earthquakes, floods) and epidemics (swine flu and COVID-19).(Ivanov, 2020). The recurrent occurrence of disruptions in the supply chain due to the COVID-19 pandemic has increased supply chain vulnerability (SCU), which affects the performance and revenue generation of companies. If the commodity we are dealing with in a supply chain is perishable, the situation becomes more complicated (Shanker et al., 2022), as they have a shorter product life cycle and suffer from more wastage (Kumar et al., 2021). Also, the quality of these goods is constantly reduced during supply chain activities (Heidari et al., 2021). Moreover, the supply chain of perishable goods is faced with several challenges such as changes in customer demand, delivery time, and shortage of inventory (Shakerizadeh Shirazi et al., 2021).

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Numerous factors have affected the supply chain of perishable goods during the COVID-19 pandemic, including plant shutdowns, perishable commodity price changes, cash flow constraints, poor delivery, increased transportation costs, terrible buying, hoarding, and fear of breach of social distancing guidelines, less physical shopping, closure or limitation of activities, import and export restrictions, quarantine, weak transportation network, low coverage of the region by e-commerce platforms, distortion of information, poor packaging, etc (Shanker et al., 2022). Moreover, given that perishable goods supply chains provide essential commodities (medicine, dairy, blood, and food) for livelihoods, they will have to deal with a more complex situation during the COVID-19 pandemic. At large, during the outbreak of epidemics, the activities of industries (dairy, food, medicine, agriculture, etc.) can play a significant role in society. On the one hand, the goods of these industries are considered daily necessities of life. On the other hand, there are many new restrictions to control the spread of the COVID-19 virus, such as closing all official gatherings and reducing working hours, which will subsequently affect economic growth and GDP (Shafiee et al., 2022). Since perishable goods comprise a significant portion of any country's GDP, many countries' GDP has seriously declined during the COVID-19 pandemic; for example, Germany's GDP in 2020 Compared to 2019 has decreased by 6% (Shafiee et al., 2022; Burgos & Ivanov, 2021). Likewise, statistical evidence reveals that COVID-19 has negatively affected the GDP of India, France, China, Singapore, etc. (Shafiee et al., 2022; Shaikh et al., 2021).

These issues have encouraged researchers worldwide to study the disruptions to perishable goods supply chains caused by the COVID-19 pandemic and develop mitigation and adaptation strategies. Though, there is still a lack of studies with a systematic approach that aims to recognize strategies for managing perishable goods supply chain disruption through bibliometric and network analyses. To fill this gap in the literature, this study conducts a series of bibliometric and up-to-date network analyses to identify influential contributors, mainstream research, and disruption management strategies related to perishable goods chain performance during the COVID-19 pandemic. To this end, this research is done to answer the following research questions:

Question 1) What are the most influential authors, journals, and countries that have studied the supply chain of perishable goods during the COVID-19 pandemic?

Question 2) What are the most influential articles on the supply chain of perishable goods in light of the effects of the COVID-19 pandemic? Furthermore, what are their research streams?

Question 3) What strategies can be applied to manage perishable goods supply chain disruptions during the COVID-19 pandemic?

So, this study can be considered the first attempt that conducts a bibliometric, citation, and network analysis to identify the mainstream of research focusing on disruption reduction and adaptation of perishable goods supply chain strategies. The other sections of this article are organized as follows: Section (2) explains how to conduct a literature search, select relevant articles, and do analyzes to answer the research questions. Then sections (3) and (4) deal with bibliometric, citation and network analyses. Section (5) provides managerial insights for stakeholders and policymakers of perishable goods supply chains. Section (6) offers important conclusions based on the findings and states future research needs.

Research Method

The Main Stages of the Research

To conduct a complete review of the background related to the management of perishable goods supply chain disruptions, a systematic process has been used, which includes: (1) literature search, (2) bibliometric analysis, (3) citation and network analysis (Moosavi et al., 2022). Figure (1) shows the main steps of the research method used in this study. In the first step, we searched for the most suitable

keywords in the database. In the second stage, we conducted a bibliometric analysis to identify authors, journals, and countries that actively aim to address the supply chain disruptions of perishable goods during the COVID-19 pandemic (research question 1). Likewise, the most recurrent keywords were also recognized in the second stage. In the third step, citation analysis and network analysis were done to identify the most influential articles and show the main research streams (research question 2). Furthermore, strategies suggested by highly cited articles to manage disruptions during the COVID-19 pandemic were also extracted (research question 3).

