Impact of COVID-19 on logistics sector companies

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Abstract

Purpose – The scale and measure of the impact of the coronavirus disease 2019 (COVID-19) on economic development has been a popular topic in the literature. The global pandemic has posed challenges to the supply chains and logistics in many countries, causing delays and disrupting supply chains and decreasing the volume of logistics flows. To ensure economic growth in the future, it is essential to acknowledge the impact the COVID-19 in order to increase the accuracy of anticipating changes during widespread pandemic. In this study, the linkage between economic development and the COVID-19 estimated and real impact is illustrated in a case study comparison between the Finnish and German logistic companies' viewpoints. The study shows how the international COVID-19 pandemic has affected to logistics organization perceptions on the changes in operational environment and continuity of business.

Design/methodology/approach – The empirical part of the study relies on mixed methods approach using panel data from logistics companies and expert group discussion. The panel data participants were logistics sector actors and the data was collected through a questionnaire. Numerous sources found from the literature are used to gain a holistic understanding of the attributes and impact of change in the logistics field.

Findings – This study provides an important, yet sparsely addressed viewpoint to the supply chain management literature by illustrating the changes caused be a widespread pandemic can cause to the logistics sector companies. Furthermore, the findings illustrate how different roles in supply chain actors perceived the COVID-19 in their operations, before and during the pandemic. The findings of the paper illustrate how drastic uncertainty and changes in the operational environment is seen in the logistics organizations. The findings suggest that increased uncertainty and changes in the operational environment can cause significant drop in expectations of the business development in the logistics sector depending on the actor's role in the supply chain and international perspective.

Originality/value – This paper contributes to the supply chain management and logistics literature with insights into how widespread pandemic is perceived in different roles of the supply chain as well as in different countries where the pandemic has spread in different pace. Analyzing the differences between the expected and realized impact from the business environment can give valuable information for academics and managers in the field, and thus give insights to improve the planning and decision-making in logistics field during a global pandemic.

Keywords Impact, Risk management, COVID-19, Logistics companies

Paper type Case study

1. Introduction

The rapidly increasing frequency of both natural and man-made disasters has illustrated the need for organizations and supply chains to cope amid uncertainty and turbulence (Zinn *et al.*, 2009). The ongoing COVID-19 crisis has had a drastic impact on companies and crippled economies around the world (Hilmola and Lähdeaho, 2021). Since the beginning of the pandemic, different sectors have experienced this impact in different ways, and in the

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logistics sector, for example, different modes and operators have experienced differently the consequences of both the pandemic and the restrictions it has caused.

The COVID-19 pandemic has underlined the importance of preparedness and risk management and shown how different strategies work in different situations (e.g. Choi, 2021; Liu *et al.*, 2022). Some multinational companies have benefitted from their better international visibility in the supply chain, and there have been great differences in how organizations are preparing for upcoming threats (Ye *et al.*, 2022). Some companies suffered from poor visibility in and outside the supply chain and could not thus manage their operations in the face of a global pandemic.

Governmental restrictions have been shown to have had a drastic impact on transportation systems, including maritime, air, rail and road transportation modes (Loske, 2020). Restrictions to limit the movement of people to slow down the spread of COVID-19 had different impacts on different industries in which logistics acted as an essential part of value production. For example, food retail logistics saw a rapid increase in popularity, while traditional restaurant services suffered. The restrictions and recommendations implemented by governments included (1) contact restrictions and minimum distance rules; (2) temporary closure or restricted availability of retail and service organizations, including restaurants and cultural and sports facilities, in addition to stricter hygiene requirements; (3) travel restrictions domestically or abroad for non-essential travel; and (4) the obligation or advice to wear mouth-and-nose coverings when in a public place or on public transport (Loske, 2020; Regional State Administrative Agency, 2021).

The COVID-19 pandemic has caused many types of risks that have led to disruptions both at the beginning and the end of supply chains and has thus caused problems in both supply and demand (Ivanov, 2020). Such disruption risks are by nature unplanned and unintentional events that disrupt upstream and downstream material flows in the supply chain, causing negative or positive effects on prices, inventories, demand and delivery times (Craighead *et al.*, 2007). Some studies of COVID-19 have also revealed a strong connection between the upstream and downstream factors of supply chains. In such research, disruptions in both upstream supply chains and many product groups reflected downstream demand as a ripple effect (Dolgui and Ivanov, 2021). For example, in the way that demand for some product groups strengthened strongly as a result of COVID-19-related disruptions, demand for other products was correspondingly suppressed, leading to disruptions upstream of the chain (Paul and Chowdhury, 2020). As a result of the pandemic, there have been major uncertainties concerning product availability and suppliers' delivery times, and companies have not received products and service capacity in the required quantity or at the desired price, leading to them potentially losing sales. In the past, it was not possible to study the effects of such disruptions on supply chains on such a large scale made possible by the COVID-19 pandemic. In particular, the supply chain disruptions at the beginning of the pandemic forced companies to make quite rapid changes to their supply chains in to transport routes, alternative sources and the repositioning of operations (Kähkönen *et al.*, 2023). From a research point of view, it will be interesting to observe how the pandemic will eventually bring about a permanent change in supply chains. Although COVID-19-related effects have already been studied widely, it will be of interest to identify how the demand and supply elements of a certain sector developed before and during the pandemic. The logistics sector offers a good context for this, since the changes caused by the pandemic were strongly connected to the material flows of all supply chains globally. The logistics sector is also strong in both upstream and downstream operations in supply chains, so the changes due to the pandemic were presumably reflected in the sector in a multidimensional way.

