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# Enabling retail food supply chain, viability and resilience in pandemic disruptions by digitalization – a conceptual perspective

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Ahmed Zainul Abideen Muzamil
*Faculty of Transport and Logistics, Muscat University, Muscat, Oman*
Jaafar Pyeman, Sofianita binti Mutalib and
Kamalia Azma binti Kamaruddin
*UiTM, Shah Alam, Malaysia, and*
Norsariah binti Abdul Rahman
*Pertubuhan Keselamatan Sosial, Kuala Lumpur, Malaysia*

## Abstract

**Purpose** – Supply chain disruptions are a significant risk to businesses in a global marketplace because they make it more challenging for suppliers to effectively transport goods and services to customers. Therefore, it is essential to comprehend how these disruptions affect the retail food supply chain during pandemics and explore how digitalization might help to mitigate these issues in the future.

**Design/methodology/approach** – A hybrid systematic review and analysis was conducted by retrieving data set from the scopus database using strong keyword search strategy. Later a content analysis was also done to gain more insights on the proposed research.

**Findings** – The results show that there are several possibilities enabling optimal scenario planning supply chain disruptions and mitigation. In this area, digitalization improves customer satisfaction and logistical efficiency, particularly in transportation and network optimization. In order to cope with uncertainty and grasp significant enhancements proactive strategies and collaboration that are guided by scenario planning and digitalization assist in developing robust supply chains that are sufficiently adaptable to adapt to shifting market conditions.

**Research limitations/implications** – The study is limited to research papers indexed in Scopus from 2015 to 2023 with a more comprehensive review of retail food supply chain disruptions.

**Practical implications** – This research provides practical insights for retail food supply chain managers, highlighting the importance of digital maturity and scenario planning by leveraging digital tools and proactive strategies to improve logistical efficiency.



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**Social implications** – This study helps in building resilient supply chains ensures the reliable availability, and food security of essential goods, particularly during crises.

**Originality/value** – This research uniquely links digitalization and scenario planning to managing supply chain disruptions, highlighting how digital tools and strategic planning enhance resilience and adaptability in the retail food supply chain.

**Keywords** Retail food supply chain, Pandemic disruptions, Digitalization, Resilience

**Paper type** Literature review

## 1. Introduction

Businesses face a significant challenge in the modern globalized economy known as supply chain disruption. This phrase refers to any circumstance or occurrence that inhibits the timely delivery of products and services from suppliers to consumers. These disruptions can be caused by a variety of factors, such as pandemics, natural disasters, traffic issues, labor shortages and geopolitical conflicts (Kane and Whitehead, 2017). A disruption in the supply chain can have significant effects on the community at large as well as many facets of business operations. Specifically, disruptions can cause delays, shortages and increased expenses by delaying the production and distribution of commodities. Disruptions in the supply chain of necessities like food and medicine can have potentially fatal consequences for those in need in important sectors like healthcare (Asadi *et al.*, 2015).

Disruptions in the supply chain have a major effect on the economy, society and environment. They increase unemployment, reduce productivity and restrict access to basic products and services. Organizations should use supply base diversification, sustainable practices, backup sources, risk identification and emergency planning to reduce these difficulties. During disruptions, it is essential to have a strong contingency plan, manage expectations and foster trust in order to minimize ambiguity. Resilient supply chains can be improved by using sustainable techniques including ethical labor practices, eco-friendly operations and responsible sourcing. To evaluate vulnerability, identify critical components and ascertain susceptibility to risks such as political instability and catastrophic occurrences, regular monitoring and audits are important. With this knowledge, businesses can put risk-reduction and resilience-building plans into action. To pinpoint the major disruption points in the retail food supply chain and investigate the possibilities of digital transformation, more investigation is required. The purpose of this study is to consolidate existing research and better understand past and present research work in this area. This study plans to answer the following research questions:

- *RQ1.* To evaluate the impact of pandemic and post pandemic disruptions on retail food supply chain.
- *RQ2.* How can digitalization support in developing resilience and overcome the impact caused by those disruptions.
- *RQ3.* What are the different enablers of digitalization that assist in developing retail supply chain resilience and viability.

## 2. State of the art

### *2.1 Supply chain disruptions*

Supply chain disruptions can result from disasters, pandemics, political instability and cyber-attacks, leading to increased costs, reduced efficiency and decreased customer satisfaction. The COVID-19 pandemic underscored the need for research on supply chain resilience and the importance of digital technology in minimizing disruption. Businesses need more resilient and adaptable supply chains to handle disturbances, as disruptions can cause economic disruptions, shortages of critical goods, inflationary pressures and national security risks (Ivanov *et al.*, 2017). To mitigate these negative effects, ongoing studies are needed to understand supply chain disturbances, increase resilience and develop effective mitigation strategies. Proactiveness in supply chain design and planning is crucial, with businesses detecting potential disruptions and developing recovery plans. Supply chain disruptions can significantly impact economically disadvantaged individuals, increasing living costs and making it difficult to access necessities.

### *2.2 Challenges in retail food supply chain*

The food supply chain in general begins with the production of raw materials, such as crops, livestock and aquatic resources. These raw materials undergo processing, which involves various operations such as cleaning, sorting, packaging and transforming them into finished or semi-finished food products. Once processed, the products are then distributed through a network of transportation, storage facilities, wholesalers, retailers and other intermediaries, ultimately reaching the end consumers (Haleem and Sufiyan, 2021). The management of the food supply chain involves the integration and coordination of various activities spanning from production and processing to distribution and consumption of food products.

The increasing demand for better food options and globalization provide problems for the food supply chain. There are dangers associated with the industry's complicated and associated structure, including higher pollution, supply disruptions and lengthier transit times. A shift in consumer tastes toward healthier food options has also made changes to the supply chain necessary. Quality assurance, traceability and transparency are essential if we are capable of living up to these expectations. The production, shipping and distribution processes can be disrupted by external variables such as disease outbreaks, natural catastrophes and climate change (Siddh *et al.*, 2017). This can result in shortages, price changes and compromised product integrity. Supply chain management needs to be flexible and agile, implementing risk management techniques and backup plans, in order to reduce these risks.

Fresh products typically have a high risk of markdowns and waste, making it very important to forecast demand accurately and synchronize replenishment availability of food products. Longer-shelf-life products require efficient goods handling and optimization of inventory flow. Omnichannel based add-on service exempt from standard efficiency requirements. For example, online fulfilment accentuates the need for high quality and freshness because end-consumers can't evaluate products themselves. High levels of speed and accuracy are invaluable in an industry where retailers must control millions of goods flows and accurately match supply to demand at hundreds or even thousands of locations daily (Zhong *et al.*, 2017).

To address these challenges, companies and stakeholders in the retail food industry are concentrating on improving food supply chain management techniques. This involves using innovative technologies for real-time monitoring, data analytics and supply chain visibility to increase efficiency, decrease waste and improve food safety. Farmers, processors, distributors, retailers and consumers are establishing collaborative partnerships along the supply chain to promote cooperation, information sharing and sustainable practices (Karlsen *et al.*, 2013).

The use of sustainable agriculture practices, farm-to-table initiatives and local sourcing are becoming more popular as ways to lessen environmental effect and increase the resilience of the food supply chain (Abideen *et al.*, 2023). These programs encourage community involvement, shorten travel times and give priority to local products. Businesses can improve forecasting efficiency by using artificial intelligence and machine learning to help with data analysis. A process-oriented definition that takes into account the steps of production, processing, distribution and consumption is necessary for a complete grasp of food supply chain management.

### *2.3 Impact of pandemic disruption on retail food supply chain*

The pandemic caused supply chain activities to become unstable and unclear, which increased the risk of collapses and disruptions in the delivery of products and services. Predicting the pandemic's effects and analyzing supply chain responses are the main research goals. Comprehending diverse situations with differing intensity and speed is essential to comprehending connection and the cascade effect. Effective facility design and lead time reduction are critical elements in assessing how the pandemic will affect the performance of the supply chain. When forecasting resilience under uncertainty, variables such as lead-time, epidemic transmission speed and disruption durations are significant factors (Chin, 2020; Singh *et al.*, 2021).The Viable Supply Chain model emphasizes the need for sustainable supply chain management in a changing environment, focusing on supply chain ecosystems, multistructural network designs and viability capabilities, aiming to redesign structures and repaint performance with long-term impacts (Abideen *et al.*, 2021c; Singh *et al.*, 2021).