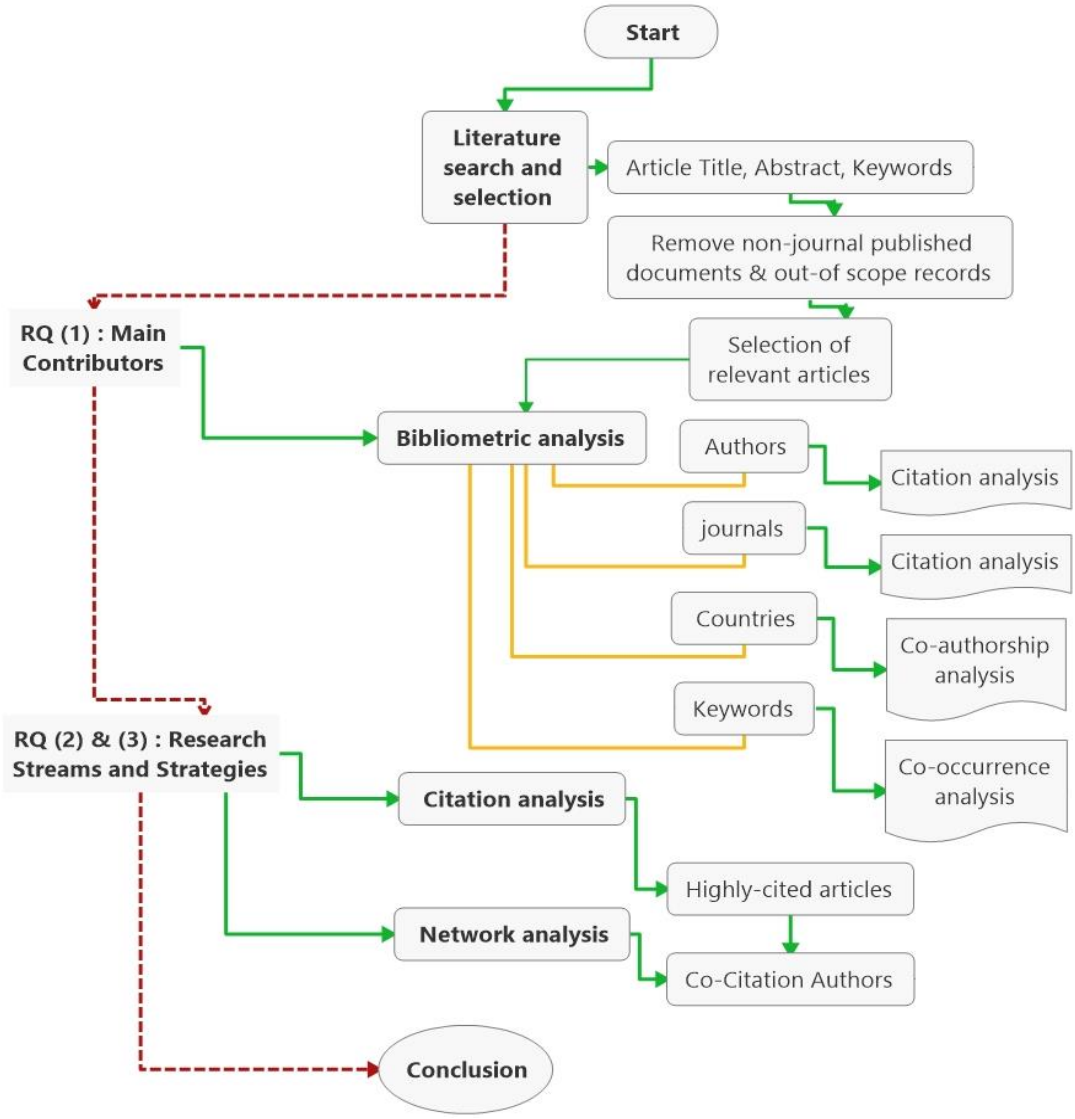

Figure 1. *Research method*

Literature Search and Selection

The Scopus database was selected as one of the most comprehensive and superior sources for literature review in this study. During the literature search, "supply chain," "perishable," and "COVID-19" were used as the main keywords. The literature search was done on 08 September 2022. For scientific articles, the period of 2 years of research (2020-2022) has been selected on this topic. Scopus search was done using the article title, abstract, and keywords. A one-step search was done on "supply chain," "perishable," and "COVID-19," which resulted in 48 records. Then we excluded non-journal published documents, resulting in 37 articles. Lastly, the extracted data set was prudently evaluated to remove out-of-scope records. To this end, we studied the titles, abstracts, and keywords and decided on the relevance of 35

articles. All the articles recognized as the most relevant to the subject of this research were used to perform bibliometric, citation, and network analysis.

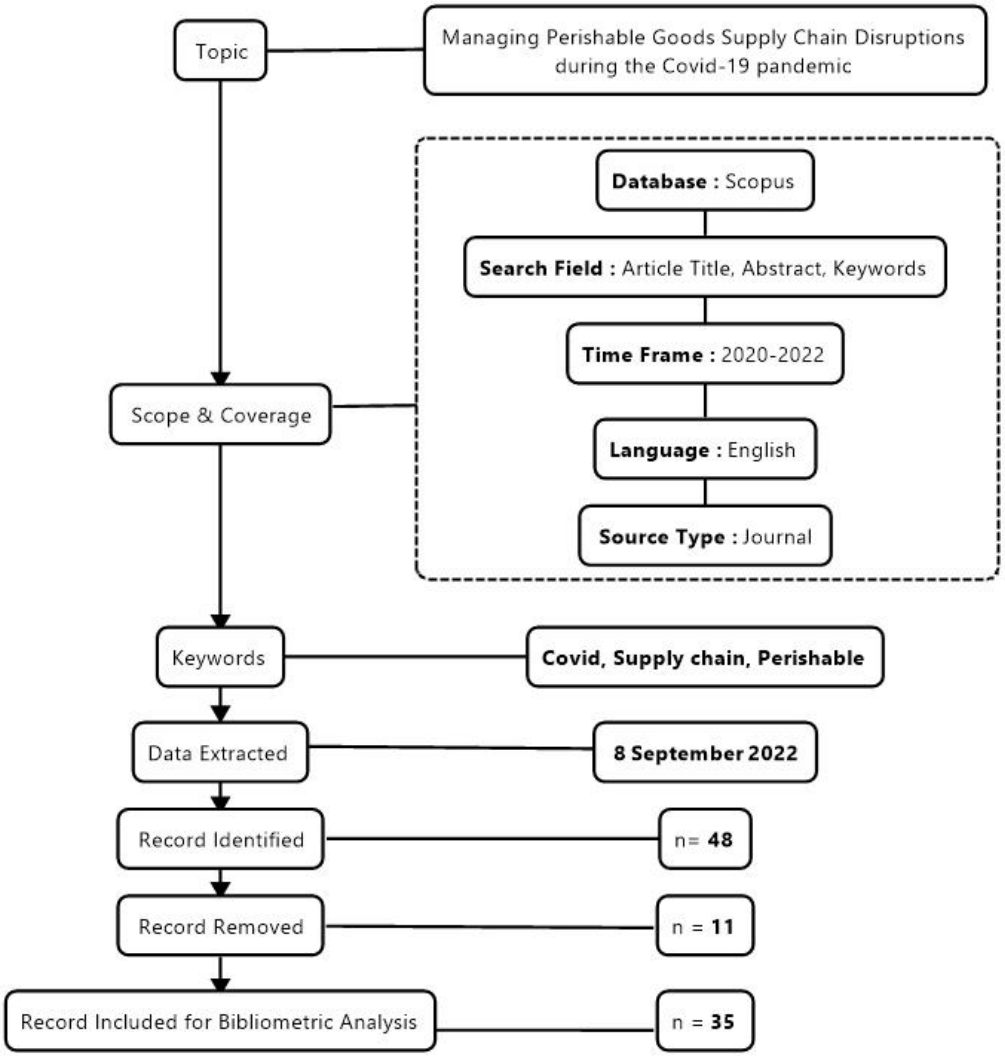

Figure 2. *Procedures of getting the dataset in the Scopus for review of the literature Perishable Goods Supply Chain during the Covid-19 Pandemic*

Bibliometric Analysis

Bibliometrics is a systematic analysis tool that when examining the current state of a specific research field, various indicators of the most influential authors, journals, and countries can be used, as well as identifying the level of research collaborations between authors, institutions, and different countries (Rejeb et al., 2021). Also, bibliometric analysis with a comprehensive evaluation of publications, journals, and citations helps to identify gaps and relevant research streams for future research (Yu et al., 2022). It has been used in interdisciplinary and multidisciplinary research. For example, Also, Arora and Majumdar (2022) used a bibliometric analysis in an interdisciplinary field, namely supply chain and machine learning. Also, Kayikci et al (2022) used a bibliometric analysis in a multidisciplinary field, i.e., supply chain of perishable goods, blockchain, and covid 19. Likewise, this study applies a bibliometric analysis to multidisciplinary research, for example, COVID-19 and the supply chain of perishable goods. To do a bibliometric analysis (Moosavi et al., 2022), researchers use diverse software, for example, HistCite (Petljak & Kotzab, 2020), Publish or Perish (Meyliana et al., 2021), BibExcel (Marty,

2022), and VOSViewer (Moosavi et al., 2022). VOSviewer software was used in this research because it can process Scopus data format and has user-friendly settings compared to other software packages.