This study explores the impact of COVID-19 on logistics sector companies before and during the crisis based on companies' expectations and how they were realized. More precisely, the empirical part of the study relies on panel data from logistics companies in Finland that were both logistics sector purchasers and logistics service providers during the

pandemic and from discussions with a group of experts to provide insights from the field. The study relies on both a descriptive analysis of the panel results and a quantitative data analysis of key indicators. Numerous sources identified from the literature are used to gain a holistic understanding of the attributes and impact of changes in the logistics field. Using the panel data collected, the empirical statistical analysis seeks to find answers to the following research questions: Based on the indicators before and during the COVID-19 pandemic, has there been a change in the logistics sector? Was there a difference in the perspectives of logistics buyers and service providers before and during the COVID-19 pandemic? Has the COVID-19 pandemic caused greater volatility in the logistics sector? This paper contributes to the industrial management literature by providing novel insights into how a widespread pandemic affects actors within the logistics supply chain. It also offers insights into crisis management in logistics and estimates of future trends in the industry. The research and its results can benefit industrial companies by illustrating how a major disruption affects the dynamics between demand and supply of different supply chain actors in the logistics sector and thus provide future insights into supporting and improving logistics planning and decision-making, as well as preparing for crises.

The rest of the paper is structured as follows: Section two reviews the relevant literature on supply chain disruptions management, and more specifically, the literature related to COVID-19's impact on supply chains and logistics. Section three presents the used research methodology and process as well as the data utilized. Thereafter, section four describes the results from both quantitative and qualitative perspectives. Finally, the fifth section discusses the results of the study, and the sixth section presents the contributions in the light of theoretical and managerial perspectives and gives suggestions for future research.

2. Theoretical background

The scale and measurement of the impact of the COVID-19 pandemic on economic development has been a popular topic in the literature since 2020. In that year, studies about the pandemic's impacts on logistics and supply chains peaked, amounting to 359 published papers, compared with the previous three years, when there were only 35 in total that addressed the subject (Montoya-Torres *et al.*, 2023). Most of the authors seem to have addressed the challenges posed by the global pandemic for supply chains and logistics in many countries by causing delays, disrupting supply chains and decreasing the volume of logistics flows. Only a few publications have considered the positive impacts, which were done for specific logistics sectors (Liu *et al.*, 2022; Earley and Newman, 2021). Overall, it can be argued that the pandemic's impacts were negative and disruptive in an otherwise growing economy. To ensure economic growth in the future, it is essential to acknowledge the impact of the COVID-19 pandemic and to anticipate changes more accurately during a widespread pandemic event.

The impact of the COVID-19 pandemic on the economic development of different countries has been discussed frequently in both the scientific and managerial literature (Choi, 2021). In practice, logistics operations and supply chains were disrupted due to closed borders and production facilities, thereby limiting materials manufacturing and shipping to customers (del Rio-Chanona *et al.*, 2020). Estimating the different impacts that COVID-19 had varies among the different fields of logistics. While most studies have solely focused on freight logistics, passenger transportation also suffered severe consequences, and several routes were canceled during the pandemic due to travel restrictions on all air, sea, road and rail modes (Plzáková and Smeral, 2022).

2.1 Responses and restrictions during COVID-19

Different countries had varying strategies in response to the crisis, which also impacted different sectors in several ways. As some countries prevented social encounters altogether,

others relied on personal protective equipment in their fight against the virus (Finkenstadt and Handfield, 2021). Different strategies had their own outcomes; for example, countries that went into lockdown were seen to strongly disrupt supply chains, while others relied on increasing personal hygiene and avoiding encounters with risk groups to limit the pandemic's disruptive impact on the economy. Finland and Germany had similar strategies in their responses to COVID-19 backed by their respective strong enabling environment, functioning public health system and expert scientific institutions (Tiirinki *et al.*, 2020; Wieler *et al.*, 2021). In many ways, logistics and supply chains have had a key role in the response to the crisis and recovery from it. Thus, to ensure economic recovery, it is necessary to ensure the performance of the logistics sector and the companies within it.

The restrictions had a major impact on the logistics sector in terms of the transportation of goods, passengers and information. The impact can be seen in many ways, including transport volumes and freight capacity dynamics (Loske, 2020), supply chain network design structure (Ivanov, 2020), transport mode selection (Xu *et al.*, 2022), small actors' ability to operate abroad (Hilmola and Lähdeaho, 2021), the agriculture and food supply chain (Siche, 2020), pollution and air quality (Saadat *et al.*, 2020), e-trade (Rothengatter *et al.*, 2021), localizing production (Sarkis *et al.*, 2020; Romanello and Veglio, 2022) and food logistics (Singh *et al.*, 2021). While most of the research on the COVID-19 pandemic's impact on logistics has focused on the risk perspective, only a few studies have concentrated on the overall impact of the crisis (Atayah *et al.*, 2022). Some of the consequences directly affecting companies' resilience and responsiveness have been identified as workforce downsizing, safety requirements, supply chain breaks and inventory shortages (Ambrogio *et al.*, 2022). As mentioned, some logistics operations experienced higher demand for their services, and the logistics segment was seen to compensate for the impact of social distancing through home delivery and similar services (Choi, 2020). Indeed, many delivery services and package logistics companies experienced high demand when many countries were operating under restrictions.

