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COVID-19 Pandemic Impact on the Supply Chains of the UK-Based Multinational Manufacturing Companies

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Abstract

The main objective of this paper is to evaluate the main impacts of the COVID-19 pandemic on the supply chain structures and arrangements of UK-based multinational manufacturing companies. The main objectives of this research are (1) to establish the main risks posed by COVID-19 to the existing supply chains established by multinational manufacturers in the UK, and (2) to evaluate whether multinational manufacturing businesses in the UK can learn from challenges faced during the COVID-19 pandemic by referring to the concept of supply chain resilience and (3) to provide practical recommendations to multinational manufacturers in the UK on how the key impacts of COVID-19 could be overcome and leveraged as a source of new knowledge in the area of supply chain management. The posed objectives were realized via the mixed methods research strategy involving a quantitative survey and its triangulation with the results of qualitative interviews conducted with managers of such organizations. We used two different data collection channels (1) LinkedIn and (2) Reddit. Our data set was constructed with 12 questionnaires and three interviewers. Using these data sets, our findings strongly suggest that the seven identified risk dimensions influenced the supply chain integrity of these companies both before and after the global COVID-19 pandemic. It could be attributed to the insular state of the UK and other macro-environmental factors limiting the procurement capabilities of local firms. However, most of these dimensions were severely affected by the pandemic, demonstrated by both the performed Friedman tests and the statements voiced by the interviewees. While some mitigation strategies were cited as relatively effective for addressing the emerging risks, most of the respondents noted that the systemic nature of encountered problems and their magnitude made it difficult for individual companies to avoid, mitigate, or transfer these risks.

1. Introduction

The present study focuses on evaluating the key effects of the COVID-19 pandemic on the supply chains of multinational manufacturing companies for which the UK constitutes their domestic market. When categorizing the impacts of COVID-19 on supply chains, authors such as Remko (2020) and Sarkis (2020) primarily focused on the means through which the global pandemic challenged supply chains highlighting companies' lack of preparedness, the emergence of unexpected risks (e.g., delays to lead times), and a shortage of supply chain effectiveness. Contributing to these findings, Rizou et al. (2020) argued that the

supply chains of food manufacturing companies worldwide failed to protect workers against the spread of COVID-19. Nonetheless, none of the above studies attempted to present an exhaustive typology of the key impacts of COVID-19 on the supply chains of UK-based manufacturing firms. While the above literature (Remko, 2020; Sarkis, 2020) listed some obstacles posed by the global pandemic to existing supply chain arrangements, the authors did not link their findings to fundamental frameworks describing supply chains arrangements, including models of supply chain resilience or the supply chain operations reference (SCOR) model. Without such knowledge, manufacturing firms in the UK lack formally articulated means for explaining the effects of COVID-19 on their supply chains and, subsequently, overcoming these challenges and recovering from the pandemic. The study hopes to address the above research gap by presenting a typology of the key impacts of COVID-19 on the supply chains of UK-based manufacturing firms and linking this classification to both fundamental and state-of-the-art frameworks describing core supply chain structures and supply chain resilience.

1.1. Research Background. The following figure presents the results of Statista's (2021) survey about the key challenges posed by COVID-19 to the smooth functioning of supply chains worldwide.
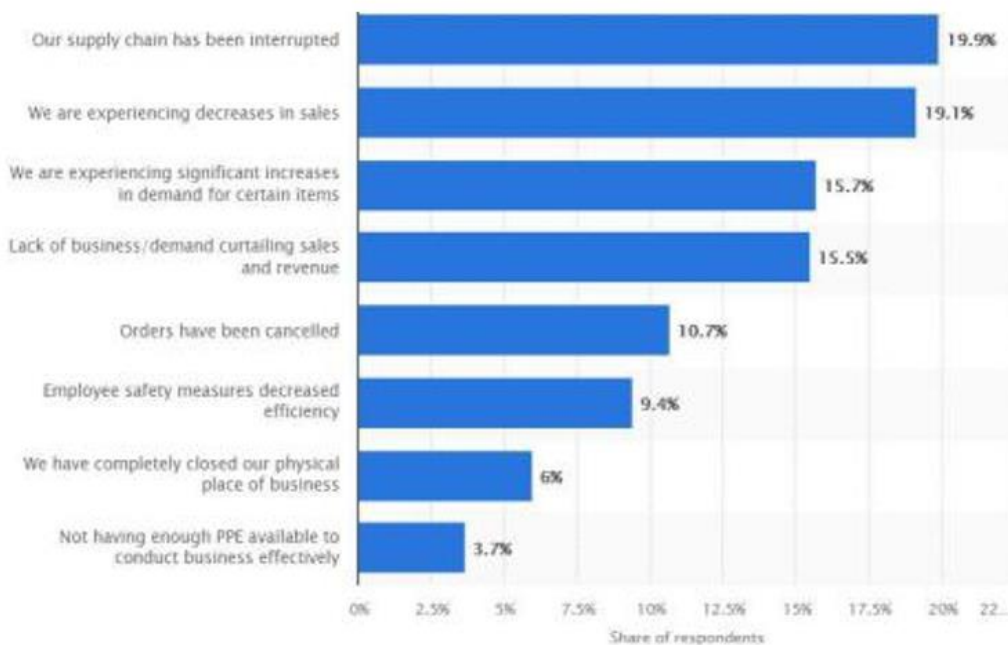