Influence of Authors & Journals

In this study, we selected the country based on the Citation network analysis, which resulted in 56 authors. To recognize influential authors, the researchers set the minimum number of papers per author to 2 articles and 10 citations, resulting in 8 featured authors. Table (1), shows the top eight authors, the number of articles, their total citations, the average of citations per article, and the total link strength. It can be seen that Kumar A., with 3 articles and 76 citations, is the most influential author in perishable goods supply chain research during the COVID-19 pandemic. Likewise, Kumar P. is the highest citation author compared to other authors (an average of 46 citations per article). Figure (3) shows the overlay visualization of the Authors. In this figure, the size of the nodes indicates the number of publications of each author. Authors with more weight in articles are shown with larger nodes. In Figure (3), two authors, Kumar A. and Kazancoglu Y. have the largest node, which indicates the highest number of articles among other authors (three articles each). Likewise, the distance between two nodes designates the intensity of the relationship; the closer two nodes are to each other, they tend to have a stronger relationship, and the stronger the link between two items, the thicker the line. The thickness of each line indicates the number of citations between authors. Furthermore, the color range from blue to yellow indicates the least to most citations to each author. For example, Kumar P., with yellow color, indicates the most citations compared to other authors (average of 46 citations per article), and Kazancoglu Y., with a blue color, indicates the least citations compared to other authors (an average of 4 citations per article).

Table 1.
The top 8 Authors

Authors	No. of articles	No. of citations	Avg. citations	Total Link Strength
kumar a.	3	76	25.33	14
kazancoglu y.	3	12	4	5
kumar p.	2	92	46	6
mangla s.k.	2	71	35.50	5
sharma m.	2	18	9	7
barve a.	2	16	8	11
muduli k.	2	16	8	11
shanker s.	2	16	8	11

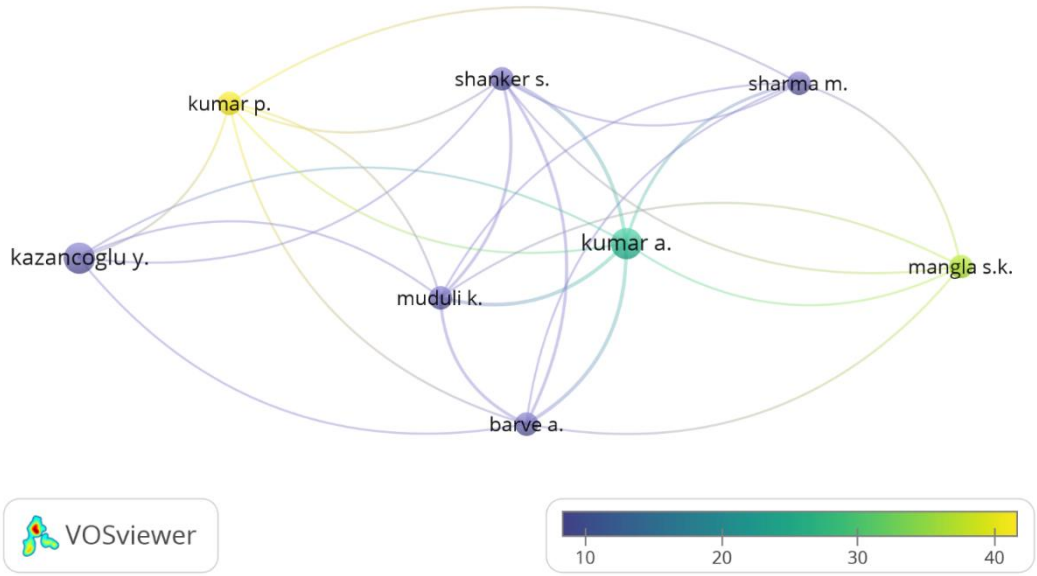

Figure 3. *Authors Citation network analysis (Overlay Visualization)*

Furthermore, numerous journals have published various articles on the supply chain of perishable goods during the COVID-19 pandemic. Table (2) shows the top 5 journals that published most articles related to the current literature review. International Journal of Logistics Management and International Journal of Logistics Research and Applications emerged as the most active journals on the perishable goods supply chain during the COVID-19 pandemic, ahead of other sources by 4 records.

Table 2.
The top contributing journals

Source title	No. of articles	No. of citations
International Journal Of Logistics Management	4	60
International Journal Of Logistics Research And Applications	4	17
Sustainability Switzerland	3	111
Socio-Economic Planning Sciences	2	8
Transportation Research Part E Logistics And Transportation Review	2	4

Influence of Countries

Identifying disruptions caused by Covid-19 and providing mitigation strategies to manage disruptions is one of the challenges of research communities, which will not be possible without the participation of different countries. Here, we aim to classify influential countries contributing to this research field. In the VOSViewer software, we selected the country based on the co-authorship analysis, which resulted in 56 countries. To identify the top 10 countries, we limited the minimum number of documents per country to 2 and the minimum number of citations to 24. Table (3) shows the largest number of articles, citations, and link strength related to countries in this field of study. India ranked first with 19 articles and 417 citations. Figure (4) shows the overlay visualization of the countries. In this figure, the size of the nodes indicates the number of publications in each country. Countries with more weight in terms of articles are shown with larger nodes. India and England have the largest nodes, with the largest number of articles among other countries. Likewise, the thickness of each line indicates the scale of cooperation between countries (cooperation in several articles). For instance, in Figure (4), India and England had scientific cooperation in 7 articles.

Furthermore, the color spectrum from blue to yellow indicates the least to the most citations to each country. For example, the country Australia with yellow color indicates the most citations (that is, an average of 84 citations per article) compared to other countries, and the country of Turkey with blue color indicates the least citations (that is, an average of 5 citations per article) compared to other countries. Total link strength also indicates the total number of collaborations of a country in articles with other countries. For example, India has 28 cooperation with other countries, including England (7), Turkey (5), United States (4), Australia (3), China (3), Malaysia (2), Philippines (2), Netherlands (1), and Italy (1).

