



# The response to Covid-19 in logistics and supply chain processes: evidence from a review of the literature

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## Abstract

It is well-known that the Covid-19, originated in December 2019 in China, had a huge impact not only on the population but also on supply chains, which were forced to stop their activities or quickly adapt to the changes. The severity of the impact of Covid-19 on logistics and supply chain processes varied across the industrial sectors and depending on the moment in which they were observed. Often, supply chains were found to be not ready for counteracting a pandemic emergency (which is undoubtedly an exceptional event). Some early studies in the literature have analysed the extent of the Covid-19 impacts, or, alternatively, have evaluated the possibility of applying (traditional) risk management models for counteracting a pandemic emergency. Hopefully, after approximately two years of pandemic spread of the virus, we are now entering the post-Covid era. Hence, it is a good time for tracing a balance of the studies focusing on the Covid-19 and in particular, on its effects on logistics and supply chains, on modelling approaches, on strategies used for counteracting the emergency and on suggestions for making supply chains more resilient in the future. This is the focus of this paper, which analyses and classifies the literature published in 2021 and 2022 ( $\approx 70$  studies) and related to Covid-19 in the supply chain. Keyword analysis helps in evaluating the key topics treated, their popularity and recurrence across the studies. Simulation appears to have been seldom used by researchers in recent times, while general modelling tools (e.g., multi-criteria decision making or structural equation modelling) are definitely more popular among researchers. Suggestions for future research activities can be easily delineated starting from these findings.

**Keywords:** Supply chain; resilience; covid-19; logistics; literature review

## 1. Introduction

The Supply Chain (SC) represents a network of organizations that are connected through upstream (e.g., suppliers) and downstream (e.g., distributors) links (Mentzer et al., 2001), involved in various processes and activities with the aim of generating value in the form of products and services delivered to the end consumer (Christopher, 1992). The SC can encompass different stages such as procurement, manufacture, distribution and waste disposal, together with associated transport, storage and Information Technology (IT) (Gechevski et al., 2016). The

connections and nodes in a SC perform functions that contribute to the value of the goods transported through the chain and thus to its realization and any connection that does not work well reduces the overall effectiveness of the entire SC (Janvier-James, 2012). For this reason, the concept of Supply Chain Management (SCM) is introduced, which involves improving a company's competitiveness in the global market despite strong competitive forces and changing customer needs (Coyle et al., 2013). Over the years, SCM has been subject to various definitions in the academic literature. According to (Ayers, 2000), SCM can be defined as the activity of maintaining, planning, and managing SC processes to meet consumer needs.



Similarly, (Ganeshan & Harrison, 1995) describe it as a chain of facilities that encompass product procurement, transformation from intermediate to finished goods, and the distribution of these finished goods to customers through a distribution system. Undermining the balance of the SC can be a variety of entities, from human errors to fluctuating demand, from the outbreak of war to the outbreak of a pandemic. In December 2019, the first patient affected by a previously unknown virus, later named Covid-19 (Belhadi et al., 2020), was identified in Wuhan, China. In early 2020, the world witnessed the rapid global spread of Covid-19 and, recognizing its severity, the World Health Organization (WHO) declared it a pandemic on March 11, 2020 (Belhadi et al., 2020). In response, governments worldwide implemented various precautionary measures, including social distancing, the introduction of personal protective equipment, and travel restrictions (Shen & Sun, 2021). These measures profoundly affected not only the general population but also businesses, causing significant disruptions to their operations. As a result, businesses had to swiftly adapt to the evolving circumstances in order to navigate through the challenging times (Shen & Sun, 2021). The Covid-19 pandemic, unlike other disruptions, is referred to as a "black swan" event: a rare and unforeseen occurrence with a devastating impact (Mishra, 2020). It is characterized by high uncertainty and long-lasting effects (Badhotiya et al., 2022). Unlike other catastrophic events, the Covid-19 pandemic caused simultaneous disruptions in demand, supply, and logistical infrastructure, with simultaneous and/or sequential openings and closures of suppliers, facilities, and markets (Aldrighetti et al., 2021). During the Covid-19 pandemic, the risk associated with material flow, encompassing supply, production, and delivery stages (Tang & Nurmaya Musa, 2011), increased due to lockdowns and restrictions that affected production and logistics in various countries. It was inevitable that businesses relying on primary suppliers in Wuhan would face disadvantages (Ghadir et al., 2022), leading to an elevated financial risk, involving improper investments and payment defaults (Tang & Nurmaya Musa, 2011). Furthermore, the pandemic necessitated a surge in remote work and information sharing on online platforms. However, this practice amplified the risk of information flow, vulnerability of corporate IT systems, and data breaches (Corallo et al., 2022). A greater focus on Supply Chain Risk Management (SCRM) has therefore become necessary, that aims to identify risk factors and implement mitigation strategies through coordination and collaboration among SC actors (Ali et al., 2023). To manage and prevent such risks, companies have implemented mitigation strategies that converge into the concept of resilience (Madhavika et al., 2022). Supply chain resilience is defined as the system's ability to return to its original position (i.e., restoration of normalcy) or transition to a new and more desirable state after being disrupted (Aman & Seuring, 2023).