Figure 1. Key Challenges Posed by COVID-19 to Supply Chains (%)

Source: Statista (2021, n.p.)

According to the above figure, during the period of the global pandemic, firms experienced interruptions to their supply chains, faced a decreased level of demand, responded to order cancellations, and, in some cases, were forced to close some of their physical places of distribution (Statista, 2021). Supporting the above results, Sharma et al. (2020a, p. 1) categorized the impacts of COVID-19 on supply chains into "supply risks, demand risks, financial risks, logistics and infrastructure risks, management and operational, policy and regulation, and biological and environmental risks". While the study of Sharma et al. (2020a) presented an extensive typology of risks posed by COVID-19 to existing supply chains, this project failed to consider manufacturing organizations in developed countries (including the UK) could also learn from global crises and, subsequently, improving the resilience and efficacy of supply chains (Mollenkopf et al., 2020). Mollenkopf et al. (2020) briefly considered this concept but did not apply their findings to manufacturing organizations or the UK. The study addresses the above gaps by considering both the negative and positive effects of COVID-19 on supply chains and articulating how the risks faced by UK-based manufacturers could contribute to future supply chain structures and arrangements.

The study aims to elucidate and evaluate the major impacts of the COVID-19 pandemic on the supply chain structures and arrangements of UK-based multinational manufacturing companies. This goal is supported via the following objectives.

1. To establish the main risks posed by COVID-19 to the existing supply chains established by multinational manufacturers in the UK.

2. To evaluate whether multinational manufacturing businesses in the UK can learn from challenges faced during the COVID-19 pandemic by referring to the concept of supply chain resilience.
3. To provide practical recommendations to multinational manufacturers in the UK on how the key impacts of COVID-19 could be overcome and leveraged as a source of new knowledge in supply chain management.

1.2. Research Questions. The study answers the following questions.

RQ1: How could the key impacts of COVID-19 on the supply chains of UK-based multinational manufacturers be categorized and defined?

RQ2: How have manufacturing firms in the UK leveraged the resilience of their supply chains to react to the global pandemic in the area of supply chain management?

RQ3: What are the key means and areas of improvement that should be prioritized by multinational manufacturers in the UK following the COVID-19 pandemic?

The study is divided into five sections. Section 2 continues the discussion by referring to fundamental and recent works on supply chain management during global crises and the possible challenges to supply chain structures. Section 3 defines the methodology of the study and justifies the chosen means of data collection and analysis. Section 4 outlines the findings of the project and, subsequently, compares the results to what is stated in the literature review. In concluding the project, section 5 summarizes the findings, provides recommendations to UK-based manufacturers, and acknowledges the limitations of the study.

2. Literature Review

2.1. Reviewing the Key Models of Supply Chain Resilience. The study refers to the concept of supply chain resilience to determine the key impacts of the COVID-19 pandemic. According to Wieland and Durach (2021), supply chain resilience could be defined as the ability of supply chains to withstand challenges, recover from experiencing significant risks, and transform to adapt to major macro-environmental factors. Defining the key areas of supply chains in which resilience is typically exhibited, Ivanov (2020) provided the following framework.