2.2 Managing and analyzing supply chain disruptions

Several approaches to tackle the impact of severe and unexpected events have been proposed in the scientific literature, such as supply chain visibility (Brandon-Jones *et al.*, 2015) and simulation-based risk analysis (Ivanov, 2020). Recent studies of logistics and supply chain management have highlighted the need to increase collaboration in the supply chain to enable better synchronization and visibility across it (Montoya-Torres *et al.*, 2023). One of the dangers in supply chain risk management during a pandemic is making hasty decisions, which can happen at different levels of both supply chains and society (Ambrogio *et al.*, 2022). Many companies in the logistics field are small, which typically limits their visibility and resources to cope with disruptions. When considering this, the impact of a pandemic can be difficult to assess, and the reaction and control measures hard to decide, as the real impacts on businesses do not come immediately, which is the case typically in a natural disaster or an operational disruption (Sheffi and Rice, 2005). This extended time causes increased pressure and uncertainty for decision-makers, as no immediate disruption to operations are experienced other than decreased performance in the supply chain (Ambrogio *et al.*, 2022). In terms of logistics processes, the impact can mean that supply chains adopt extraordinary procedures. Alongside lower overall performance, the measures typically entail effort and cost, which can also increase demand for special logistics services and thus improve the profitability of logistics operators' services in the short-term. The fear and restrictions caused by pandemics can also be a lucrative opportunity for logistics service providers, as normal operations, routes, pricing, supplier bidding processes, material storage limitations and modes of transport do not necessarily apply.

Economic development on logistics performance has been a popular topic in the literature studying competitiveness and performance (see, e.g. Sergi *et al.*, 2021; Rogers *et al.*, 2018; Christina *et al.*, 2021). In these studies, the focus was on utilizing such indices in particular to provide predictive value (Rogers *et al.*, 2019), which becomes increasingly important in uncertain and turbulent times. However, the use of different indicators is still in its infancy in the logistics sector, and the indicators themselves are at an early stage of development in many ways (Beysenbaev and Dus, 2020). The use of indices to estimate developments in the operational environment or policy development is still rather unexplored in logistics. When considering the risk management perspective in the utilization of index data, the literature is scarce. Furthermore, when looking at the need for such information at a time of high uncertainty (Vilko *et al.*, 2014), such as that caused by a global pandemic, the gap in the literature is obvious. The utilization of index data is difficult, as turbulent times may impact respondents' perceptions in different ways, and different actors in the supply chain may too experience uncertainty differently. In some countries, and Finland and Germany in particular, national logistics associations publish indices detailing their members' views on the operational environment extending to the near future. These have been traditionally used by managers to understand the field better; however, in the scientific literature, it can be argued that they are an underutilized resource that can facilitate an understanding of the perceptions of logistics companies and managers. This can be especially useful when assessing the impact of widespread and high-impact risks, such that of the COVID-19 pandemic.

Overall, there has been much research on the impacts of the COVID-19 pandemic, although, in many ways, studies still fail to provide a holistic picture of the effects of the pandemic on the logistics sector. Indeed, scholars continue to underline the need for further research to gain a better understanding of the situation (Choi, 2021; Narasimha *et al.*, 2021). While the economic impact of logistics companies has been studied using financial performance data, no research could be found that investigated the COVID-19 pandemic's effects on different roles in logistics or the ability to make forecasts amid the uncertainty created by the event. To gain a better understanding of the nature and gravity of the overall impact caused by the pandemic, this article puts forward multiple perceptual analyses by focusing on both top-down and bottom-up approaches. In doing this, we consider the nature of transportation (goods, combined, passenger), national and international perspectives (national transportation, exports, imports), different fields of industry and different roles in logistics (purchasing and service provision).

3. Methodology

The research applied a mixed-methods approach with both qualitative and quantitative perspectives. This allowed us to gain a holistic viewpoint from the logistics field through a survey element and also to gain insights into the phenomena through qualitative expert group informants. The data selection strategy in the study was information-oriented, by which the goal was to maximize the utility of the information (Flyvbjerg, 2011). The study can be seen to have strategic importance for the logistics sector; however, it can be also considered an extreme case, due to the COVID-19 pandemic's catastrophic and wide-ranging nature.

The iterative research process (Figure 1) included six steps, beginning with considering the research aim and gap. Thereafter, an integrated literature review of the theoretical background was conducted to understand the state-of-art literature and to form a picture of the body of knowledge on the phenomena. The third step of the research was the empirical data collection. The main quantitative data in the study were compiled from the database of the Finnish Association of Purchasing and Logistics, enabling the analysis to take a longitudinal perspective of how the COVID-19 crisis affected companies in the logistics sector. In addition to the quantitative data, a qualitative expert group was interviewed to gain

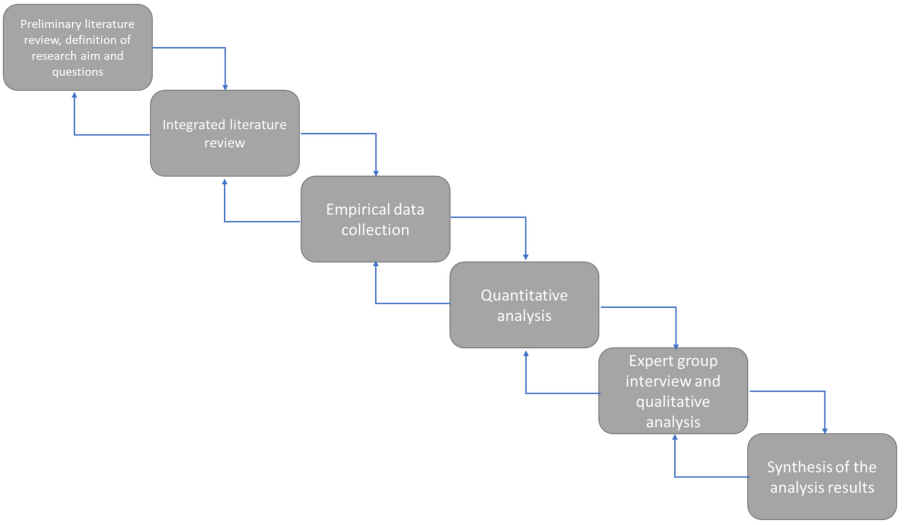

Figure 1.
Research steps

Source(s): Authors own work

a more in-depth understanding of the real impact of the COVID-19 pandemic on the operations of logistics sector companies.