The distribution of a product through the supply chain commences with the acquisition of raw materials, which are subsequently transformed and processed into intermediate items or components. These components are then integrated or merged to form the finished product. Throughout this process, coordination, communication and good management are critical to ensuring timely production and delivery. Any breakdown in these areas, whether due to logistical concerns, inventory management issues or external factors, can impede supply chain development and cause delays.

The exponential growth of the global population has amplified the complexity of addressing food security in the modern food supply chain due to the diverse and not similar market demands. Measures such as lockdowns and movement restrictions implemented to fight COVID-19 have compelled food small and medium-sized enterprises (FSMEs) to temporarily close down, making employees and supply chain participants unable to work remotely. This has exposed both individuals and the food products to the risk of virus transmission. The COVID-19 pandemic has led to reduced food production, delayed access to essential items, stock depletion, job losses and worsened food insecurity. The economic disruption has caused financial hardships and forced permanent closures, exacerbated by the negative impacts on the food industry (Cappelli and Cini, 2020). In response to these disruptions, SCRes enables the supply network to withstand, adapt and recover by aligning operations and the environment to meet consumer demand and ensure performance. Prioritizing SCRes is crucial for the food industry to ensure the resilience and sustainability of the food supply chain in the face of disruptive events like the COVID-19 pandemic.

COVID-19 continues to impact several countries, causing home confinement, travel bans and business closures. These measures have significantly impacted food supply chains, particularly in agriculture sectors like crop, livestock and fishery. China's livestock farming has been particularly affected due to limited animal feed and labor shortages. Fish farmers face challenges in aquaculture production and selling their harvests due to lack of seed and feed. Perishable agriculture produce has also been affected (Jafri *et al.*, 2021). Dairy farmers face shortage of milk, inputs like seed, fertilizer and pesticides due to global trade disturbances, closure of processing companies and lockdown (Solaymani *et al.*, 2019).

The pandemic has significantly impacted food demand and security, leading to increased stockpiling and decreased availability of goods. The price of these commodities depends on the country's pandemic control policies (Poudel *et al.*, 2020). Food insecurity, malnutrition and obesity are serious worldwide health challenges that affect more than 25% of the world's population. The COVID-19 pandemic has worsened these problems, resulting in a global food crisis and upsetting economic markets. Mitigation efforts have influenced production, processing, transportation and commerce, generating substantial disruptions in food supply and accessibility, which are essential to maintaining a stable food security system (Alam *et al.*, 2016; Huizar *et al.*, 2021). The pandemic has drastically reduced food supply and accessibility, resulting in increasing food insecurity and an abrupt change in eating preferences. This has resulted in a lack of emphasis on healthy eating behaviors among those with limited resources. To preserve resilience and limit the pandemic's impact, immediate and aggressive solutions are required, including strategies to ensure food supply for vulnerable groups. Stockpiling essential foods for future use is a popular practice (Jafri *et al.*, 2021). The productivity of food businesses has been impacted by supply-demand imbalances and panic buying caused by disruptions in the food system. Developing resilience is essential for anticipating, organizing, reacting to and recovering from disruptions. Making supply chain resilience a top priority guarantees success and survival in future.

### *2.4 Impact of pandemic on retail food supply chain transportation network and logistics*

The COVID-19 pandemic has disrupted transportation, particularly in the food industry, making marine freight and rail transport more accessible. However, container shortages and supply chain issues require coordination among stakeholders, transportation providers and regulatory bodies. Truck transport has shown resilience, but issues like limited toilet access and customer behavior need to be addressed. Optimizing online meal delivery systems and providing proper restroom facilities can help truck transport run more efficiently. Effective supply chain tactics are crucial for seamless operations, and inefficiencies, particularly in wholesaler roles, can cause delays, stockouts and quality issues.

## 3. Methodology

The research methodology used in this study is to thoroughly investigate the current literature on disruptions in the retail food supply chain, with a focus on the period before, during and after the pandemic. To begin with this approach, a thorough literature review was conducted to determine the scope of the study and identify relevant keywords. These keywords were carefully picked to cover a wide range of retail food supply chain disruptions, including pandemics and related events. Scopus was chosen as the primary database for this study because of its extensive coverage of scholarly literature from a variety of topics. To ensure that the most recent research capturing evolving trends and developments was included, the literature search was carried out between 2015 and 2023. Boolean operators were used in conjunction with a methodical search methodology to efficiently combine keywords and refine search results. A total of 204 documents with 150 sources were initially identified. According to Zang *et al.* (2022), limiting the search to Scopus helped to avoid selection bias, as it supported to exclude studies from non-indexed sources and grey literature, thereby potentially skewing the results.

Using a hybrid research methodology, the study concentrated on supply chain disruptions in the retail food industry. Strict inclusion and exclusion criteria were employed to choose solely peer-reviewed papers, hence removing redundant and superfluous sources. Key findings, publication dates, author names and other pertinent information were checked for in the publications that were retrieved. R software was used to first sort and analyze the data collection, and then scientometric tools and cluster analysis were combined. For content analysis, the Atlas.ti program was utilized, and codes were assigned to the most pertinent terms. Strong methodological rigor was supplied by the study's approach, which helped to accomplish goals and address research concerns. The study's conclusions offer insightful information about the applicability of different studies.

## 4. Results and analysis

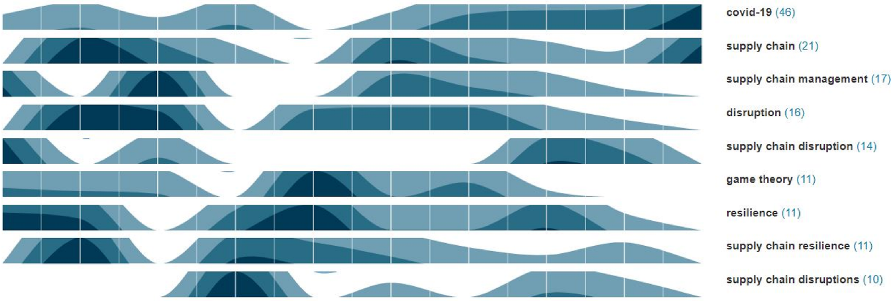
As previously mentioned, 204 publications were found through a keyword search that included the terms "Retail Supply Chain","Disruption" and "Retail Food Supply chain" with the AND Boolean operator under the (Title; Keywords; Abstract) sub division under Scopus search strategy. In general, this data set that was initially obtained highlighted the path of research development in the field of retail supply chain research, encompassing a wide range of subjects such as the adoption of technology (digital twins, machine learning), sustainability, logistics and performance. Simultaneously, our focus on disruptions in the retail supply chain elucidated both external factors such as geopolitical events and internal factors like inventory management as critical challenges. This study provides a holistic understanding of the current state of knowledge in the field, offering valuable insights for academics, industry practitioners and policymakers. The findings serve as a foundation for strategic decision-making, risk mitigation strategies and future research directions aimed at enhancing the resilience of retail supply chains in the face of evolving global dynamics. The basic information as shown in Figure 1. A total of 152 sources with 204 documents were identified. The total number of authors were 591 out of which 23 documents were s ingle authored. The international collaboration is indicated in the international coauthor percentage which is 26.47%. A total of 716 keywords were identified and average citation per document is 20–21 with over 10,000 documents captured as total references in overall data set.

The very first outcome of this research is shown below in Figure 2 which describes the keyword distribution over the years. The keywords are considered as research area (nodes) in bibliometric and thematic analysis. As per that, three major areas (COVID 19, Supply Chain Disruption and Supply Chain Resilience) have been identified as most targeted research keywords. To understand the author, research area and journal source, is shown in Figure 3.

In the above Figure 2, COVID-19, Supply Chain disruption and related strategies seem to gain more importance whereas resilience and operations research methods like game theory to tackle supply chain disruptions during pandemic have gained very less importance.