Table 3.
Countries Co-authorship network analysis

Countries	No. of articles	No. of citations	Total Link Strength
India	19	417	28
United Kingdom	10	121	24
China	8	93	15
United States	7	45	18
Turkey	7	36	16
Australia	3	252	9
Italy	3	136	7
Indonesia	2	24	13
Philippines	2	24	13
Netherlands	2	37	1

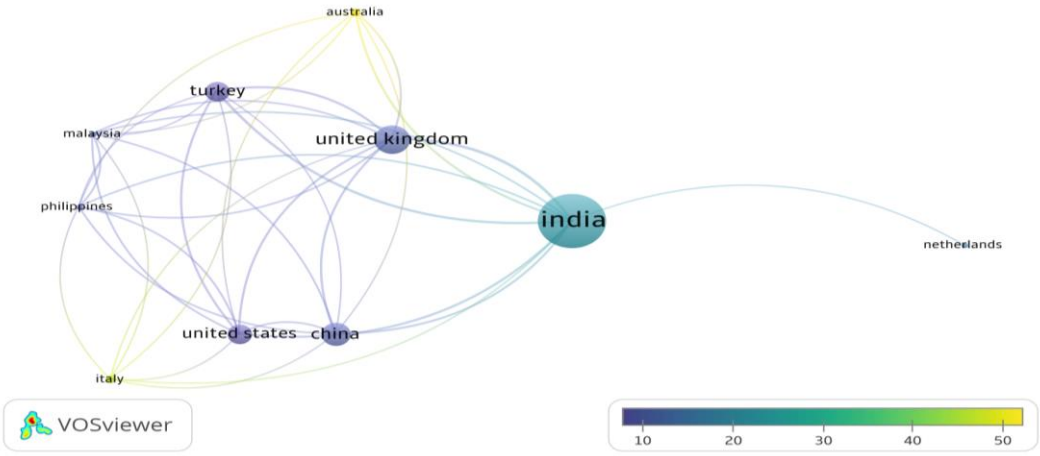

Figure 4. *Countries Co-authorship network analysis (Overlay Visualization)*

Keywords C**o-occurrence**

The keyword co-occurrence network is used to identify "keywords" and by displaying clusters it provides a broader view of different research streams in a specific knowledge area (Rejeb et al., 2021). In this study, we chose a co-occurrence analysis in the VOSviewer software, which can provide the top keywords among the collected articles on the supply chain of perishable goods during the COVID-19 pandemic. This software offers three analysis items, namely all keywords, author keywords, and index keywords. We selected all keywords to exclude irrelevant words. This search resulted in 313 keywords. The minimum number of keyword occurrences was set to 2 to determine the top 37 keywords. The researchers excluded the searched keywords, i.e., supply chain, perishable goods, and COVID-19. Likewise, combinations of the word "supply chain" with other terms, i.e., supply chain management, and supply chains were excluded from the results. Also, terms associated with the name pandemic, COVID-

19 pandemic, 2019 coronavirus disease, and pandemic were eliminated.

Table (4) shows occurrences & clusters of all keywords, while Figure (5) shows the dense network for the most frequent all keywords. The denser the area and color of the keyword, the more the keyword is repeated, and the closer the keywords are, the more relevant the topics are. In the meantime, the bluer the color, the less the keyword is repeated. The redder the color, the higher the occurrence of the keyword (Moosavi et al., 2022). According to the network analysis, resilience, food supply, and perishable food supply chain have the highest occurrence compared to other keywords. Furthermore, close relationships between keywords were identified and placed in five clusters: (1) resilience, sustainability, decision-making, stakeholders, food availability, crisis management, and food markets; (2) food supply, disruption, food security, supply chain resilience, risk management, and economic aspect. (3) Risk assessment, catering services, health risk, food products, and food supply chain. (4) Lockdown, food waste, food loss, and food consumption. (5) Operational excellence, perishable food supply chain.

Table 4.
Occurrences & Cluster of all keywords

Keywords	Occurrences	Cluster	Keywords	Occurrences	Cluster
Resilience	8	1	Food loss	2	4
Food supply	6	2	stakeholder	2	1
perishable food supply chain	5	5	food availability	2	1
risk assessment	4	3	crisis management	2	1
disruption	3	2	health risk	2	3
decision making	3	1	food products	2	3
Sustainability	3	1	food supply chain	2	3
food security	3	2	supply chain resiliences	2	2
Food waste	3	4	food consumption	2	4
lockdown	3	4	operational excellence	2	5
catering service	3	3	food market	2	1
economic aspect	2	2	risk management	2	2