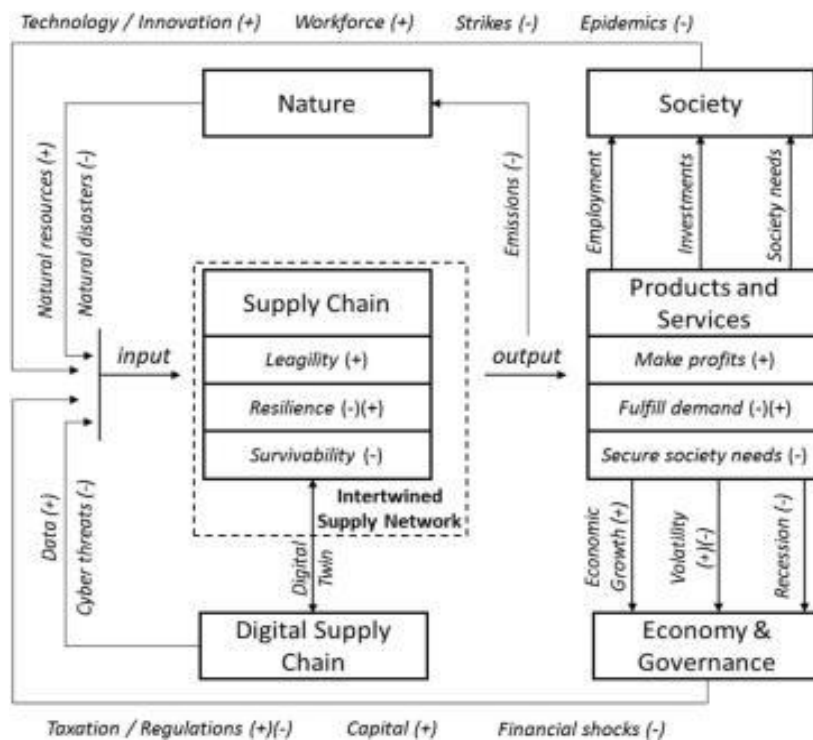**Figure 2. A General Framework of a Supply Chain Ecosystem**

Source: Ivanov (2020, p.4)

According to Ivanov (2020), supply chains transformed inputs into outputs, made profits, satisfying needs, and facilitated economic growth. Financial shocks, capital shortages, recessions, and natural disasters posed threats to different supply chain areas (Ivanov, 2020; Azzi et al., 2019). While Ivanov (2020) accurately

defined the effects of various risks on the separate areas of multinational supply chains, the above framework failed to acknowledge that some global crises (including the COVID-19 pandemic) may simultaneously produce most of the described challenges to effective supply chain functioning (Tripathi and Gupta, 2021). For example, the COVID-19 pandemic represents a financial shock to developed economies, increases capital volatility, and decreases employees' involvement in supply chain processes (e.g., packing products for subsequent deliveries) due to formal restrictions on people's movements (Remko, 2020). It is unknown how firms categorize such widespread risks and leverage the resilience of their supply chains to overcome global crises affecting several different components of supply chain arrangements. Although Ivanov (2020) thoroughly explained the most significant functions of supply chains and the possible vulnerabilities facing multinational enterprises, their framework omitted any considerations of considerable supply chain activities and control mechanisms. This issue is addressed in the following figure.

Figure 3. A Framework of Key Supply Chain Activities
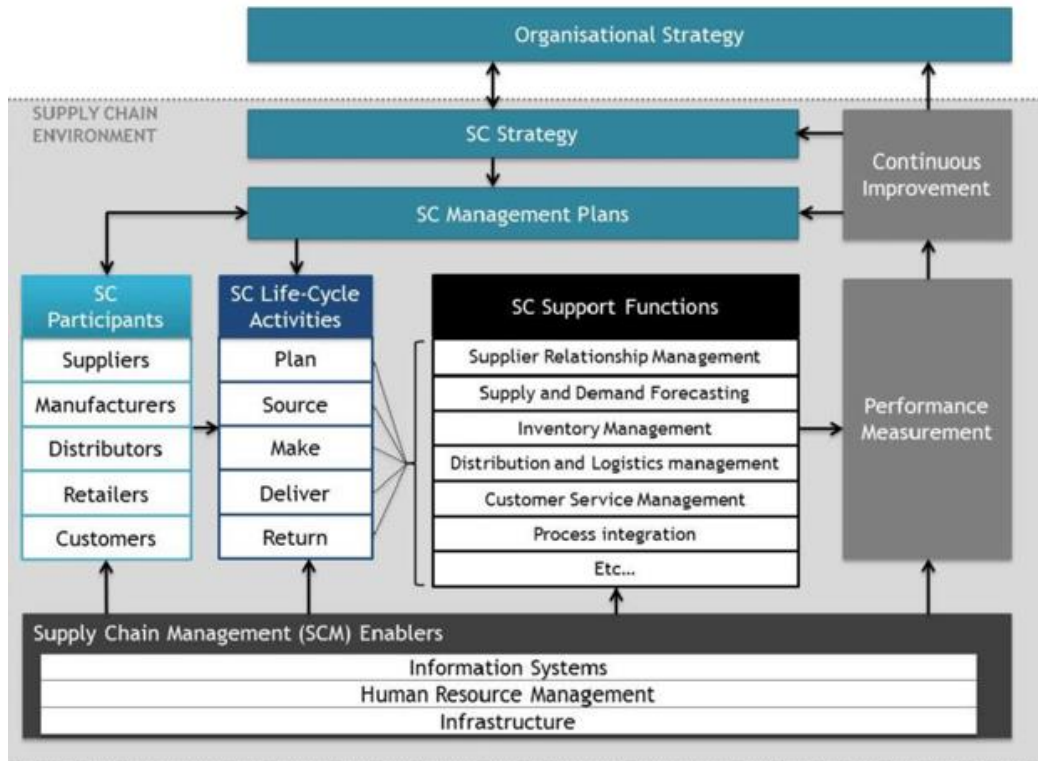
Source: Du Toit and Vlok (2014, p.25)