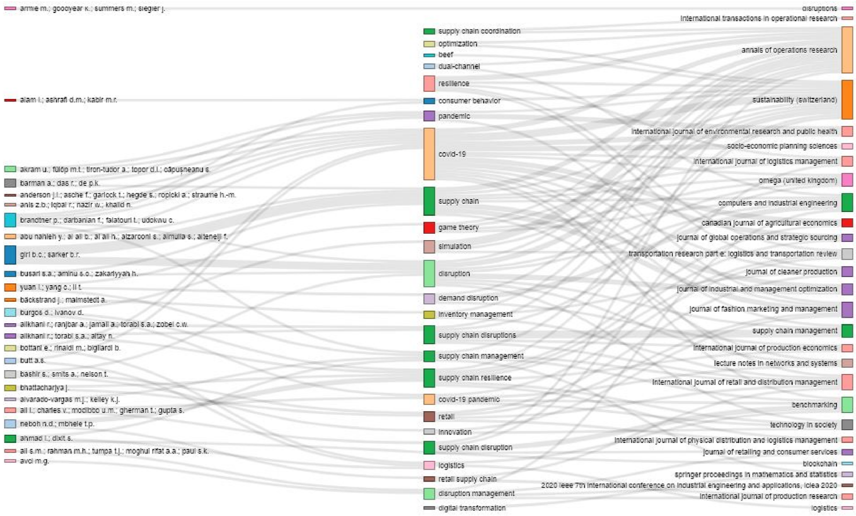

**Source(s):** Authors' own work

**Figure 1.**
Basic information on the data set




**Source(s):** Authors' own work

**Figure 2.** Research area (keyword distribution)




**Source(s):** Authors' own work

**Figure 3.** Author vs research topic vs source

Figure 3 indicates scholars vs research topic connection, as well the list of journal sources used for publication. This comparative analysis tries to shed light on the distribution of authors, research subjects and publication sources within an academic publication dataset. Visualizing the number of publications attributed to each author and examining the distribution of research topics and sources allows researchers to identify prominent contributors, understand current research trends, evaluate the impact and the reliability of various publishing outlets, map interdisciplinary associations and optimize publication strategies (See Appendix).

*International Transactions in Operations research, Annals of Operations Management, Computers in Industrial Engineering, Transportation Research Part – e: Logistics and Transportation Review* and *Journal of Global Operations and Strategic Sourcing* focused publication in area of resilience, whereas disruption and simulation-based studies were also covered by the above list of sources. Retail supply chain and management-based studies were published in *Journal of Retailing and Consumer Services, Omega*, and *International Journal of Physical Distribution and Logistics Management*.

Furthermore, Figure 4 generated provided the analysis of document frequencies in a dataset to review beneficial data about the reliability, accessibility and impact of publishing sources in an area. This allows researchers, publishers and academic institutions to discover significant venues for effective research dissemination, distinguish prominent journals, assess their reputation and make educated publication decisions. It also aids in understanding publication patterns in the academic community, which contributes to strategic decision-making and the growth of scholarly communication.

The data analysis portrayed in Figure 5 included keywords, author research location and source, has identified patterns and traits in the dataset. The inclusion of author country highlighted geographical patterns, shedding light on worldwide academic interests, collaborations and publishing routines. This data enables researchers to identify research hotspots, global collaborations and the visibility of publishing sources. It also assists publishers and academic institutions in determining reader preferences, target areas and optimizing publication strategies, thereby encouraging international collaboration and research advancements. China has focused more on cost, sales and commerce. USA and Germany have focused on decision making, game theory and profitability. India has focused on retailing and food supply chain. Many publications on COVID-19 have come from Malaysia and India. *Canadian Journal of Agricultural Economics, Benchmarking* and *International Journal of Production Economics* are among top contributors along with those sources mentioned in Figures 3 and 4.

Density analysis shown in Figure 6 is a technique for analyzing the distribution of study fields across time, revealing patterns and shifts in research concentration. It enables scholars to make informed decisions and comprehend the dynamics of their field. By analyzing the distribution over time, researchers might detect shifts in study emphasis and uncover "hotspots" of interest, which could be prominent issues drawing significant scholarly attention.

Figure 6 illustrates how the supply chain management cluster has not placed significant emphasis on research into stochastic systems, network design, optimization and blockchain. Research on food supply, price dynamics and pandemic disruptions is also needed in the COVID 19 cluster. Consequently, the study asserts that the supply chain management cluster

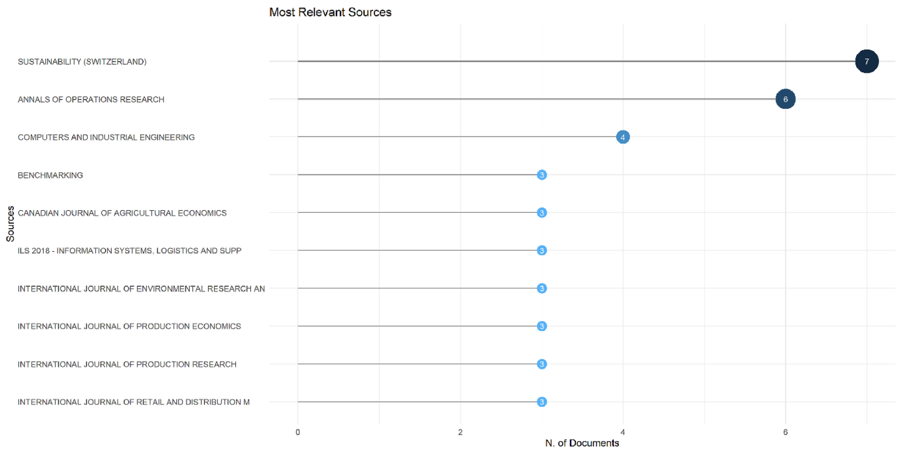
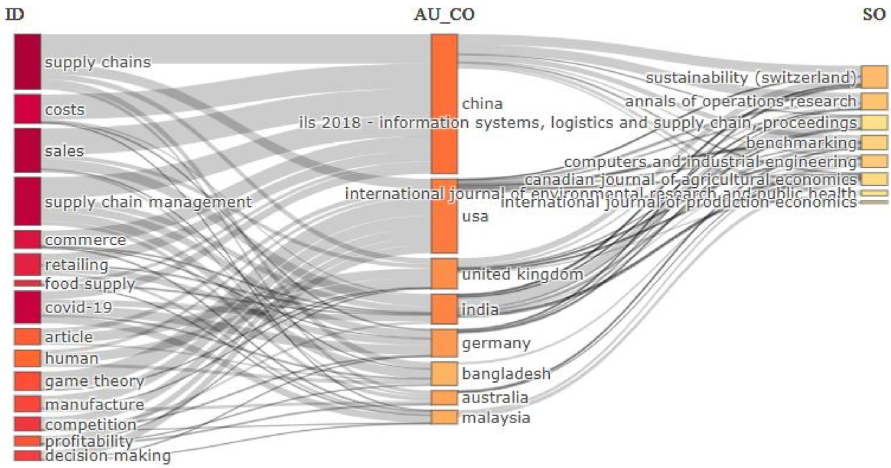


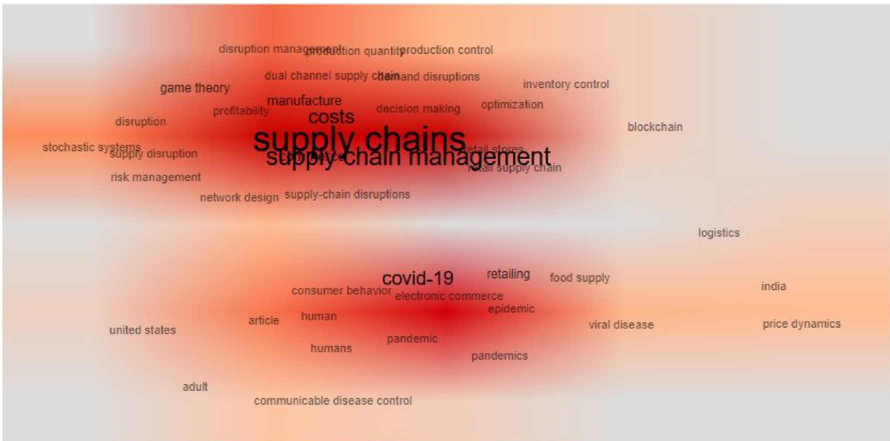

**Figure 4.**
Most relevant sources

**Source(s):** Authors' own work




**Source(s):** Authors' own work

**Figure 5.** Author vs research topic vs source




**Source(s):** Authors' own work

**Figure 6.** Density analysis of research area

has not given enough attention to research areas including blockchain, network architecture, optimization and stochastic systems. This means that additional research and the discovery of fresh perspectives are needed to enhance supply chain operations. More research on food supply, price dynamics and pandemic disruptions is necessary, as the COVID-19 pandemic has brought to light.