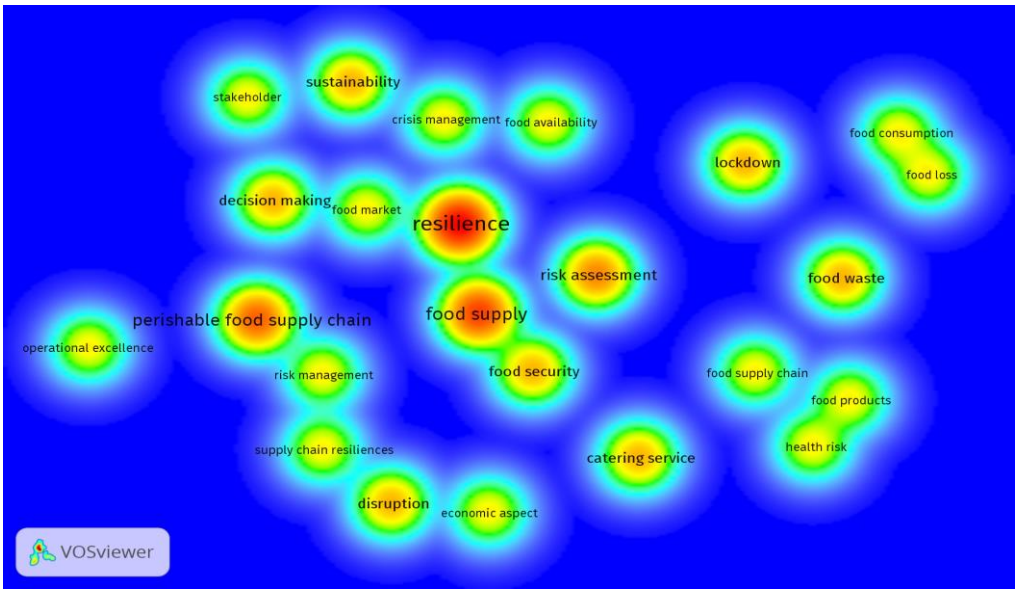

Figure 5. *The most frequent all keywords (co-occurrence)*

Citation Analysis and Network Analysis

In this study, citation analysis has been used to identify the most influential articles that have investigated disruptions and strategies for managing disruptions in the supply chain of perishable goods during the Covid-19 pandemic. Citation analysis has been used by several studies in the field of the supply chain of perishable goods (Shashi et al., 2021; Eghtesadifard & Jozan, 2021; Vrat et al., 2018). For citation analysis, we first adjusted the publication time of the articles to avoid bias. Hence, the publication time of the articles selected for citation analysis is considered from the year 2020. Then, we comprehensively read and analyzed the articles to identify dominant research streams and proposed strategies for managing perishable commodity supply chain disruptions during the COVID-19 pandemic. The results of the citation analysis for highly cited studies are shown in Table 5. Especially information is provided for each article: (1) Reference, (2) total number of citations, (3) the method used, (4) Type of perishable goods supply chain, and (5) the mainstream of research. Regarding the analysis, it was found that resilience and sustainability are the mainstream of research in articles with high citations. Roughly 57.1% of the research streams were resilience articles, 28.6% were sustainability, and 14.3% were a combination of sustainability and resilience (Figure 6). Several additional insights were extracted from the reviewed articles, including the following (Table 6): (a) Effects of COVID-19 on perishable supply chains; (b) suggested disruption management strategies; and (c) planning dimensions. It can be seen that highly-cited articles have identified different types of effects of COVID-19 on perishable goods supply chains, such as changes in purchasing behavior and consumption, disruptions on the demand side, supply, procurement/logistics, finance, information, and food waste management. Furthermore, a different range of strategies for managing disruptions to perishable supply chains was identified as a result of the analysis performed (for example, Price Reduction, information sharing, online delivery systems, Financial Sustainability, localizing the supply chain of perishable goods, shortening the supply chain of perishable goods, digitization of processes, use of digital platforms, capacity building on waste management practices, etc.). According to the planning dimensions considered, the most influential studies have considered disruption preparedness and response are the most common planning dimensions.

Table 5.
Citation analysis of highly-cited articles on Perishable Goods Supply Chain during the Covid-19

Reference	Citations	Methodology	Type of perishable goods supply chain	Research streams
Sharma et al., (2020)	234	Qualitative	Food supply chain	Sustainability
Janssen et al., (2021)	95	Quantitative	Food supply chain	Resilience
Pulighe & Lupia (2020)	78	Qualitative	food supply chains of fresh agricultural products	Sustainability & Resilience
Kumar et al., (2021)	60	Quantitative	food supply chain	Sustainability (socio-economic)
Coluccia et al., (2021)	51	Qualitative	agri-food supply chain	Resilience
Kumar & Kumar Singh (2022)	32	Quantitative	Agri-Food Supply Chains	Resilience
Zhu & Krikke (2020)	31	system dynamics	cheese supply chain	Sustainability & Resilience

Dixon et al., (2021)	17	Qualitative	Agri-Food Supply Chains	Resilience
Shanker et al., (2022)	16	Quantitative	food supply chains	Resilience
Mangano et al., (2022)	12	Quantitative	Aquaculture supply chain	Resilience
Ozdemir et al., (2022)	7	Quantitative	UK perishable goods	Resilience
Cariappa et al., (2022)	8	Quantitative	food supply chain	Resilience
Sharma et al., (2021)	6	Quantitative	food supply chain	Sustainability
Kayikci et al., (2022)	5	Qualitative	food supply chain	Sustainability

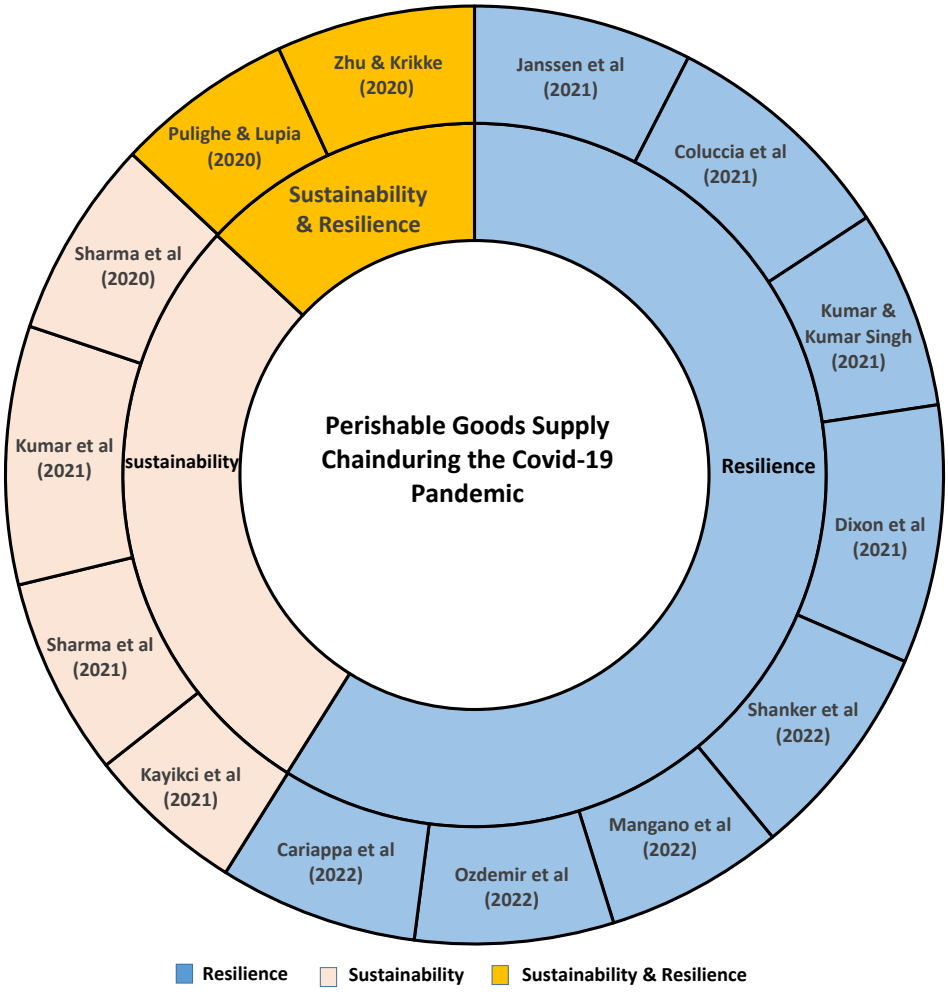

Figure 6. *Research streams of the highly-cited articles*

Table 6.
Citation analysis of highly-cited articles based on effects of COVID-19 on perishable supply chains, disruption management strategies, and planning dimensions considered