Resilience thus aims to reduce disruptions and restore the smooth functioning of the SC (Madhavika et al., 2022). Resilient strategies can be proactive or reactive in nature. The proactive approach involves anticipating future disruptions and planning strategies in advance to mitigate their effects. It also focuses on enhancing the absorptive capacity of the SC, i.e., the ability to withstand disruptions while minimizing their negative impacts. In contrast, the reactive approach responds to the disruption by adapting to the new situation or restoring the previous state (Maharjan & Kato, 2022). The aim of this study is to identify the impacts of the Covid-19 pandemic in SC and its management through the identification of risks that may occur as a result of disruptions. Furthermore, to provide insights to companies, this study aims to identify risk mitigation strategies that lead to building a resilient SC. The paper is structured as follows: the next section outlines the research methodology employed in this study, followed by the presentation of the achieved results. Finally, this paper concludes by summarizing the key contributions of the review and suggests potential directions for future research in this field.

## 2. Materials and Methods

### 2.1. Sample creation

The aim of this study is to analyse the resilience capacity implemented by SC members to mitigate the effects of the pandemic. Specifically, this review aims to extend the research conducted by (Rinaldi et al., 2022) by focusing on the years 2021 and 2022, with a specific focus on the disruption caused by Covid-19. To collect relevant papers for the systematic literature review (SLR), the authors conducted a query on the Scopus database. Given the goal of updating the (Rinaldi et al., 2022)'s article, the same keywords used in the cited study were adopted. However, it was decided that all retrieved results must (also) include the term "Covid-19", which in the meanwhile became popular. The final query was: TITLE-ABS-KEY ("supply chain" OR "logistics") AND TITLE-ABS-KEY ("risk management" OR "disruption" OR "pandemic") AND TITLE-ABS-KEY ("quantitative") AND TITLE-ABS-KEY ("covid-19"). The query results were restricted to "article" written in English. Regarding the time frame, articles published in the biennium 2021-2022 were considered. With these settings, the query returned a total of 289 articles, which were retrieved and screened by reading the full paper to ensure relevance to the topic. After reading, some papers were excluded from the initial sample, resulting in a total of 69 articles.

### 2.2. Papers classification

For all the documents, a comprehensive set of data was collected *via* the analysis of the complete texts, including:

- Paper's metadata.

- Macro-theme.
- Industrial contest.
- Data collection method.
- Scientific method, i.e., statistical, simulation, empiric, economic, econometric etc.

In addition, the papers were analyzed to determine the correlations between implications with reference to industrial settings.

### 3. Results

#### 3.1. Descriptive statistics

This section presents the results of descriptive statistics carried out on the sample of 69 items. As shown in Figure 2, there are more than twice as many studies published in 2022 as in 2021. This could be attributed to the increasing availability of information and data about Covid-19, thanks to more in-depth studies, as well as the growing interest in the topic.