## 5. Thematic and cluster analysis

This research was carried out using another bibliometric software (Voswiever) that use clustering algorithms to detect groups of phrases with significant links. Thematic clusters are then represented as nodes in a network graph, with edges denoting relationships. The size and color of nodes commonly indicate the frequency or relevance of phrases inside clusters. This allows researchers to observe how thematic clusters evolve over time. Researchers can learn about the dynamics and evolution of research themes within a certain domain by evaluating changes in cluster composition and density. Identify and investigate areas where different themes intersect, creating potential for interdisciplinary collaboration and knowledge integration. Furthermore, thematic clusters are visually linked based on the co-occurrence or co-citation associations between phrases. This visualization enables researchers to perceive the interconnections between different research themes, facilitating a holistic understanding of the field as shown in Figure 7. A minimum number of occurrences of keyword was selected as 3. Out of 716 keywords, 42 met the threshold.

The clusters that help group related items together were determined from the results of Figure 7, and they are displayed in Table 1. Certain items in the context of bibliometric data could include authors, publications or keywords. Researchers can find recurring themes or subjects in a body of literature by identifying clusters. This is especially helpful for figuring out how a research field is organized and identifying the primary areas of interest. Clusters can be seen in a VOSviewer-generated network diagram as different colored groupings or nodes. This image, which illustrates the links and linkages between several clusters, facilitates understanding of a field's knowledge structure. Through this analysis we have captured collaborative patterns among authors or research groups by identifying clusters that represent closely related collaborations.

This is a method that highlights the similarities between different clusters in order to find multidisciplinary links. By identifying strengths, shortcomings and new trends, it aids in the strategic resource allocation of academics, organizations and governments. It also facilitates the navigation of huge quantities of scholarly knowledge by providing a visual representation of the key research topics and their connections (van Eck and Waltman, 2009).

Based on bibliographic coupling, the cluster analysis identifies distinct subject clusters within supply chain management and associated domains. The many facets of supply chain

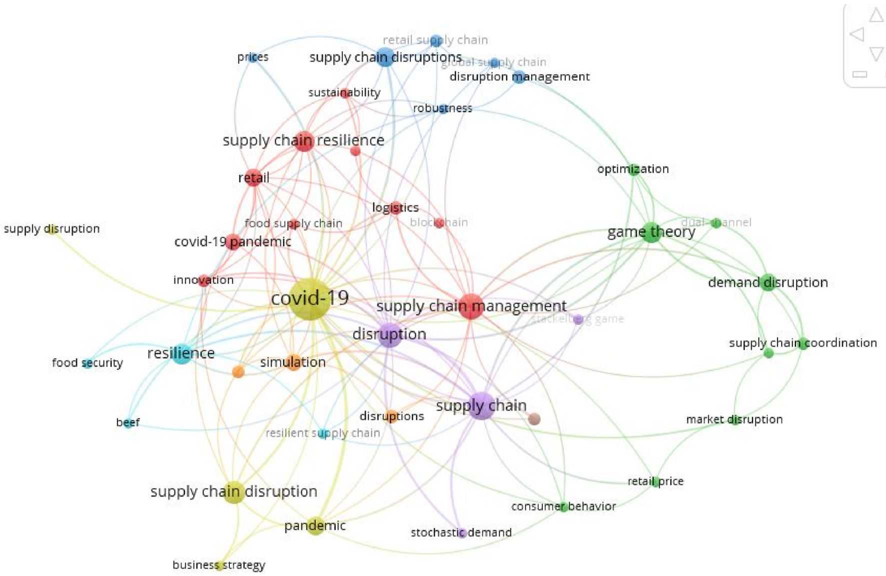



**Figure 7.**
Keyword coupling

**Source(s):** Authors' own work

| Cluster 1 | Cluster 2 | Cluster 3 |
|---|---|---|
| *Blockchain* | *Consumer Behavior* | *Disruption Management* |
| *Covid 19 pandemic* | *Demand Disruption* | *Global Supply Chain* |
| *Food supply chain* | *Dual Channel* | *Prices* |
| *Innovations* | *Game theory* | *Retail Supply Chain* |
| *Logistics* | *Market disruption* | *Robustness* |
| *Marketing* | *Optimization* | *Supply Chain Disruption* |
| *Retail* | *Retail price* | |
| *Supply chain management* | *Revenue-sharing contract* | |
| *Supply chain resilience* | *Supply chain coordination* | |
| *Sustainability* | | |
| **Cluster 4** | **Cluster 5** | **Cluster 6** |
| *Business Strategy* | *Stackelberg game* | *Beef* |
| *Pandemic* | *Stochastic demand* | *Food security* |
| *Supply Chain Disruption* | *Supply Chain* | *Resilience* |
| *Supply Disruption* | | *Resilient Supply Chain* |
| **Cluster 7** | | **Cluster 8** |
| *Disruption* | | *Digital Transformation* |
| *Inventory Management* | | |
| *Simulation* | | |

**Source(s):** Authors' own work

**Table 1.**
Cluster analysis

operations are highlighted in Cluster 1, such as the application of blockchain technology, resilience tactics in the face of the Covid-19 pandemic and sustainability issues in the retail, marketing and logistics industries. In order to improve operational efficiency, Cluster 2 delves deeper into the dynamics of customer behavior, market disruptions and optimization tactics. It does this by implementing ideas like supply chain coordination and game theory. Meanwhile, Cluster 3 addresses issues concerning supply chain disruptions, resilience and the influence of pricing dynamics on retail supply chains, emphasizing the significance of disruption management within the global supply chain landscape. In addition to providing opportunities for additional study and strategic planning to minimize disruptions and maximize supply chain performance, each cluster offers insightful information on the nuances of supply chain management.

In light of the pandemic and its effects on supply networks, in particular, Cluster 4 focuses on strategic issues during disruptions. It covers subjects including supply chain interruptions, company strategy and stochastic demand, demonstrating the importance of flexible and adaptable tactics for successfully navigating uncertain circumstances. Expanding on the concept of supply chain resilience, Cluster 5 focuses on developing robust supply chain networks, food security and supply chains for beef. It emphasizes how crucial it is to maintain food supply chains' continuity and stability, particularly in the face of unforeseen events and disruptions. Cluster 6 emphasizes the use of optimization methods and game theory to supply chain dynamics management. The importance of inventory management and simulation methods in reducing supply chain risks and interruptions is emphasized in Cluster 7. In order to improve the resilience and responsiveness of the supply chain, it emphasizes the necessity of efficient inventory planning and simulation-based decision support systems. In order to promote efficiency and innovation, technology adoption and digitalization are becoming increasingly important. This is reflected in Cluster

8, which is dedicated to supply chain digital transformation. It covers subjects including tactics for digital transformation and how technology will change supply chain operations in the future.

The research gap emphasized is mostly related to the connection of sustainability and supply chain resilience. While sustainability is acknowledged as a significant concern in supply chain management, particularly in terms of environmental and social responsibility, there appears to be a scarcity of research that specifically explores how sustainability strategies lead to increased supply chain resilience. Investigating the connections between sustainability programs and resilience strategies could provide useful insights into how firms can solve environmental and social concerns while also developing strong and adaptable supply chains.

The need for more thorough investigations on the application of cutting-edge technologies, such blockchain and digital transformation, in supply chain management has also been noted as a gap in the literature. Although supply chains could benefit from increased transparency, efficiency and agility as a result of these technologies, more research is needed to fully understand the difficulties in implementing them, how they affect supply chain performance and how they integrate with current procedures. Examining these facets can assist in determining best practices and recommendations for utilizing developing technology to efficiently handle problems in the modern supply chain.

Research on supply chain disruptions and resilience tactics unique to certain sectors or industries, such manufacturing or healthcare, is also necessary. Although the fundamentals of supply chain resilience are applicable to all industries, distinct industries may have particular difficulties that call for customized resilience plans. Organizations participating in certain industries can benefit greatly from additional study that looks at resilience strategies, vulnerabilities and disruptions that are specific to those sectors. This will help them become more prepared and responsive to disruptions.