Reference	Effects of COVID-19 on perishable goods supply chains	Disruption management strategies	Planning Dimension
Sharma et al., (2020)	Demand Spike + Waste Spike	Local supply chain + Pooling of Resources by online service providers + Drone delivery + Price Reduction	Respond + Recover
Janssen et al., (2021)	Decrease in Shopping and Consumption frequency	online delivery systems (prioritize the more frequent delivery)	Respond
Pulighe & Lupia (2020)	Food Insecurity + Disruption of Food supply and Access	Strengthening urban agriculture with edible green infrastructure + Shortening supply chains	Prepare + Respond
Kumar et al., (2021)	Market Disruption + Shortage of Resources + HR Disruption(labor shortage, staff limitations, and absenteeism) + Operating Costs Increase	collaborative management + proactive business + continuity planning + Financial Sustainability	Prepare + Respond
Coluccia et al., (2021)	Demand & Production Disruption + Price Spike	Emerging and Disruptive Innovations	Respond
Zhu & Krikke (2020)	Endogenous Demand (Product Shortages)	loosely coupled strategy	Respond
Kumar & Kumar Singh (2022)	Logistical + Operational + Socio-Economic + Financial Disruption	Supply chain Collaboration + Coordination between the Stakeholders + Information Sharing + Resource Sharing	Prepare + Respond
Dixon et al., (2021)	Disruption of Farm Produce Markets, Local Labor Markets, Input Supply Chains (i.e., Seeds and Fertilizers)	E-commerce Platforms + Government Support + Support of Cross-Sectoral Coordination Mechanisms	Prepare + Respond+ Recover
Shanker et al., (2022)	Price Variation + Panic Buying and Stockpiling	Price Strategy	Respond
Mangano et al., (2022)	Demand Decline + Supply Shortage	Direct sales to customers + Online retail system and brand + Financial Sustainability +	Respond
Ozdemir et al., (2022)	Resilience-Building Activities Disruption	Innovation + Supplier Empowerment & Key Partners + Building Strong Relationships with Suppliers and Employees	Recover
Cariappa et al., (2022)	Supply Disruption + Demand Decline + Prices Increase + Waste Increase	Increase Production Capacity + Access to Digital Markets + Capacity Building on Waste Management Practices	Respond
Sharma et al., (2021)	Waste Increase	Information Sharing with Customers & Suppliers + Information Gathering and Tracking Supply chain	Prepare + Respond
Kayikci et al., (2022)	Disruption of information + Crop losses + food contamination and spoilage	Using blockchain technology	Prepare + Respond+ Recover

Network Analysis

Network analysis has recently been employed by some supply chain researchers, such as Mousavi et al., (2022), to assess the logical correlation between highly-cited articles. In this manuscript, we selected co-citation authors' analysis in VOSviewer software for network analysis. The Co-citation of two articles happens when both are cited in another article (Aria & Cuccurullo, 2017). The network analysis of highly Co-cited articles is depicted in Figure 7. In the figure, each node signifies an author with at least 5 citations. The analysis of 14 highly cited articles includes 2535 authors, and 37 of these authors have been cited at least 5 times in another article. The color of the clusters indicates the research stream and common topics among the authors of a cluster. Resilience and sustainability are common and favorite topics of authors in clusters. The result of the network analysis is in line with the results of the citation analysis.

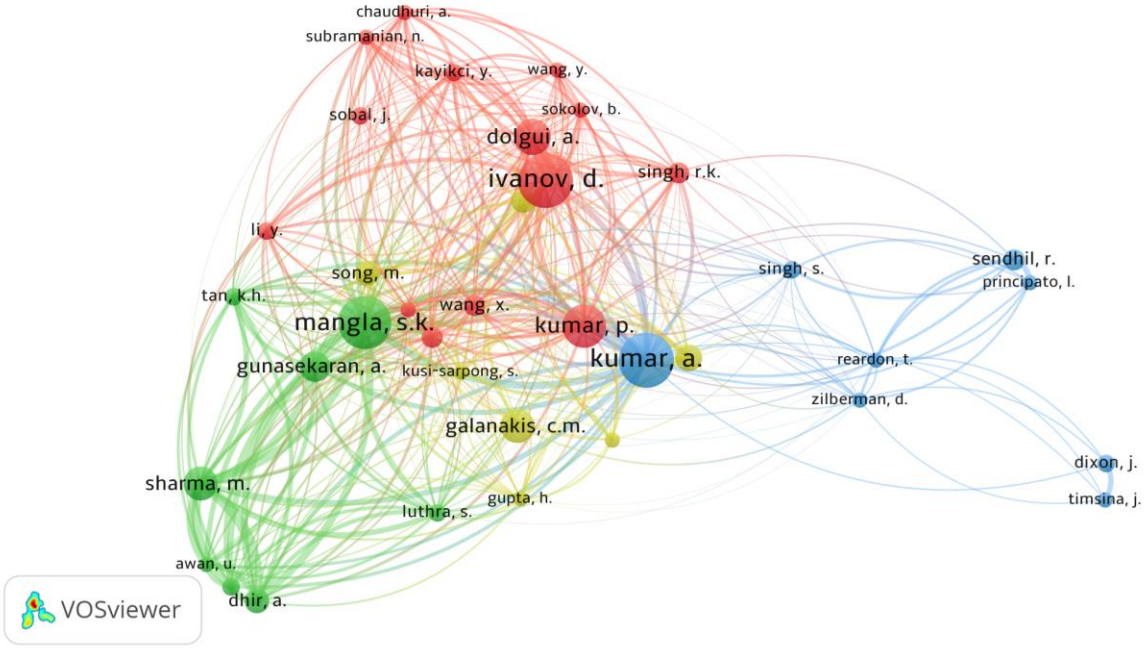

Figure 7. *Network analysis of the highly Co-cited articles*

Management Insight

Succeeding the severe disruption caused by the coronavirus pandemic, manufacturing companies have changed their supply chain strategies to attain a resilient and sustainable chain with customers, suppliers, and other stakeholders (Alhawari et al., 2021). Particularly companies that manage short-lived and perishable goods. This study has conducted a comprehensive analysis to identify key research streams and critical strategies for managing perishable commodity supply chain disruptions during the COVID-19 pandemic. In this section, we offer management insights based on the analysis.

Resilience and sustainability are the most important main streams of research in the supply chain of perishable goods. Hence, the necessity for the combination and interaction of resilience and sustainability was further demonstrated. Resilience and sustainability must be considered in an integrated framework to benefit from the synergy effects between them and achieve the best result. Therefore, the new requirement for managers working in perishable industries is to design a resilient and sustainable perishable goods supply chain.

It is important to develop and implement a strategic plan for managing perishable goods supply chain disruptions during the COVID-19 pandemic that can integrate planning dimensions. A strategic plan is necessary not only to recover from the current crisis but also to properly prepare for the next pandemic or

other specific disruption. Therefore, considering all three dimensions of preparation, response, and recovery in a strategic plan can more effectively help manage disruptions in the supply chain of perishable goods in epidemics.