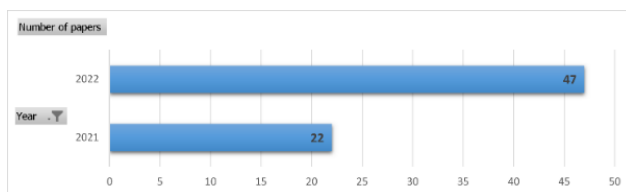


Figure 1. Distribution of papers in time.

In the field of Covid-19 pandemic effects management and the interdisciplinary supply chain, several top journals were identified. These journals published a substantial portion of the sample, with eight of them contributing significantly to the research (29 out of 69 papers, 42%). Notably, the most prominent journals in terms of the number of papers published were *Sustainability*, with 7 papers, and the *International Journal of Logistics Management*, comprising 5 papers. Relevant special issues on the topic (e.g., “Resilience in Sustainable Supply Chain post-COVID-19: Future Pathways”) have also been published by these journals. It is also noteworthy that 40 articles were published in distinct journals, underscoring the wide range of publications in this area.

#### 3.2. Common classification fields

##### 3.2.1. Macro-theme

The journal "Sustainability" is supported by the findings in Figure 2, where 11 articles specifically addressing sustainability were published in 2022, while only one emerged in 2021.

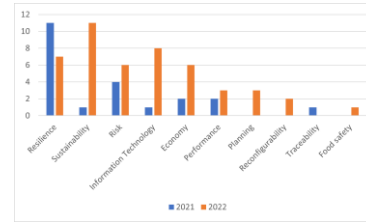


Figure 2. main topic vs. publication year.

As for publications focusing on IT, there were 7 articles related to 2022 and only one related to 2021. In contrast, the concepts of resilience and risk were addressed early in the sample study. This is probably in line with the fact that the first studies on Covid-19 have tried to provide suggestions for an immediate response (i.e., for a resilient system), while progressively the attention has shifted towards the implementation of solution approaches. Resilience emerged as the most relevant macro-theme, with 18 articles addressing adaptation strategies such as scalability, replacement, and repurposing (Ivanov, 2021). Other authors have highlighted the importance of connectivity and coordination for resilience (Madhavika et al., 2022) and have divided the concept of resilience into three phases, including risk mitigation, response and recovery, and resilience (Badhotiya et al., 2022). (Ali et al., 2022), instead, based it on readiness, response and recovery. An exemplary case study concerns JD.com, in which there was an emphasis on collaboration, effective information sharing, agility, and a high level of digitization using intelligent platforms (Shen & Sun, 2021). The second most prominent macro-theme in this study is sustainability, comprising a total of 12 articles. In this area, (El Khoury et al., 2023) employed a structural equation model to evaluate the impact of green supply chain management (GSCM) practices on environmental performance. Meanwhile, (Sharma et al., 2022) support that the pandemic itself exerts a positive influence on environmental practices and sustainable distribution. The third identified macro-theme pertains to risk and encompasses 10 articles. The studies in this field primarily aim to determine strategies for risk mitigation through decision-making methods (Althaf & Babbitt, 2021; Dohale et al., 2023; Gui et al., 2022; Paul et al., 2023). In particular, (Dohale et al., 2023) presented a case study of the apparel industry in India, focusing on strategies centered around flexibility, redundancy, collaboration, and coordination. Some researchers have employed simulation analysis to depict risk propagation across the nodes of the SC. They conducted simulations to reproduce disruptions stemming from potential risks in demand, transportation capacity, and procurement phases. It has been observed that due to the bullwhip effect, the risk of demand decline propagates upstream, impacting the supply phase. Risks related to procurement include shortages of raw materials, inventory, and labour scarcity (Ghadge et al., 2022). The three themes of resilience, sustainability, and risk overall account for over half of the total number of

papers. Following them are the macro-theme of IT, consisting of 9 articles, and the macro-theme of economy, comprising 8 articles.