## 6. Conceptual network mapping (Atlas.ti)

Research on supply chain disruptions and resilience strategies relevant to certain sectors or industries, such as manufacturing or healthcare, is additionally important. Although the foundations of supply chain resilience are applicable to all industries, specific businesses may face unique challenges that necessitate bespoke resilience plans. Organizations in certain industries might greatly benefit from extra research that examines resilience methods, weaknesses and disruptions unique to those sectors. This will enable them to become better prepared and responsive to delays.

As a result, grounded density is a metric used to determine the concentration and density of codes or themes within a dataset. It provides information about the distribution of various themes and their importance in the literature. High grounded density indicates a more focused and concentrated study environment, whilst low grounded density may indicate a broader and diverse field. Analyzing grounded density allows academics to assess the range and intensity of scholarly investigation in various subject areas as shown in Figure 8.

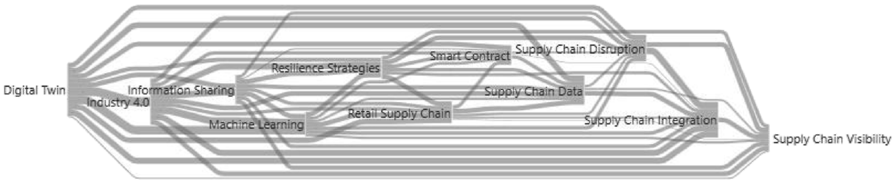
Furthermore, we developed a Sankey diagram, as shown in Figure 9, to depict the flow and interrelationships between distinct codes or themes in a bibliometric network. It clearly depicts the linkages and transitions between different research areas, illustrating the channels via which knowledge evolves. A Sankey diagram improves the knowledge of how multiple codes are interconnected, helping researchers find key linkages, collaborative patterns and the general structure of a research subject.

Table 2 on code co-occurrence of researchers provides a quantitative depiction of how frequently distinct codes appear together. It enables researchers to detect common patterns

| Name | Grounded | Density |
|---|---|---|
| Digital Twin | 30 | 2 |
| Industry 4.0 | 24 | 1 |
| Information Sharing | 15 | 1 |
| Machine Learning | 19 | 2 |
| Resilience Strategies | 18 | 3 |
| Retail Supply Chain | 17 | 2 |
| Smart Contract | 13 | 2 |
| Supply Chain Data | 19 | 3 |
| Supply Chain Disruption | 19 | 3 |
| Supply Chain Integration | 22 | 1 |
| Supply Chain Visibility | 12 | 2 |

**Source(s):** Authors' own work

**Figure 8.**
Code vs grounded density




**Source(s):** Authors' own work

**Figure 9.**
Sankey relationship diagram

and theme clusters, as well as uncover interdisciplinary linkages and emerging trends. Analyzing the author-code relationship enables mapping individual academics' contributions to certain subject areas, identifying prolific contributors, assessing influence and recognizing collaboration networks. This information can help academics, institutions and governments make informed resource allocation decisions and stimulate multidisciplinary collaboration.

Figure 9 illustrates the progression of supply chain management research, culminating in "Supply Chain Visibility." The most important concepts are "Digital Twin" and "Industry 4.0". Digital twin technology duplicates real-world supply chain activities in a virtual environment, increasing resilience and guaranteeing that operations run smoothly amid disruptions. Automation, data interchange and interconnectivity are all Industry 4.0 traits that serve as the foundation for flexible and collaborative supply chain management. Organizations can employ these technologies to reduce interruptions, improve decision-making and foster better stakeholder participation. The following code co-occurrence Table 2 shows the relationships between different codes or categories in a dataset. Here the number of codes relate to the density of the keywords explored in the study. The count co efficient gives the grounded density as per Table 2.

The highly cited authors, their contributions to a dataset and their areas of interest in research are shown in Figure 10 above. This research looks at the co-occurrence or correlation between authors and keywords to help identify patterns of collaboration, subject matter expertise and thematic focus. Gaining insights into developing trends, interdisciplinary linkages and prospective research gaps within a subject can be achieved

**Table 2.**
Code Co occurrence

| | ○ digital Twin Gr = 30 Count | Coefficient | ○ industry 4.0 Gr = 24 Count | Coefficient | ○ information Sharing Gr = 15 Count | Coefficient | ○ machine learning Gr = 19 Count | Coefficient | ○ resilience Strategies Gr = 18 Count | Coefficient | ○ retail supply chain Gr = 17 Count | Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ○ Digital Twin Gr = 30 | *0* | *0.00* | *15* | *0.38* | *8* | *0.22* | *14* | *0.40* | *7* | *0.17* | *9* | *0.24* |
| ○ Industry 4.0 Gr = 24 | *15* | *0.38* | *0* | *0.00* | *11* | *0.39* | *12* | *0.39* | *10* | *0.31* | *6* | *0.17* |
| ○ Information Sharing Gr = 15 | *8* | *0.22* | *11* | *0.39* | *0* | *0.00* | *8* | *0.31* | *8* | *0.32* | *6* | *0.23* |
| ○ Machine Learning Gr = 19 | *14* | *0.40* | *12* | *0.39* | *8* | *0.31* | *0* | *0.00* | *8* | *0.28* | *8* | *0.29* |
| ○ Resilience Strategies Gr = 18 | *7* | *0.17* | *10* | *0.31* | *8* | *0.32* | *8* | *0.28* | *0* | *0.00* | *8* | *0.30* |
| ○ Retail Supply Chain Gr = 17 | *9* | *0.24* | *6* | *0.17* | *6* | *0.23* | *8* | *0.29* | *8* | *0.30* | *0* | *0.00* |
| ○ Smart Contract Gr = 13 | *8* | *0.23* | *6* | *0.19* | *2* | *0.08* | *5* | *0.19* | *6* | *0.24* | *6* | *0.25* |
| ○ Supply Chain Data Gr = 19 | *10* | *0.26* | *8* | *0.23* | *7* | *0.26* | *4* | *0.12* | *6* | *0.19* | *8* | *0.29* |

(*continued*)

Table 2.

| | ○ digital Twin Gr = 30 Count | Coefficient | ○ industry 4.0 Gr = 24 Count | Coefficient | ○ information Sharing Gr = 15 Count | Coefficient | ○ machine learning Gr = 19 Count | Coefficient | ○ resilience Strategies Gr = 18 Count | Coefficient | ○ retail supply chain Gr = 17 Count | Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ○ Supply Chain Disruption Gr = 19 | *8* | *0.20* | *7* | *0.19* | *5* | *0.17* | *6* | *0.19* | *8* | *0.28* | *4* | *0.13* |
| ○ Supply Chain Integration Gr = 22 | *10* | *0.24* | *10* | *0.28* | *6* | *0.19* | *6* | *0.17* | *5* | *0.14* | *3* | *0.08* |
| ○ Supply Chain Visibility Gr = 12 | *2* | *0.05* | *8* | *0.29* | *7* | *0.35* | *4* | *0.15* | *6* | *0.25* | *1* | *0.04* |

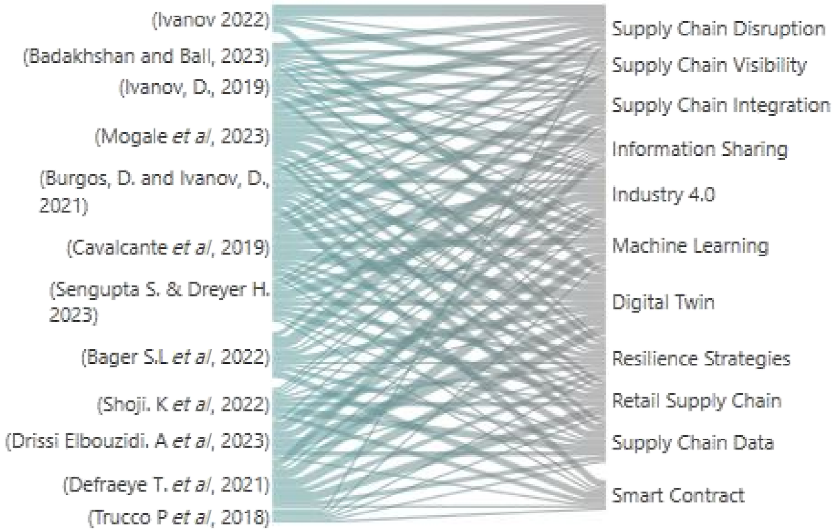
| | ○ Smart contract Gr = 13 Count | Coefficient | ○ supply chain data Gr = 19 Count | Coefficient | ○ supply chain disruption Gr = 19 Count | Coefficient | ○ supply chain integration Gr = 22 Count | Coefficient | ○ supply chain visibility Gr = 12 Count | Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ Digital Twin Gr = 30 | *8* | *0.23* | *10* | *0.26* | *8* | *0.20* | *10* | *0.24* | *2* | *0.05* |
| ○ Industry 4.0 Gr = 24 | *6* | *0.19* | *8* | *0.23* | *7* | *0.19* | *10* | *0.28* | *8* | *0.29* |
| ○ Information Sharing Gr = 15 | *2* | *0.08* | *7* | *0.26* | *5* | *0.17* | *6* | *0.19* | *7* | *0.35* |