The quantitative data of the study consists of panel data from the logistics sector from 2018 to 2021, with the sector's indicators collected quarterly from a Finnish expert panel. For the panel data, the respondents represented suppliers and sellers of logistics services mainly in large- and medium-sized companies. Panel data are particularly well suited for longitudinal analysis because they include both cross-sectional and time series dimensions (Dougherty, 2011). The research was carried out exploratively with the help of descriptive materials and by comparing the indicators of the logistics sector before and during the COVID-19 pandemic. An analysis of variance was used to confirm the findings and compare differences in the distribution divisions statistically. The parametric Mann–Whitney U test was used to test two or more groups to see if there was a statistical difference between them.

The results of the statistical analyses were used as the basis for the qualitative expert group discussion; the quantitative findings provided a macro-level perspective of the industry, and the expert group's views enabled a deeper inquiry into the underlying events to be conducted. The empirical findings were furthermore reflected in the secondary data, namely the academic and managerial literature, which both offered additional information about the phenomena and provided a good reflection point for the findings. Thus, the triangulation of the data and results (Denzin and Lincoln, 2000) ensures the reliability and validity of the findings. The expert group utilized the views of three relevant key informants (see Table 1) and was seen to work well for gaining a better and deeper understanding of the

	Role	Field of expertise	Experience in the field (years)	Age (years)
Expert 1	Director	Logistics service provider	25	49
Expert 2	Specialist	Supply chain management research	20	48
Expert 3	Specialist	Logistics research and education	17	41

Table 1.
Expert group

Source(s): Authors' own work

underlying causalities and the changes imposed by the COVID-19 pandemic on companies. By way of consensus with experts from different fields, including logistics, supply chain management and purchasing, the results were validated and reported.

The concurrent process of using qualitative and quantitative research methods enabled a holistic view to be formed, and the qualitative and quantitative analyses were seen to complement each other and facilitate the drawing of a full picture of the COVID-19 pandemic's impact on logistics companies and the factors behind this impact. With their different backgrounds, the experts were able to provide a wide range of information about the field of logistics. All the panelists were in close collaboration with many logistics actors and were well-informed about the impact that different companies had faced during the focal period.

4. Analysis and results

The years 2020 and 2021 were turbulent for the global economy, and the international logistics system was devastated by several disruptions. The outbreak of COVID-19 at the beginning of 2020 caused severe regional and international restrictions that impacted not only passenger logistics but also goods and information logistics. Figure 1 illustrates the combined index of logistics sector companies in Finland and Germany as well as COVID-19 infections (by 100,000 population, reflecting the situation on 17-11-2021) by quartiles. The logistics sector index represents both realized and expected values by companies. The left-hand side of the figure illustrates the logistics industry index and the right-hand side the COVID-19 infection rate.

When the first COVID-19 outbreak emerged in Europe in the first quarter of 2020, fear of and uncertainty about the virus forced governments and companies to respond in various ways. In logistics organizations, which are typically quite traditional but also flexible, this meant avoiding unnecessary contact with people and engaging in remote work. Many logistics sector companies were used to handling things through telecommunications methods; however, social contact was also considered an essential part of the work. This was clearly identified by the logistics companies.

> The situation emerged on 9th March 2020, and the next day, 10th March, was the last time our company's personnel met face to face. Then, and after that, the indications and impulses started to impact us.

Initially, cautiousness was present in the industry, and this was clear in the Finnish logistics sector in particular, where the variation between the expectations and outcomes are shown in Figure 1. In Germany, the same initial shock is not that apparent; however, as the infection rates in the country started to climb rapidly later on, the variation between the two indicators grew.

One of the segments that suffered the most from restrictions due to COVID-19 was passenger logistics, and this was also the case for goods logistics, due to the combined logistics in all modes. The airline industry in particular was affected by this, and in Finland, the country's largest airline, Finnair, was the first in the world to respond to the crisis by modifying its passenger airplanes for cargo use by removing some of their seats (Harry, 2021). This was later followed by other airlines. Further restrictions were implemented due to the loss of cargo capacity in passenger transportation, and some courier cargo service providers, for example, would not accept small or lightweight (under 100 kg) packages due to lack of capacity. In 2021, these restrictions were increased (to under 300 kg). The companies responded to these restrictions in various ways, as mentioned by one expert group member.

> We had a package that weighed 92 kg, and it was returned to us due to the restrictions. As a solution, we added a few metal sheets to increase the weight to just over 100 kg, and it was accepted. We just had to get the package through.

After the first wave of COVID-19 emerged in the spring/summer of 2020, the tighter regional restrictions were dismantled in Finland; however, since many restrictions on gathering and traveling remained, most people were forced to stay in their homes or at summer houses. As money could not be spent on travel and related services, demand pressure was directed toward goods such as electronics and other household products. The growth in demand for these can be seen in Figure 2 as the continuous growth of both the expected and the realized indices. The growth was not as high in Germany, however, and COVID-19 infections and restrictions also developed differently there, lessening the growth.