### 3.2.2. Industrial sectors

Figure 3 presents the results of a classification based on the industrial context. The agrifood sector is the most prevalent with 13 papers, followed by companies with 11 papers, which include publications referring to generic companies. The transportation, food, and manufacturing sectors rank third, fourth, and fifth, respectively, with 10, 9, and 8 articles. There are also 11 other sectors represented by few articles (1-3), reflecting a diverse range of fields covered. "Transport & logistics" was included to account for an article that equally addressed both fields, but they were considered separately to provide more details and consider significant numerical differences (Rinaldi & Bottani, 2023).

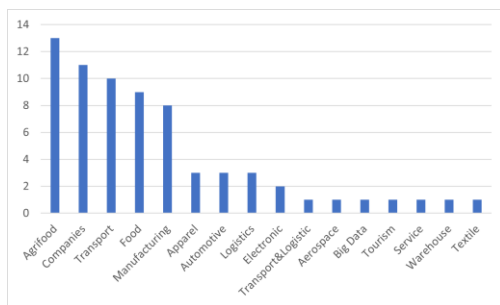


Figure 3. Distribution of papers by industry context.

Applying a similar approach, the "Agrifood" and "Food" contexts were considered separately. Interestingly, these two fields collectively contribute 22 articles, accounting for nearly one-third of the total sample. Within the agrifood context, studies have emerged on the vulnerable aspects of the SC (Palouj et al., 2021) and range from risk management to building a resilient system (Ali et al., 2023). Some authors have highlighted new opportunities through adaptability, including exploring new sales channels (Grigorescu et al., 2022; Perrin & Martin, 2021) and leveraging accumulated redundancy (Coopmans et al., 2021). The issue of food shortages due to mobility restrictions is also addressed (Ababulgu et al., 2022; Grigorescu et al., 2022; Igberi et al., 2022; Mugabe et al., 2022; Nchanji & Lutomia, 2021). Among the articles pertaining to the food context, the importance of IT is highlighted as it enhances SC visibility (Kumar & Singh, 2023). The significance of blockchain in cold chain traceability systems during the Covid-19 pandemic is mentioned (Masudin et al., 2021). (Riahi Dorcheh et al., 2021) identified weaknesses, threats, and offensive, competitive, conservative, and defensive strategies in response to the pandemic in the red meat SC. Regarding articles with a generic company context, two articles focused on small and medium-sized enterprises (Abdelfattah et al., 2023; Munongo & Poee, 2022). (Zidi et al., 2022) evaluated the reconfigurability of

companies through quantitative measurement of modularity, integrability, convertibility, diagnosticability, scalability, and personalization. (Munongo & Poee, 2022) have studied the contribution of Industry 4.0 technologies in enhancing business resilience to deal with the Covid-19 pandemic, while (Nisar et al., 2022) analyzed the capability of Big Data in improving employee preparation and sustainable SC performance. (El Khoury et al., 2023) also addressed the implementation of sustainable practices and eco-design. From the articles on transportation, two papers focused on container transportation (Kim et al., 2022; C.-N. Wang et al., 2022), and 3 papers addressed maritime transportation (Gui et al., 2022; Sun & Zhang, 2022; X. Wang et al., 2022). There were also articles covering drop shipping (Miljenović & Beriša, 2022), electromobility (Figura & Gađek-Hawlena, 2022), land transportation (Brdulak & Brdulak, 2021), and transportation in a more general context encompassing all modes (Kiani Mavi et al., 2022; Xu et al., 2021). Overall, there are 10 articles related to transportation, making it the third most recurring sector. This is likely due to the significant impact the pandemic had on transportation, such as government-imposed travel restrictions to contain the spread of the virus. Within the manufacturing industry context, there are also articles related to sustainability: (Zulkiffli et al., 2022) discussed how many small and medium-sized manufacturing enterprises in Malaysia have adopted eco-innovation. (Moosavi & Hosseini, 2021) measured the impact of resilience strategies in a manufacturing SC during the pandemic through simulation of two recovery scenarios.