(*continued*)

Table 2.

| | ○ Smart contract Gr = 13 Count | Coefficient | ○ supply chain data Gr = 19 Count | Coefficient | ○ supply chain disruption Gr = 19 Count | Coefficient | ○ supply chain integration Gr = 22 Count | Coefficient | ○ supply chain visibility Gr = 12 Count | Coefficient |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ Machine Learning Gr = 19 | *5* | *0.19* | *4* | *0.12* | *6* | *0.19* | *6* | *0.17* | *4* | *0.15* |
| ○ Resilience Strategies Gr = 18 | *6* | *0.24* | *6* | *0.19* | *8* | *0.28* | *5* | *0.14* | *6* | *0.25* |
| ○ Retail Supply Chain Gr = 17 | *6* | *0.25* | *8* | *0.29* | *4* | *0.13* | *3* | *0.08* | *1* | *0.04* |
| ○ Smart Contract Gr = 13 | *0* | *0.00* | *6* | *0.23* | *3* | *0.10* | *1* | *0.03* | *0* | *0.00* |
| ○ Supply Chain Data Gr = 19 | *6* | *0.23* | *0* | *0.00* | *4* | *0.12* | *8* | *0.24* | *3* | *0.11* |
| ○ Supply Chain Disruption Gr = 19 | *3* | *0.10* | *4* | *0.12* | *0* | *0.00* | *11* | *0.37* | *8* | *0.35* |
| ○ Supply Chain Integration Gr = 22 | *1* | *0.03* | *8* | *0.24* | *11* | *0.37* | *0* | *0.00* | *8* | *0.31* |
| ○ Supply Chain Visibility Gr = 12 | *0* | *0.00* | *3* | *0.11* | *8* | *0.35* | *8* | *0.31* | *0* | *0.00* |

**Source(s):** Authors' own work




**Source(s):** Authors' own work

**Figure 10.** Top cited authors vs keywords

by analyzing whether authors relate to specific study topics or areas of interest, as well as the frequency and context of specific keyword usage in their writing. Additionally, a conceptual network framework was created, as seen in the image below, to illustrate the connections between various codes, themes or concepts extracted from the dataset visually. Researchers can comprehend the underlying structure and patterns in their data more fully by visualizing these relationships. Researchers can find clusters of related concepts, discover correlations and co-occurrences across various codes and investigate the complexity of the qualitative data by utilizing the nodes and edges in the network diagram as shown in Figure 11. This has given a comprehensive and intuitive way to explore, interpret and communicate the rich interconnections within their qualitative data.

## 7. Discussion

### *7.1 Disruption based scenario planning – retail food supply chain (insights answering RQ1)*

The pandemic has created a long-term disrupted state, characterized by instability and uncertainty about markets, supply base, and capacities. This instability poses a risk of supply chain collapses and market interruption. The gradual and long-lasting disruption profile allows for different insights than instant-event disruptions. Recovery during the pandemic begins with disruption, challenging deep uncertainty about demand and supply (Ivanov, 2021). Disruption risks during the COVID-19 pandemic have evolved significantly, with different supply chain echelons experiencing simultaneous or sequential openings and closures of suppliers, facilities and markets. Both instantaneous and pandemic disruptions are characterized by capacity disruption and recovery needs, but the impact grew, evolved and continued with no clear end in sight. Two major research gaps exist: prediction of pandemic impacts and supply chain adaptive behaviors during the pandemic, and disruption tails in the pandemic context. Route optimization tools can help users assess, validate and present optimization results by showing routes on a map.

This approach allows for a clear understanding of the itinerary and helps retailers, manufacturers and logistics service providers optimize costs. To be successful, detailed


**Figure 11.**
Network visualization

**Source(s):** Authors' own work

order statistics such as cost, profit and revenue for each trip, duration of trips, average time and distance covered and vehicle utilization should be built. Custom reports can be created to highlight insights and monitor changes (Marmolejo-Saucedo, 2020).

Future research focuses on digital technologies to improve supply chain resilience during epidemic outbreaks. Data analytics, artificial intelligence and machine learning are key areas of focus. Digital SC twins, computerized models that represent the network state in real-time, can be used to support decision-making during outbreaks. In pre-disruption mode, digital twins can visualize SC risks, assess supplier disruption risks, predict supply interruptions and compute alternative supply network topologies. In dynamic, reactive mode, they can simulate disruption impacts on SCs and alternative designs based on real-time inventory, demand and capacity data. Scenario planning is a strategic tool for managing supply chain disruptions, such as those triggered by the COVID-19 pandemic. By creating and analyzing multiple scenarios, organizations can proactively prepare for potential futures and adapt swiftly to changing circumstances. This approach fosters resilience, enhances decision-making capabilities and promotes proactive strategies to navigate uncertainty and volatility in the supply chain landscape. Implementing scenario planning empowers organizations to stay ahead of the curve, anticipate challenges and seize opportunities in an ever-evolving business environment (Amorim Varum and Melo, 2010).

Scenario planning helps organizations identify and assess supply chain risks and opportunities, enabling strategic planning, contingency planning, supplier diversification and improved communication among stakeholders to mitigate potential disruptions and capitalize on opportunities (Dean, 2019). Organizations can understand supply chain disruptions through scenario exploration, identifying vulnerabilities and developing strategies to minimize disruptions, maintain operations and maintain customer satisfaction (Martelli, 2014). Scenario planning enhances supply chain resilience by identifying risks and uncertainties, enabling proactive strategies to manage and mitigate challenges, minimizing disruptions and minimizing impact (Rosyida *et al.*, 2018). Scenario planning helps organizations evaluate potential disruptions and develop contingency plans, such as alternative sourcing strategies, inventory management, transportation diversification and backup production facilities. This approach maintains operational continuity and minimizes supply chain disruptions, fostering proactive decision-making and adaptability and building a resilient supply chain (Angkiriwang *et al.*, 2014).

Disruption-based scenario planning is a crucial tool for retailers in the retail food supply chain, providing a framework to anticipate and mitigate potential disruptions. This approach enables stakeholders to proactively identify and prepare for events like natural disasters, supply chain disruptions or public health crises like pandemics. By systematically exploring different scenarios and their potential impacts, retailers can develop robust contingency plans and response strategies to maintain continuity of operations and ensure food availability.

Disruption-based scenario planning also enhances retailers' resilience by identifying vulnerabilities and weak points in the supply chain. This proactive approach allows retailers to implement measures like diversifying suppliers, establishing redundant distribution channels or stockpiling essential goods to minimize disruptions' impact. Scenario planning also facilitates collaboration among supply chain partners, enabling effective coordination and resource sharing during crises. It also informs strategic decision-making by simulating scenarios and assessing their potential outcomes, identifying opportunities for innovation, optimizing resource allocation and adapting business models to better withstand future disruptions.

### *7.2 Digitalization in retail food supply chain to overcome disruption (insights answering RQ2)*

When a firm has to deliver to multiple locations their deliveries should be well planned in such a way that they should choose optimal routes for the multiple vehicles that will visit the set of locations. To find optimal routes, different factors such as customer demand, locations, dates and times they want to be serviced, vehicle availability, product mix for each customer, (hours of service) restrictions for drivers applicable for the state. Distance covered by each vehicle and the number of vehicles needed to complete the delivery such as client demands and SLA requirements, calendar constraints and delivery time windows and visual representation of a transportation network on a map and its relation to real roads Such a granular approach to transportation optimization is important. Considering the factors above would improve model accuracy and, consequently, bring more accurate results. Read on to find out how route optimization helps solve business challenges and uncover the technology aspects that make it so powerful When supply chain specialists plan last-mile routing strategies, they need to map out itineraries in a way to minimize transportation costs and satisfy customer demands on time. Imagine a supplier delivering shipments to three clients. Each client has different periodic demand and preferred lead time – the interval in which an order should be delivered (Ivanov and Dolgui, 2019).