Overall, the impact of the COVID-19 pandemic was quite drastic for logistics sector companies due to the restrictions, but surprisingly, it had a positive impact on the logistics sector in terms of cargo, despite the negative impact on the passenger side. There were, however, several differences between the different transport modes; for example, there was mostly no impact on the road transportation of goods in Finland or Europe. However, the combination of passengers and goods and also project logistics saw major disruptions. On the other hand, some logistics and customer-facing services, such as food deliveries and online shopping services, experienced rapid growth. At first, maritime transportation was unimpacted by the crisis, although later, when China started to shut down ports due to individual cases of COVID-19 there, the disruptions started to have a role. While the COVID-19 restrictions led to an increase in demand for consumer goods, at the same time, a fire at one of the world's largest semiconductor factories caused both delays and price increases for many products.

> Since the fall of 2020, the shutdown of ports and airports in China, and at the same time, their power failures, have caused severe restrictions to transportation volumes, which still limit our operations. The delays and limitations due to global container capacity have caused six times higher transportation costs. . . . Just yesterday, I was discussing with a customer the possibility of moving their production back from Southeast Asia to Europe.

If there was going to be an ease in the global pandemic, it was estimated that it would take a year to sort out the ongoing supply chain disruptions and delays. Thereafter, the focus would

Figure 2.
The combined indices (Finland and Germany) with COVID-19 infections

Source(s): Authors own work

shift more to the environmental impact and other issues. The initial estimations about the digitalization leap did not come to pass, however, and companies did not seem to recognize any major developments in that area, as illustrated by a key expert group actor in the field:

> We are still one step away from the stone age when it comes to seizing the opportunities of digitalization in the logistics industry. . . . Our systems are still poorly interconnected; suppliers are still building portals that have poor connectivity and serve only a few customers; robotics is not being utilized; operative coordination is poor. . . . At this point, the growth in applying automatization should be exponential.

4.1 Statistical analysis

The empirical part of the study is based on the panel data from the Finnish logistics actors, which were divided into purchasers and logistics service providers. Data came from the panel data of logistics experts, who estimated quarterly indicators, no change, or increase in the current state and forecast (−1, 0, +1). The data span was limited to the 10-quarter period from the last quarter of 2018 to the first of 2021. By doing this, data from five months before and during the COVID-19 crisis were included. The service buyers and service providers (N = 588) were combined, with 233 answers from before COVID-19 emerged and 355 answers during the period of the pandemic. Table 2 shows the distribution of the entire database across different industries. The dataset contains 332 responses from logistics provider companies and 256 from buying companies. Group comparison was analyzed by parametric analysis of variance (Mann–Whitney *U* test), and the mean between different groups was statistically compared by analysis of variance. In the analysis, a significance >0.05 is interpreted as a statistically significant deviation between groups.

4.2 Logistics sector before and during COVID-19

The impact of COVID-19 on the indicators of the panel data in the logistics sector was studied by dividing the data into two parts, namely before COVID-19 and during the pandemic. We consider the impact of COVID-19 starting in Q1/2020, and the reference period lasts until 2/2021. The overall period was analyzed using parametric analysis of variance (Mann–Whitney *U* test) by statistically comparing the mean between different groups by analysis of variance. In the analysis, a significance >0.05 is interpreted as a statistically significant deviation between groups.

The results of the mean test (Table 3) show that the mean values of the indicators in the data differ significantly for all indicators when comparing the situation before and during the COVID-19 pandemic. As a result, domestic transport, imports and exports were clearly higher during the pandemic than before it. The realized situation and forecast for all indicators were

Industry	n	%
Transport	238	40.5
Industry	130	22.1
Trade	101	17.2
Other	75	12.8
Public sector	18	3.1
Building	17	2.9
Total	588	100

Source(s): Authors' own work

Table 2.
Sample distribution

significantly weaker during the pandemic than before it, which means that the pandemic had a clear impact on key indicators in a declining sense.

4.3 Service providers and logistics purchasers

As the impact of COVID-19 may have been different for different actors in the logistics supply chain, it is worth comparing it on an operator-by-operator basis. We have distinguished logistics service providers from service buyers for comparison. From the panel data, it is possible to group these respondents into their own datasets by the actors.

When comparing the impact on buyers of logistics services before and during the COVID-19 pandemic (Table 4), there is a significant difference in the reference periods for all indicators except for domestic transportation and the projected quantity of goods stored and inventory turnover speed.

When comparing the impact on logistics service providers before and during the COVID-19 pandemic (Table 5), it can be seen that the mean values of all indicators differ statistically significantly between the reference periods (before and during the COVID-19 pandemic). The mean values of all indicators are at a lower level during the pandemic than

	Before the COVID-19 pandemic		During the COVID-19 pandemic		
Indicator	Mean	Std. Deviation	Mean	Std. Deviation	Sig
Domestic transportation	0.16	0.64	0.01	0.68	0.01 **
Imports	0.28	0.64	−0.05	0.72	0.00 **
Exports	0.13	0.66	−0.16	0.66	0.00 **
Prediction for the following quarter	Mean	Std. Deviation	Mean	Std. Deviation	Anova Sig
Domestic transportation	0.23	0.62	0.07	0.63	0.01 **
Imports	0.26	0.66	0.07	0.67	0.00 **
Exports	0.29	0.58	0.14	0.64	0.07 *

Note(s): ** Sig. <0.05; * Sig. <0.01
Source(s): Authors' own work

Table 3.
Comparison of before (n = 233) and during (n = 355) the COVID-19 pandemic