Considering the short life cycle of perishable goods, managers should provide appropriate planning to encourage consumers to buy and consume perishable goods, including developing online shopping systems, price strategies, new propaganda, various discounts, innovative marketing strategies, etc.

Numerous innovative technologies, such as blockchain (Kayikci et al., 2021) and artificial intelligence (AI) (Chitikela et al., 2021), are valuable tools that can help manage perishable goods supply chain disruptions during the COVID-19 pandemic. Blockchain by increasing transparency and traceability can reduce waste, reduce the time and cost of transactions, and optimize the storage of perishable goods, which is very important for the sustainability of perishable goods supply chains. Furthermore, artificial intelligence can be used to correctly model and predict the demand, supply, and price of perishable goods during an epidemic, which is very necessary for the resilience of the supply chain of perishable goods during epidemics.

Conclusion

The purpose of this study is to investigate the trends and performance of research on the types of effects of the COVID-19 epidemic and the different management strategies of perishable goods supply chain disruptions using bibliometric, citation, and network analysis. As a result of the analyzes conducted, research streams and recommended approaches for managing important disruptions in the supply chain of perishable goods, such as the COVID-19 pandemic, were identified. The most influential author on perishable goods supply chain research during the COVID-19 pandemic was Kumar A. The most active journals on the perishable goods supply chain during the COVID-19 pandemic were the International Journal of Logistics Management and the International Journal of Logistics Research and Applications. The country with the highest participation level in this field was India, which is ahead of England, China, the United States, and Turkey. The most repeated keywords were resilience, food supply, and perishable food supply chain. Citation analysis showed that resilience and sustainability are the mainstream of research in articles with high citations. Likewise, the analysis of the co-citation network of the authors disclosed that resilience and sustainability are the main topics in the clusters. Consequently, the results of the network analysis were aligned with the results of the citation analysis. Furthermore, The recommended strategies were mostly price reduction, information sharing, online delivery systems, financial sustainability, localizing the supply chain of perishable goods, shortening the supply chain of perishable goods, digitization of processes, use of digital platforms, and capacity building on waste management practices.

Based on future research needs, during the literature review, it was found that some of the research streams identified in high-cited studies have been discussed less than others and can be further investigated in future studies. Most of the conducted studies have dealt with resilience and sustainability separately, and only two articles have examined sustainability and resilience simultaneously. In addition, future research can focus more on evaluating uncertainty modeling approaches, trends, and techniques in the perishable goods supply chain during the COVID-19 pandemic.

Conflict of Interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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References

Alhawari, O., Bhutta, M., & muzzafar, a. (2021). Supply Chain Emerging Aspects and Future Directions in the Age of COVID-19: A Systematic Review. *Uncertain Supply Chain Management*. doi:10.5267/j.uscm.2021.1.007

Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, *11*(4), 959-975. https://doi.org/https://doi.org/10.1016/j.joi.2017.08.007

Arora, S., & Majumdar, A. (2022). Machine learning and soft computing applications in textile and clothing supply chain: Bibliometric and network analyses to delineate future research agenda [Review]. *Expert Systems with Applications*, *200*, Article 117000. https://doi.org/10.1016/j.eswa.2022.117000

Burgos, D., & Ivanov, D. (2021). Food retail supply chain resilience and the COVID-19 pandemic: A digital twin-based impact analysis and improvement directions [Article]. *Transportation Research Part E: Logistics and Transportation Review*, *152*, Article 102412. https://doi.org/10.1016/j.tre.2021.102412

Cariappa, A. G. A., Acharya, K. K., Adhav, C. A., Sendhil, R., & Ramasundaram, P. (2022). COVID-19 induced lockdown effects on agricultural commodity prices and consumer behaviour in India – Implications for food loss and waste management. *Socio-Economic Planning Sciences*, *82*, 101160. https://doi.org/https://doi.org/10.1016/j.seps.2021.101160

Chitikela, G., Meena, A., Kumari, R., Bandumula, N., Ondrasek, G., Sundaram, R., & Rathod, S. (2021). Artificial-Intelligence-Based Time-Series Intervention Models to Assess the Impact of the COVID-19 Pandemic on Tomato Supply and Prices in Hyderabad, India. *Agronomy*, *11*, 1878. https://doi.org/10.3390/agronomy11091878

Coluccia, B., Agnusdei, G. P., Miglietta, P. P., & De Leo, F. (2021). Effects of COVID-19 on the Italian agri-food supply and value chains [Article]. *Food Control*, *123*, Article 107839. https://doi.org/10.1016/j.foodcont.2020.107839

Dixon, J. M., Weerahewa, J., Hellin, J., Rola-Rubzen, M. F., Huang, J., Kumar, S., Das, A., Qureshi, M. E., Krupnik, T. J., Shideed, K., Jat, M. L., Prasad, P. V. V., Yadav, S., Irshad, A., Asanaliev, A., Abugalieva, A., Karimov, A., Bhattarai, B., Balgos, C. Q., . . . Timsina, J. (2021). Response and resilience of Asian agrifood systems to COVID-19: An assessment across twenty-five countries and four regional farming and food systems [Article]. *Agricultural Systems*, *193*, Article 103168. https://doi.org/10.1016/j.agsy.2021.103168

Eghtesadifard, M., & Jozan, F. (2022). A systematic literature review on the blood supply chain: exploring the trend and future research directions [Article]. *Journal of Ambient Intelligence and Humanized Computing*, *13*(2), 1173-1200. https://doi.org/10.1007/s12652-021-03563-5

Heidari, S., Bavarsad, B., Nili Ahmad Abadi, M., & Mullah Alizadeh Zavardehi, S. (2021). Identifying and Prioritizing Supply Chain Sustainability Indicators for Perishable Products Via Grounded Theory and Fuzzy Hierarchical Analysis Approach. *Journal of System Management*, *7*(1), 233-264. doi:10.30495/jsm.2021.1919814.1427

Ivanov, D. (2020). Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case. *Transportation Research Part E: Logistics and Transportation Review*, *136*, 101922. https://doi.org/https://doi.org/10.1016/j.tre.2020.101922

Janssen, M., Chang, B. P. I., Hristov, H., Pravst, I., Profeta, A., & Millard, J. (2021). Changes in Food Consumption During the COVID-19 Pandemic: Analysis of Consumer Survey Data From the First Lockdown Period in Denmark, Germany, and Slovenia [Article]. *Frontiers in Nutrition*, *8*, Article 635859. https://doi.org/10.3389/fnut.2021.635859

Kayikci, Y., Durak Usar, D., & Aylak, B. L. (2022). Using blockchain technology to drive operational excellence in perishable food supply chains during outbreaks [Article]. *International Journal of Logistics Management*, *33*(3), 836-876. https://doi.org/10.1108/IJLM-01-2021-0027