Therefore, to devise a solid route plan, the supplier applies optimization solvers that help eliminate manual work. When building itineraries, the software aggregates periodic demand for the clients and proposes an itinerary to cover all three clients in one trip within a defined time slot. The optimization solvers, however, cannot account for lead times specific to each client, because they do not support such a granular setup. This might result in clients not receiving their shipments in time, and lead to a decline in service level.

Such events can cause immediate financial and reputational risks. To enhance last-mile delivery operations and help supply chain specialists plan trips more easily, advanced route optimization can consider estimated lead times when planning routes. On-time delivery is one of the key metrics fleet operators need to stay on top. However, with tight time-related requirements from customers, operators need to adjust scheduling to each customer's preferred delivery dates and time windows. A lack of drivers may be another reason why on-time deliveries fail to happen. Logisticians need to consider driver work time to prevent regulation breaches. Violation of hours of service can lead to penalties for both the driver and the carrier. Meeting such requirements when planning routes manually can be time-consuming for supply chain planners, especially as it often requires reshaping delivery plans. At the same time, common spreadsheet solutions or other basic planning tools are not designed for considering such a complex set of time-related restrictions. Here's where route planning and optimization software comes into play (Alfayad, 2020; Ivanov, 2020).

The result of a route optimization scenario is a detailed schedule with trip times conveniently split into order processing and driving times. Based on predefined time windows and driver total work time, it provides a comprehensive overview of all trips with related such as cost, profit, revenue, fleet mix, its utilization and vehicle payload capacity, distance covered, arrival time for each trip leg.

With such a plan, fleet operators can rest assured that all time-related requirements are met and deliveries are completed on time. A transportation model can be integrated with current logistics processes and become a part of a supply chain digital twin – a simulation which uses real-time data snapshots and historic data to forecast supply chain dynamics. It can be used in cases such as to test supply chain design changes and development, discover bottlenecks and monitoring risks in real time and forecasting operational impacts over time etc. With it, analysts can better understand supply chain's behavior, predict abnormal situations and work out an action plan. We developed a discrete-event simulation model by combining simulation and optimization of supply chains, allowing for building a digital supply chain twin for operations and performance analysis under disruptions (Gutierrez-Franco *et al.*, 2021).

Because the COVID-19 pandemic is a very special kind of disruption, that is, a long-term supply chain crisis or a super disruption, we address its specific characteristics in our simulation model. First, the pandemic is characterized by a very long-term period of disruption. There should be an account for that in the timeline of our simulation. Second, the pandemic disruption is shaped by disruptions at several supply chain echelons with simultaneous and/or sequential openings and closures of suppliers, facilities and markets. The project outcome can assist us in many way. Firstly, modelling parameters can be considered based on the pandemic disruption allowing to first understand them better and make decisions about in–advance supply chain capacity adjustments (e.g. pre-positioning extra inventory or ramping-up capacity prior to demand recovery). Later, a recovery strategy when capacity is ramped-up in anticipation of a demand peak after the pandemic as new orders are added to the backlogged demand from the pandemic time can also be developed and tested (Ivanov, 2021).

These steps can be repeated over a period of time, with a particular focus on after-shock effects such as disruption tails. Discrete-event simulation model can be used to investigate potential disruption tails at the time of exiting the COVID-19 pandemic. With the conceptualization and experimental part, this study shall contribute to both state-of-the-art and deduce some interesting managerial implications. Theoretical insights from our study, for the first time, articulate an awareness of a novel and specific decision-making area in supply chain resilience related to exiting a pandemic and post-pandemic recovery. Moreover, the major determinants of demand dynamics, capacity management dynamics and inventory-ordering control policies during the pandemic and in the course of exiting the pandemic shall be considered when modelling and managing supply chains at the stages of pandemic elimination and post-pandemic recovery. On a managerial aspect, the retail supply chain managers will be greatly benefited by knowing the existence and risk of disruption tails in their supply chains and be instructive for the selection of post-pandemic recovery strategies (Abideen *et al.*, 2021b).

With the help of data driven digital twin and machine learning, a more practical strategy can be framed and reduce the impact of disruption tails on supply chain networks. In particular, increase supply chain coordination and allow demand smoothing over time in the post-disruption period. In addition, gradual capacity ramp-ups prior to expect peaks of postponed demand can also be effectively leveraged through another control strategies. This research also increases end-to-end visibility that shall ensure early disruption recognition, data transparency and prediction of possible scenarios along with collaborative decision-making support (Abideen *et al.*, 2021b; Voss *et al.*, 2017).

The results or outcome of this study can provide some recommendations for policy makers. Due to system inertia effects caused by different time lags of surges in demand and capacity adjustment, it might be instructive to inform supply chain companies about lockdown and re-opening times well in advance. That could help firms in managing shut-downing and ramping-up activities in the most efficient and responsive manner, and so avoiding disruption tails in particular and negative delayed effects of a pandemic in general. In addition, too frequent lockdown and re-opening decisions wreak havoc in supply chains due to their complexities, time lags and delayed effects in shutting-down and ramping-up the supply, production capacities and logistics Supply chains have experienced multiple shocks in the wake of the COVID-19 pandemic, both at Its beginning and during the long-term period of deep uncertainty about short-term and long-term dynamics of demand and supply. Moreover production based disruption can damage inventory dynamics and crease performance decrease in the post-disruption period causing product deficits in the markets and high inventory costs in the supply chains (Ivanov, 2021).

Digitalization in the retail food supply chain is revolutionizing logistics operations, improving efficiency, sustainability and customer satisfaction. By integrating digital technologies and optimization techniques, retailers can streamline transportation processes, optimize route planning and enhance supply chain visibility. Advanced tracking systems provide real-time insights into goods movement, facilitating better coordination and resource allocation. Network optimization allows retailers to design and manage distribution networks more effectively, analyzing customer demand, supplier capabilities and transportation constraints. This optimizes distribution centers, warehouses and delivery routes, minimizing costs and maximizing service levels. Network optimization also allows for consolidation and collaboration with other stakeholders, improving efficiency and resource utilization. Digital platforms and mobile applications provide real-time visibility of orders, convenient delivery scheduling and personalized services, fostering brand loyalty and repeat business. This transformative opportunity allows retailers to optimize supply chain operations, reduce costs and deliver superior customer experiences.

Moreover, data analytics is a vital tool in supply chain management, enabling organizations to make informed decisions based on historical and real-time data. This data helps in identifying trends, optimizing inventory levels and identifying cost savings opportunities. Advanced analytics techniques like predictive modeling and machine learning can also help identify potential disruptions. In tactical areas, data analytics aids in supplier selection, transportation routing and production planning, enabling informed trade-offs and resource allocation. Overall, data analytics is essential for optimizing the physical supply chain (Shafiq *et al.*, 2020). Through data analytics, organizations can accurately capture and model the complexities of the supply chain network. By integrating and analyzing data from different sources, such as transportation systems, warehouse management systems and sales data, organizations can gain a holistic view of their supply chain. This allows them to identify bottlenecks, inefficiencies and areas for improvement across the supply chain (Gopal *et al.*, 2022).

With access to real-time data, organizations can make informed decisions that drive operational efficiency. For example, by analyzing transportation data, organizations can optimize routes, reduce empty miles and improve delivery times. By analyzing inventory data, organizations can optimize stock levels, reduce carrying costs and ensure product availability. Similarly, by analyzing demand data, organizations can forecast demand patterns, improve production planning and minimize stockouts or overstock situations (Helo and Hao, 2019).