Buyers	Before the COVID-19 pandemic		During the COVID-19 pandemic		
Indicator	Mean	Std. Deviation	Mean	Std. Deviation	Sig
Domestic transportation	0.17	0.66	0.00	0.71	0.12 n
Imports	0.30	0.65	−0.91	0.75	0.00 **
Exports	0.19	0.63	−0.12	0.63	0.00 **
Stored goods	0.41	0.64	0.09	0.67	0.00 **
Inventory turnover speed	−0.10	0.64	−0.14	0.74	0.08 *
Prediction for the following quarter					
Domestic transportation	0.32	0.60	0.16	0.66	0.08 *
Import transport	0.40	0.59	0.10	0.63	0.00 **
Exports	0.40	0.55	0.11	0.59	0.00 **
Stored goods	0.12	0.63	0.05	0.63	0.51 n
Inventory turnover speed	0.36	0.67	0.21	0.67	0.06 n

Note(s): ** Sig. <0.05; * Sig. <0.01
Source(s): Authors own work

Table 4.
Comparison of logistics buyer indicators before and during the COVID-19 pandemic

Service providers Indicator	Before the pandemic Mean	 Std. Deviation	During the pandemic Mean	 Std. Deviation	 Sig
Domestic transportation	0.16	0.63	0.02	0.65	0.05 *
Imports	0.27	0.64	−0.20	0.71	0.00 **
Exports	0.08	0.67	−0.18	0.68	0.00 **
Number of goods stored by customers	0.06	0.65	−0.22	0.65	0.00 **
Company staff	0.36	0.55	0.08	0.62	0.00 **
Prediction for the following quarter					
Domestic transportation	0.15	0.62	−0.01	0.60	0.02 **
Imports	0.16	0.69	0.06	0.69	0.21 n
Exports	0.20	0.59	0.16	0.67	0.93 n
Number of goods stored by customers	0.10	0.61	−0.03	0.64	0.07 *
Company staff	0.26	0.53	0.16	0.57	0.10 n

Note(s): ** Sig. <0.05; * Sig. <0.01
Source(s): Authors' own work

Table 5.
Comparison of service provider indicators before and during the COVID-19 pandemic

before. The changes in the indicators are thus in line with the changes experienced by the purchasers of logistics services.

4.4 Indicator variance

We also looked statistically at the quarterly indicator variation before and during the COVID-19 pandemic. The aim here was to show whether the pandemic influenced both the actual turbulence of indicator fluctuations and the predictability of operations. In the panel data, the actors predicted the realization of the indicators for the following quarter, and it is thus possible to compare this variation between quarters before and during the pandemic.

As can be seen from Table 6, in the service providers section, there is only a slight difference in the indicators and forecasts for the following period during the period before the COVID-19 pandemic. The analysis shows that there was only a significant variation in the number of company staff and the forecast imports during the period. During the pandemic, on the other hand, there was significant variation in domestic transportation and goods stored by customers. In addition, the largest fluctuations came from the variation in forecasts with the indicators of domestic transportation, imports, exports and goods stored by customers. The results show that during the pandemic, forecasting operations was very challenging, and turbulence in operations is particularly evident from the significant variation in the forecasts and the unpredictability of the future.

If we look at the quarterly variation of logistics buyers with different indicators (see Appendix 1), it can be seen that only the amount of products stored vary significantly from quarter to quarter, and the variation is significant before and during the COVID-19 pandemic periods. Thus, the pandemic did not have a significant effect on inter-quarter variability.

Quarterly variation of the predictions shows that during the COVID-19 pandemic, there was a statistically significant variation in the forecasts of several indicators, namely domestic transportation, imports and inventory turnover speed.

As buyers of logistics services represent different industry sectors, an analysis was also conducted to control the differences between the industries of the purchasing companies. When the analysis was controlled by the industries in the data (agriculture, construction industry, trade, transportation and others), there was no statistically significant difference between the variables in the different industries during the COVID-19 pandemic except for the number of goods stored by customers. It can therefore be said that the industries did not significantly bias the analysis in this respect.

Service providers	Before the COVID-19 pandemic			During the COVID-19 pandemic		
Indicator	Mean	Std. Deviation	Sig	Mean	Std. Deviation	Sig
Domestic transportation	0.16	0.63	0.11	0.02	0.64	0.01**
Imports	0.27	0.64	0.67	−0.02	0.70	0.18
Exports	0.08	0.67	0.73	−0.18	0.68	0.50
Number of goods stored by customers	0.06	0.65	0.55	−0.22	0.65	0.02**
Company staff	0.36	0.55	0.072**	0.08	0.62	0.23
Prediction for the following quarter						
Domestic transportation	0.15	0.62	0.38	−0.01	0.60	0.01**
Imports	0.16	0.70	0.029**	0.06	0.69	0.00**
Exports	0.20	0.59	0.62	0.16	0.67	0.00**
Number of goods stored by customers	0.10	0.60	0.32	−0.03	0.64	0.05**
Company staff	0.26	0.53	0.15	0.16	0.57	0.15
Buyers	Before the COVID-19 pandemic			During the COVID-19 pandemic		
Domestic transportation	0.17	0.66	0.98	0.00	0.71	0.69
Imports	0.30	0.65	0.63	−0.09	0.75	0.32
Exports	0.19	0.63	0.19	−0.12	0.63	0.38
Stored goods	0.41	0.64	0.064**	0.09	0.67	0.04**
Inventory turnover speed	−0.01	0.64	0.97	−0.14	0.74	0.83
Prediction for the following quarter						
Domestic transportation	0.32	0.60	0.77	0.16	0.66	0.02**
Imports	0.40	0.59	0.66	0.10	0.63	0.05**
Exports	0.40	0.54	0.11	0.11	0.59	0.87
Stored goods	0.12	0.63	0.36	0.05	0.63	0.50
Inventory turnover speed	0.36	0.67	0.18	0.21	0.67	0.02**