### 3.2.3. Data collection method

A majority of the authors employed empirical data collection methods, involving interviews with key stakeholders such as managers, employees, industry experts, or technical personnel from various sectors. This method constituted 63% of the overall data collection approaches utilized. Meanwhile, 29% of the studies were based on third-party sources such as literature, online company data, or data obtained through software. There was a 4% of articles that employed data collected through fieldwork. Additionally, only one article used the Delphi method to gather data, while another article did not specify the data source. These findings align with the qualitative-quantitative nature of the data and the scarcity of purely quantitative articles.

### 3.2.4. Scientific methodology

As shown in Figure 4, statistics is the prevalent methodology used in the sample of papers reviewed, encompassing 35 articles. There are also articles on simulation, mapping, and economics. The majority of articles are of a mixed nature, applying more methods, except for one method called "qualitative analysis," which is purely qualitative.

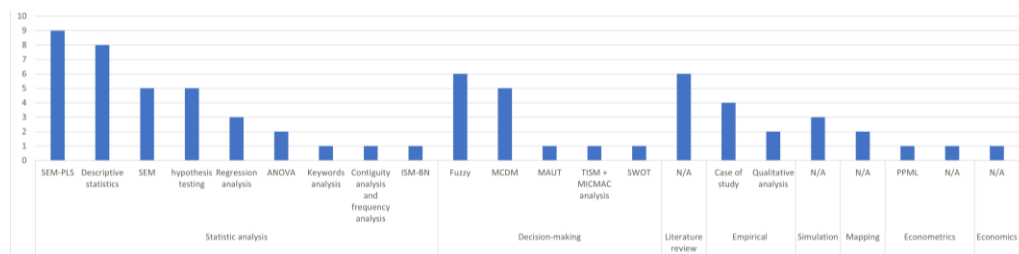


Figure 4. Scientific method.

### 3.3. Correlations between implications with reference to industrial settings

Analysis of the papers revealed four different implications and their correlations. Figure 5 illustrates the Venn diagram showing the intersections between articles containing implications on industry 4.0, sustainability, food safety and e-commerce.

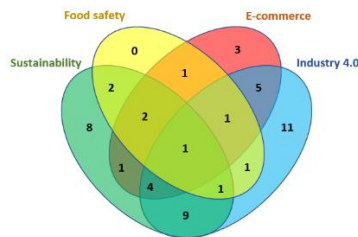


Figure 5. Venn diagram.

It is interesting to highlight that 15 out of 33 articles on Industry 4.0 also address sustainability implications. This represents almost half of all articles on Industry 4.0 and over half of the articles focusing on sustainability (28). This demonstrates a significant connection between the two topics and their associated practices. In several articles, the combination of digitalization and other Industry 4.0 technologies is mentioned as a means to enhance corporate sustainability. (Nisar et al., 2022) emphasized the necessity of digitizing Pakistan's economy and leveraging Big Data analytics to enhance the sustainability of SCs. Among the analyzed articles, 8 were identified with implications for both sustainability and e-commerce. These two areas share the commonality of being focal points for companies striving to meet customer demands and enhance their reputation. There are 11 articles that are common to both e-commerce and Industry 4.0, accounting for just over half of the total number of e-commerce-related articles. The prevalence of this intersection is logical, as e-commerce can be seen as a subset of Industry 4.0, and both are enabled by technological advancements. Furthermore, 6 out of the 9 articles focusing on food safety also incorporate sustainable implications. This can be attributed to the fact that agrifood systems, which faced vulnerabilities during the Covid-19 pandemic and encountered threats to their accessibility, have set sustainability as a primary objective (Mugabe et al., 2022). The analysis of articles