Kumar, A., Mangla, S. K., Kumar, P., & Song, M. (2021). Mitigate risks in perishable food

supply chains: Learning from COVID-19. *Technological Forecasting and Social Change*, *166*, 120643. https://doi.org/https://doi.org/10.1016/j.techfore.2021.120643

Kumar, P., & Kumar Singh, R. (2022). Strategic framework for developing resilience in Agri-Food Supply Chains during COVID 19 pandemic [Article]. *International Journal of Logistics Research and Applications*, *25*(11), 1401-1424. https://doi.org/10.1080/13675567.2021.1908524

Mangano, M. C., Berlino, M., Corbari, L., Milisenda, G., Lucchese, M., Terzo, S., Bosch-Belmar, M., Azaza, M. S., Babarro, J. M. F., Bakiu, R., Broitman, B. R., Buschmann, A. H., Christofoletti, R., Dong, Y., Glamuzina, B., Luthman, O., Makridis, P., Nogueira, A. J. A., Palomo, M. G., . . . Sarà, G. (2022). The aquaculture supply chain in the time of covid-19 pandemic: Vulnerability, resilience, solutions and priorities at the global scale [Article]. *Environmental Science and Policy*, *127*, 98-110. https://doi.org/10.1016/j.envsci.2021.10.014

Marty, J. (2022). Consumer/user/customer integration in Supply Chain Management: a review and bibliometric analysis [Review]. *Supply Chain Forum*, *23*(2), 181-196. https://doi.org/10.1080/16258312.2021.1984168

Meyliana, M., Fernando, E., Surjandy, Eka Widjaja, H. A., Cassandra, C., & Tan, A. (2021). Bibliometric study and systematic literature review of blockchain technology in vehicle industry. Proceedings of 2021 International Conference on Information Management and Technology, ICIMTech 2021. doi:10.1109/ICIMTech53080.2021.9534940

Moosavi, J., Fathollahi-Fard, A. M., & Dulebenets, M. A. (2022). Supply chain disruption during the COVID-19 pandemic: Recognizing potential disruption management strategies. *International Journal of Disaster Risk Reduction*, *75*, 102983. https://doi.org/https://doi.org/10.1016/j.ijdrr.2022.102983

Ozdemir, D., Sharma, M., Dhir, A., & Daim, T. (2022). Supply chain resilience during the COVID-19 pandemic. *Technology in Society*, *68*, 101847. https://doi.org/https://doi.org/10.1016/j.techsoc.2021.101847

Petljak, K., & Kotzab, H. (2020). Sustainable Retail Supply Chain Management – A Bibliometric Viewpoint. In *Lecture Notes in Logistics* (pp. 215-224). https://doi.org/10.1007/978-3-030-44783-0_21

Pulighe, G., & Lupia, F. (2020). Food first: COVID-19 outbreak and cities lockdown a booster for a wider vision on urban agriculture [Article]. *Sustainability (Switzerland)*, *12*(12), Article 5012. https://doi.org/10.3390/su12125012

Rejeb, A., Rejeb, K., Abdollahi, A., Zailani, S., Iranmanesh, M., & Ghobakhloo, M. (2022). Digitalization in Food Supply Chains: A Bibliometric Review and Key-Route Main Path Analysis. *Sustainability*. https://doi.org/10.3390/su14010083

Shafiee, M., Zare-Mehrjerdi, Y., Govindan, K., & Dastgoshade, S. (2022). A causality analysis of risks to perishable product supply chain networks during the COVID-19 outbreak era: An extended DEMATEL method under Pythagorean fuzzy environment [Article]. *Transportation Research Part E: Logistics and Transportation Review*, *163*, Article 102759. https://doi.org/10.1016/j.tre.2022.102759

Shaikh, S., Sultan, M., Mushtaque, T., & Tunio, M. N. (2021). Impact of Covid-19 on GDP: A Serial Mediation Effect on International Tourism and Hospitality Industry. *INTERNATIONAL JOURNAL OF MANAGEMENT*, *12, Issue 4, April 2021, pp.422-430, Article ID: IJM_12*, 422-430. https://doi.org/10.34218/IJM.12.4.2021.036

Shakerizadeh Shirazi, M. H., Jafarnejad Chaghoushi, A., Amoozad Mahdiraji, H., & Safari, H. (2021). Coordinating the Two-Echelon Supply Chain of Perishable Products with Uncertain Demand: A Game-Theoretic Approach. *Journal of System Management*, *6*(4), 103-138. doi:10.30495/jsm.2021.1910315.1368

Shanker, S., Barve, A., Muduli, K., Kumar, A., Garza-Reyes, J. A., & Joshi, S. (2022). Enhancing resiliency of perishable product supply chains in the context of the COVID-19 outbreak [Article]. *International Journal of Logistics Research and Applications*, *25*(9), 1219-1243. https://doi.org/10.1080/13675567.2021.1893671

Sharma, H. B., Vanapalli, K. R., Cheela, V. R. S., Ranjan, V. P., Jaglan, A. K., Dubey, B., Goel, S., & Bhattacharya, J. (2020). Challenges, opportunities, and innovations for effective solid waste management during and post

COVID-19 pandemic. *Resources, Conservation and Recycling*, *162*, 105052. https://doi.org/https://doi.org/10.1016/j.resconrec.2020.105052

Sharma, M., Alkatheeri, H., Jabeen, F., & Sehrawat, R. (2021). Impact of COVID-19 Pandemic on Perishable Food Supply Chain Management: A Contingent Resource-Based View (RBV) Perspective. *The International Journal of Logistics Management, ahead-of-print*. https://doi.org/10.1108/IJLM-02-2021-0131

Shashi, S., Centobelli, P., Cerchione, R., & Ertz, M. (2021). Food cold chain management: what we know and what we deserve [Article]. *Supply Chain Management*, *26*(1), 102-135. https://doi.org/10.1108/SCM-12-2019-0452

Vrat, P., Gupta, R., Bhatnagar, A., Pathak, D. K., & Fulzele, V. (2018). Literature review analytics (LRA) on sustainable cold-chain for perishable food products: research trends and future directions. *OPSEARCH*, *55*(3), 601-627. https://doi.org/10.1007/s12597-018-0338-9

Yu, Z., Waqas, M., Tabish, M., Tanveer, M., Haq, I. U., & Khan, S. A. R. (2022). Sustainable supply chain management and green technologies: a bibliometric review of literature. *Environmental Science and Pollution Research*, *29*(39), 58454-58470. https://doi.org/10.1007/s11356-022-21544-9

Zhu, Q., & Krikke, H. (2020). Managing a Sustainable and Resilient Perishable Food Supply Chain (PFSC) after an Outbreak. *Sustainability*, *12*(12). Doi: 10.3390/su12125004