Note(s): ** Sig. <0.05; * Sig. <0.01
Source(s): Authors' own work

Table 6.
Comparison of indicators between quarters

5. Discussion

This study provides an important yet sparsely addressed perspective to the supply chain management literature by illustrating the changes to logistics sector companies caused by a widespread pandemic. The impact of COVID-19 and the restrictions enforced to limit the spread of the virus led to a wide range of consequences for the logistics sector. It is challenging to describe the complex and multifilament phenomenon to understand the full scale of its impact. In this research, we have provided a holistic view of the pandemic's impact on the logistics sector by utilizing index data from logistics field companies and expert group interviews and discussions to further deepen understanding of the events that occurred and are partially still ongoing. In doing this, the mixed-methods approach seemed to work well and allowed us to deliver insights into the changes at the macroeconomic level. It also enables a better understanding of how different kinds of companies in the heterogenous field of logistics reacted to and experienced the pandemic.

The study findings illustrate how actors in different roles in the supply chain perceived their operations before and during the COVID-19 pandemic. Furthermore, the findings of this paper illustrate how drastic uncertainty and changes in the operational environment can be seen in logistics organizations, and the results are compared between two different European countries, namely Finland and Germany. The findings suggest that increased uncertainty

and changes in the operational environment can cause a significant drop in expectations for business development in the logistics sector. Despite the turbulence in the forecasts, the quarterly variation in the realized indicators was particularly significant during the COVID-19 pandemic in the studied logistics sector. In the aftermath, many logistics companies have survived the crisis well, and many have had a record year as demand for their services has boomed (Liu *et al.*, 2022). However, depending on the strategies of different countries, differences have also been witnessed among countries with stricter policies, where companies have suffered (Earley and Newman, 2021). Clearly, more studies are needed to understand better how different kinds of COVID-19 strategies impacted the economies of different countries.

The study links widely to the previous discussion about the impact of COVID-19 in the recent literature and provides both insights into logistics crisis management and some estimations of future trends in the field (Choi, 2021; Xu *et al.*, 2022). As most of the literature related to the COVID-19 pandemic has focused on the risk management perspective (Loske, 2020) and the negative consequences of the pandemic (Atayah *et al.*, 2022), the findings of this study reveal that the crisis has had numerous positive impacts on logistics as well (e.g. the rapid growth of online trade and online food shopping). Passenger transportation has suffered heavily due to governmental restrictions, which is reflected in the impact on combined logistics. In particular, air cargo, which very much goes hand in hand with charter flights, felt the impact and many airliners suffered heavy losses. Road transportation was affected as well; however, the dependence between passenger and goods transportation does not seem to be as high in that segment. In their study, Xu *et al.* (2022) argued that COVID-19 had an impact on all transportation modes except for maritime transportation in China. While this might have been the case in the early stages of the crisis, our research continues this discussion by illustrating how the pandemic went on to have a major impact on maritime supply chains. The shutdowns of ports due to infections are still having an impact on the global logistics system.

The results of the study illustrate how logistics companies had to adopt new methods of communication and doing business. The practical impacts of COVID-19 on these companies were in terms of remote working and avoiding contact with other employees, which were seen to hinder operations somewhat, although online tools were adopted quickly. While the COVID-19 pandemic was seen as a good opportunity to enable digital transformation in organizations, this did not come to be realized. The use of online communication and meeting tools was seen as only a substitute for other means of value creation, and the opportunities for real capability enhancements in information integration into value networks were not gained. In this regard, the results here confirm the findings of earlier studies that argued that digital services improvements are needed in the field (Earley and Newman, 2021; Sarkis *et al.*, 2020). While logistics is considered underdeveloped in terms of digitalization, certain flexibility when facing the crisis was observed. Service readiness and customary problem-solving skills could be seen as the actors in the field faced rapid changes from the environment or the customer. However, this did not come without cost. When there is a disturbance, costs go up, as can be seen on a global level. The unsustainable competitive advantage achieved through cheaper labor in undeveloped countries has been proven to fail in the face of increased international transportation costs. In this regard, recent studies have highlighted localization as a COVID-19 impact (see, e.g. Sarkis *et al.*, 2020; Romanello and Veglio, 2022). Indeed, the localization of production and a shorter supply chain could therefore form the coming trend, after restrictions and increased prices acted as a catalyst for the change.

Logistics actors' perceptions about the expected future state of the operational environment seemed to be highly dependent on their position in the supply chain. The logistics service providers seemed to have differing views on their buying counterparts. Overall, it was estimated that logistics service providers have less ability to forecast the future state of the sector, and purchasers and buying actors seem to have been better able to

react to pandemics such as COVID-19, compared with logistics service providers. In this respect, our research confirms earlier studies that argued that inter-organizational actors have the best knowledge of the supply chain (Vilko, 2012; Chi and Holsapple, 2005) and that there is a clear and growing need to promote end-to-end collaboration and visibility across the supply chain (Montoya-Torres *et al.*, 2023).