Data analytics improves collaboration and decision-making in the supply chain ecosystem by sharing data with suppliers, partners and customers. It enables accurate demand forecasting, aligns supply and demand, reduces lead times and enhances performance. Real-time data from sources like sensors and IoT devices helps assess disruptions and respond promptly. Data-driven decisions optimize costs, improve delivery times and enhance operational efficiency. By analyzing vast data from transportation, inventory, demand and capacity, organizations can make informed trade-offs and allocate resources effectively. Real-time data is crucial in predicting traffic patterns and optimizing road transport networks during disruptions like the COVID-19 pandemic. Supply chain analytics can forecast disruptions, optimize delivery routes and minimize delays. Data analytics leverages vast amounts of information from various activities, enabling organizations to make real-time decisions and optimize their supply chain operations (Gunasekaran *et al.*, 2017).

Real-time data in supply chain analytics is crucial for identifying alternative routes, suppliers and transportation modes during disruptions. It allows professionals to quickly adapt strategies, maintain operational continuity and mitigate disruptions (Lee and George, 2022). Data analysis helps organizations understand disruptions in transport networks by identifying patterns and trends, enabling proactive measures to optimize supply chain performance. Supply chain analytics uses data to enhance resilience in organizations by identifying vulnerabilities, risks and potential failure points. This knowledge enables proactive measures like supplier diversification and inventory optimization.

### *7.3 Enablers of digitalization that assist in developing retail supply chain resilience and viability (insights answering RQ3)*

Implementing sustainable practices in supply chain operations is another valuable strategy. This can involve reducing waste, optimizing energy usage and adopting environmentally friendly practices. Sustainable operations not only minimize the environmental impact but also contribute to the long-term viability and resilience of the supply chain. By incorporating these strategies, businesses can improve the resilience, efficiency and sustainability of their supply chains. Proactive planning, risk assessment, diversification and sustainable practices help mitigate the impact of disruptions and ensure continuity in the face of challenges. Continued research in this area can further enhance our understanding of supply chain disruption and provide valuable insights for businesses seeking to improve their supply chain management practices.

The importance of understanding the impact of the pandemic on supply chains and developing strategies to enhance their resilience. It suggests that businesses should invest in research to gain a deeper understanding of the pandemic's effects on their supply chains and identify areas for improvement. By analyzing the challenges faced during the pandemic, businesses can develop strategies to mitigate similar disruptions in the future and enhance the overall resilience of their supply chains. Furthermore, digital technologies offer opportunities for improved supply chain visibility, agility and collaboration. They enable businesses to respond swiftly to disruptions, track inventory in real-time and optimize logistics and distribution processes. However, the need for further research to explore the full potential of digital technologies in facilitating supply chain recovery and enhancing resilience.



## 8. Future scope for sustainability in retail food supply chain

The concept of sustainability has gathered significant research interest within the area of food supply chain management. A thorough examination of existing literature on food sustainable supply chain management (FSSCM) has shed light on crucial factors, practices and potential avenues for future exploration in sustainable supply chain management within the food industry. This recognition highlights the significance of integrating sustainability considerations into the food supply chain, with the aim of ensuring the industry's long-term viability.

There are specific sustainable supply chain management practices that can be adopted in the food industry. These practices span different stages of the supply chain, including procurement, production, processing, distribution and consumption. Examples of sustainable practices include sourcing ingredients from sustainable and ethical suppliers, implementing energy-efficient production processes, utilizing renewable energy sources, optimizing transportation routes to reduce emissions, implementing waste reduction and recycling initiatives and promoting responsible consumption patterns among consumers. The future directions for sustainable supply chain management in the food industry include exploring emerging technologies, such as blockchain, Internet of Things (IoT) and artificial intelligence (AI), to enhance traceability, transparency and efficiency within the supply chain. Additionally, further research is needed to address the challenges associated with sustainable packaging, reducing food waste and promoting circular economy principles in the food supply chain. Collaborative efforts among stakeholders, including governments, businesses, consumers and civil society organizations, are also emphasized to drive sustainable practices and ensure the long-term viability of the food industry.

Issues and challenges manifest in various stages of the supply chain process. These stages include production, processing, distribution, marketing and consumption. Within these stages, several key areas were identified as prone to issues and challenges, such as farm management, product quality and safety, logistics and transportation, market access, consumer education and regulatory compliance (Ghadge *et al.*, 2017). This characterization of sustainability challenges in retail food supply chain provided insights into the underlying factors contributing to these issues. For instance, issues related to farm management might involve limited access to resources, difficulties in scaling production or inadequate training and knowledge transfer among farmers. Challenges in logistics and transportation could stem from inefficient infrastructure, lack of coordination or high costs associated with short-distance delivery (Siddh *et al.*, 2017).

### *8.1 Summary of findings*

*8.1.1 Adaptive and responsive retail supply chain.* It is evident and cleat a longer-term stability and scenario mitigation plans are needed to manage supply bases and coordinate retail food supply chain capacities. Digital twin-based approach is risk free and can support in 24/7 real time data-based decision making.

*8.1.2 Leverage digital tools to overcome disruptions.* The digital twin technology supports in optimizing the retail food supply chain and also the shorten lead times and meet customer demand properly during disruptions.

Performance Analysis, Predictive Analysis, Real Time Utilization and Enhanced Decision Making.

Comprehensive periodic performance analysis would enable organizations to respond to disruptions proactively. Real time data utilization helps in predictive analysis and better decision making.

## 9. Conclusion

The retail food supply chain has undergone significant transformations due to disruptive events like the COVID-19 pandemic and digitalization and network optimization technologies. Disruption-based scenario planning is crucial for retailers to navigate uncertainties, anticipate challenges and prepare for potential disruptions. By creating and analyzing multiple scenarios, retailers can develop robust contingency plans, enhance resilience and ensure continuity of operations. Digitalization via transportation and network optimization has revolutionized logistics operations, enabling retailers to streamline processes, optimize route planning and enhance supply chain visibility. These advancements improve operational efficiency, reduce costs and deliver superior customer experiences in the dynamic retail food landscape. The convergence of disruption-based scenario planning and digitalization offers immense potential for retailers to build agile and resilient supply chains capable of withstanding future disruptions. Collaboration among supply chain partners and proactive strategies informed by scenario planning and digitalization are essential for navigating uncertainties and capitalizing on emerging opportunities in the evolving retail food market.

Simultaneously, our focus on retail supply chain disruptions indicated external causes such as political conflicts and internal factors such as inventory management to be significant challenges. This study gives a comprehensive picture of the field's current level of knowledge, with important implications for academics, industry practitioners and policymakers. The findings serve as a foundation for strategic decision-making, risk mitigation methods and future research directions aimed at improving the resilience of retail supply chains in the face of changing global dynamics.

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## Appendix
## R coding

(1) Author vs Keyword vs Source

Load necessary libraries
library(dplyr))
library(ggplot2)
Assuming you have a dataset named 'my_data' with columns like 'author', 'keywords', and 'journal_source'

(2) Author vs Keyword Analysis

author_keyword_summary < - my_data %>%
group_by(author, keywords) %>%
summarize(count = n( )) # Count occurrences of each author-keyword combination.

(3) Journal Source Analysis

journal_source_summary < - my_data %>%
group_by(journal_source) %>%
summarize(count = n( )) Summarize data by journal source.

(4) Visualization using ggplot2 for Author vs Keyword

ggplot(author_keyword_summary, aes(x = author, y = count, fill = keywords)) +
geom_bar(stat = "identity", position = "dodge") +
labs(title = "Author vs Keyword Analysis", x = "Author", y = "Count", fill = "Keywords") +
theme(legend.position = "top")

(5) Visualization using ggplot2 for Journal Source

ggplot(journal_source_summary, aes(x = journal_source, y = count)) +
geom_bar(stat = "identity") +
labs(title = "Journal Source Distribution", x = "Journal Source", y = "Count")

(6) Keyword vs Country vs Source

filtered_data < - my_data %>%
filter(keywords %in% c("important_keyword1", "important_keyword2")) # Select relevant keywords.

(7) Author Country Analysis

country_summary < - my_data %>%
group_by(author_country) %>%
summarize(count = n( )) # Summarize data by author country.

(8) Visualization using ggplot2

ggplot(country_summary, aes(x = author_country, y = count)) +

```
geom_bar(stat = "identity") +
labs(title = "Author Country Distribution", x = "Author Country", y = "Count")
```

(9) Source Analysis

```
source_summary < - my_data %>%
group_by(source) %>%
```

**Corresponding author**
Jaafar Pyeman can be contacted at: jaaf@uitm.edu.my