with implications on Industry 4.0 showed that the transportation sector is the most advanced, counting 8 papers. This result can be attributed to the importance of information sharing during transportation, a process made increasingly possible in real time thanks to new technologies (Gui et al., 2022; X. Wang et al., 2022). Also, in maritime transport for example, there is increasing emphasis on the use of fully automated terminals (Kim et al., 2022). From the analysis of articles with implications for sustainability, it has been found that, once again, the transportation sector is the most commonly addressed, followed by the industrial sector without a specific context. This can be attributed to the increasing attention towards improving the environmental impact of goods transportation. For instance, (Figura & Gądek-Hawlena, 2022) addressed the topic of electromobility in the logistics sector in Poland. In third place, the agri-food sector appears with 4 articles, confirming the relevance of agroecological models in agri-food systems as a response to the pandemic disruption (Perrin & Martin, 2021).

## 4. Conclusions

This paper represents the outcome of a research focusing on the impact of the Covid-19 pandemic on SCs and the associated risk management strategies. Through the analysis of the researched documents, it has been observed that SCs across all industrial sectors have experienced an incredible shock in the past two years due to the spread of the Covid-19 virus. In response, many studies have been conducted to examine the issue from various perspectives, including production, logistics, and finance. Many authors have also presented solutions to mitigate the consequences, providing businesses with the opportunity to overcome the crises that have arisen. In the past two years, the concept of resilience has been emphasized as never before. Resilience encompasses the capabilities inherent in the adaptive culture of enterprises, prompting them to emphasize the characteristics of reconfigurability, collaboration, flexibility, redundancy and visibility. Reconfigurability has proven to be critically important in keeping companies in business, enabling them to make changes in both supplier selection (Moosavi & Hosseini, 2021) and production (Dohale et al., 2023). Another crucial factor of resilience is collaboration among nodes in the SC and across different industries. Without collaboration, it

becomes challenging to achieve flexibility, which involves adapting quickly and effectively to changes, as well as agility, which entails responding promptly to challenges. To address this catastrophic global event that has been unfolding since 2020, it is essential to strengthen collaboration not only at the local and national levels but also among different continents. Redundancy has proven to be a key characteristic during the disruption caused by Covid-19, both for companies experiencing a surge in demand for their products and for companies where supply and production were disrupted. To implement these resilience practices, it has become essential to adopt and develop technological innovations that enable real-time access to all the necessary data for effectively addressing the risks that can occur within the SC. Naturally, these actions are more easily achievable in developed or developing countries, while in poor and underdeveloped nations, it becomes incredibly challenging to cope with the repercussions of Covid-19. In these countries, the pandemic has even put food security at risk. To implement new IT systems, it becomes essential to provide professional training courses to form a group of experts within the SC who are skilled in risk management and capable of creating operational continuity plans in emergency situations. From the analysis of the documents, a strong correlation between technological innovations of Industry 4.0 and sustainability has been observed. Sustainability has been a widely discussed and crucial topic in the past decade due to the increasingly evident damages caused by human activities, such as pollution, greenhouse effect, and depletion of non-renewable resources, contributing to the acceleration of climate change. Given the unique nature of pandemics, an insufficient number of quantitative articles has been found. However, it is reasonable to expect that future studies of this kind will increase due to the availability of ever-growing data. Furthermore, with scientific advancements and increased research, it is anticipated that future epidemic disruptions will be more extensively studied than in the past. There is a predicted and desired steady increase in sustainable studies aimed at reconciling efficiency and progress with waste reduction, pollution control, and environmental protection. It is hoped that such studies will raise awareness and encourage companies to make more responsible choices for shared benefits. In conclusion, it is evident that to reduce risks and overcome the impacts of future pandemics, the resilience strategies mentioned earlier, coupled with expert knowledge for the implementation of Industry 4.0 technologies in a sustainable manner, are essential. It is undeniable that resilience strategies come with investment costs; however, they are indispensable in the face of various disruptions for long-term advantages. Therefore, in a world with increasing geopolitical, environmental, and social uncertainties, it is desirable for companies to implement proactive strategies to be prepared for contingencies and enhance their adaptability and recovery capabilities.

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