When the results are viewed in light of the research questions, certain cautious generalizations can be drawn from the empirical findings. In response to the question of whether there was a change in the logistics sector after comparing indicators before and during the crisis, the answer is that the situation during the COVID-19 pandemic caused a significant change in the sector. This is particularly evident from the declining trend in the panel's assessments across a number of indicators. In relation to the second question, of whether there was a difference in logistics buyers' and service providers' perspectives before and during the COVID-19 pandemic, it can be said that there was no significant difference between the actors. Nevertheless, both actors experienced a statistically significant change in the operating environment as a result of COVID-19. From the point of view of logistics buyers alone, there was no significant change in domestic transport. On the other hand, there was a difference in logistics buyers' predictions, especially for imports and exports, and in service providers' forecasts for domestic transport. Finally, to answer the question of whether COVID-19 caused greater volatility in the logistics sector, it can be said that, especially for the period forecasts, the inter-quarterly change was stronger during the pandemic than before it. If viewed from the perspective of the actors, then the COVID-19 crisis significantly increased the variation of domestic transportation and goods stored for customers by service providers. From the buyers' point of view, the amount of goods stored also varied significantly during the pandemic, compared with the time before it.

Overall, the study enables a better understanding of the nature and dynamics of perceptions amid uncertainty in the logistics sector and how a global pandemic impacts the views of actors in different positions within the supply chain. The views presented offer insights into how anticipated and realized changes in the business environment differed and inform managers about how well changes in the business environment can be anticipated. The differences in the perceptions of logistics field companies illustrate the need for collaboration to gain a better understanding of the events and their real impact in the field (Montoya-Torres *et al.*, 2023). In the future, more studies should be conducted on logistics companies' vertical and horizontal collaboration and the impact of decision-making amid uncertainty to properly understand the phenomenon.

6. Conclusions

COVID-19 had a drastic impact to the logistics sector; however, the overall consequences seem to have had a positive effect on many of its actors. This study applied a mixed-method approach to investigate the impact of COVID-19 on companies in the logistics sector. This method enabled a holistic perspective of the phenomena to be provided. Various actors in the field experienced the crisis in different ways when considering the logistics modes and roles in the supply chain.

This paper contributes to the supply chain management and logistics literature with insights into how a widespread pandemic is perceived among different roles within the supply chain as well as in different countries in which the pandemic spread at different speeds. Analyzing the differences between the expected and realized impact on the business environment can provide valuable information for academics and managers in the field and thus give insights into improving logistics planning and decision-making during a global pandemic. From the combined indices, it can be seen how the different phases of the crisis impacted the sector and how the infection rates and related governmental restrictions affected expectations in the

logistics field. Although there has been some research on the effects of the COVID-19 pandemic on the logistics sector, this type of panel data was not used to analyze these effects.

The presented analysis provides a new perspective for managers, especially on how a major disruption affects the dynamics between demand and supply for different supply chain actors within the logistics sector. The anticipation of the pandemic's effects and the ability to quickly adjust to the situation gave some actors the opportunity to achieve positive outcomes as a result. One of the central elements of the success of organizations was their resilience, namely their ability to quickly recover from disruptions, as highlighted in the COVID-19 literature (Ambrogio *et al.*, 2022). Management should create a clear roadmap for how to create greater resilience in companies against disruptions, based on these experiences.

It has been noted that the changes caused by COVID-19 and the governmental restrictions can be seen as a significant indicator in many ways. Especially in the international context, the indicators showed clear changes before and after the crisis. In the domestic context, changes were noticed, although they were not as significant as they were internationally. Some field purchasing and buyer respondents were more sensitive to the turbulence; however, there were no significant differences between different segments of the industry in terms of buying.

The study provides new information on the impact of the pandemic on operators in the logistics sector, but it also has certain limitations that need to be assessed when looking at the results. Although we have been able to compare data mainly from Finland, data from several countries and regions are needed for a more general analysis. Finnish data alone were used for a more accurate statistical comparison, since more detailed data were not available from other countries. The analysis of the panel data is also limited by the number of questions that could be used to perform the analysis. An interesting research question in the future could be to examine what risk management measures companies have put in place to deal with pandemic disruptions. It would also be interesting to study the effects of the pandemic on the performance of different logistics actors.

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(The Appendix follows overleaf)

Appendix

Table A1.
During COVID-19, quarterly evaluations (Service providers n = 199)

Mean values	A 2020Q1	B 2020Q2	C 2020Q3	D 2020Q4	E 2021Q1	*p*-value	Post h oc[a]
Domestic transportation	−0.27	0.02	−0.13	0.19	0.22	0.011**	A-D, A-E
Import transport	−0.235	−0.07	−0.045	0.119	0.150	0.182	
Exports	−0.135	−0.295	−0.230	−0.097	−0.061	0.499	
Customer inventory	−0.203	−0.37	−0.394	−0.097	0.066	0.016**	B-E
Company staff	0.084	0.018	0.127	0.310	−0.032	0.234	

Source(s): Authors' own work

Table A2.
During COVID-19, quarterly evaluations (Buyers n = 156)

Mean values	A 2020Q1	B 2020Q2	C 2020Q3	D 2020Q4	E 2021Q1	*p*-value	Post hoc[a]
Domestic transportation	−0.09	0.05	−0.11	−0.07	0.11	0.685	
Import transport	0.05	−0.08	−0.32	−0.22	0.12	0.315	
Exports	−0.19	−0.15	−0.28	−0.00	0.05	0.377	
Inventory	0.32	0.19	0.00	−0.14	−0.12	0.035**	D-B, D-A
Inventory turnover	−0.157	−0.193	−0.222	−0.123	0.125	0.830	

Source(s): Authors' own work

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