Transitioning from the categorization of supply chain elements proposed by Ivanov (2020), the following model focuses on general supply chain resilience without referencing any specific supply chain components or processes.
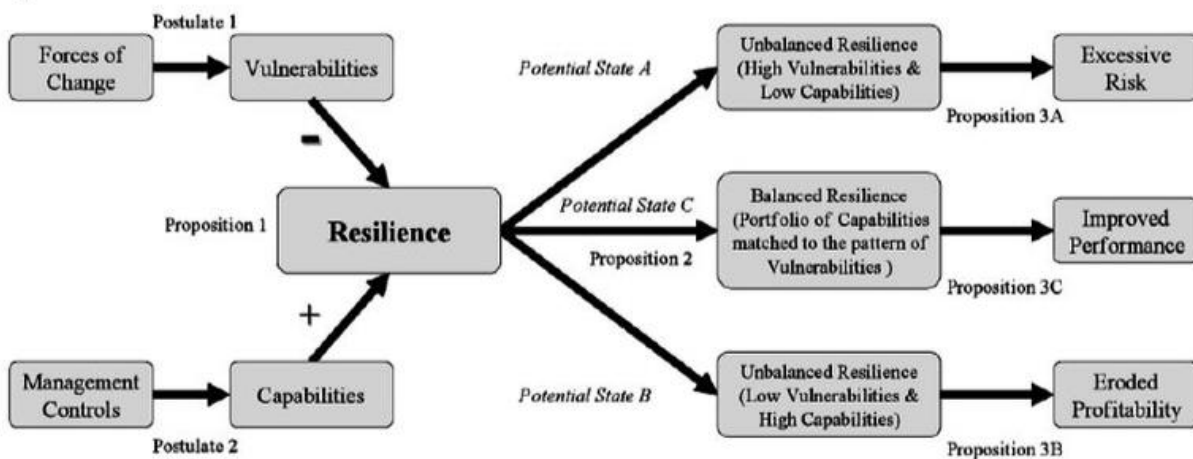

Figure 4. The State-Based Framework of Supply Chain Resilience

Source: Hanke and Krumme (2012, p.379)

As shown above, resilience depends on the degree to which management controls can react to forces of change and vulnerabilities (Hanke and Krumme, 2012). For example, if a company lacks the capabilities to overcome major macro-environmental disruptions, including global health crises, the organization will face excessive risks: canceled orders, delays to product deliveries, and supply chain interruptions. Hanke and Krumme (2012) accurately defined the key states that could be experienced by international manufacturers that have continued their operations during the COVID-19 pandemic. On the other hand, the state-based framework of supply chain resilience failed to define the key strategies that firms could use to overcome global crises and transform their supply chains by reacting to significant macro-environmental changes. Partially addressing this research gap, Thaiprayoon et al. (2019) suggested that there existed three main approaches to overcoming supply chain vulnerabilities:

➢ Avoidance: Companies following this strategy generally cease operations in a particular market or industry when encountering vulnerabilities.
➢ Containment: Firms adopting this approach choose to continue their supply chain operations without significant changes.
➢ Stabilization: Organisations choosing this strategy typically improve supply chain resilience by introducing additional supply chain channels (e.g., click-and-collect deliveries).

In turn, the success of the above strategies determines the probability of a company successfully recovering following a period of vulnerability (Thaiprayoon et al., 2019). However, the above typology has so far not been applied to the case of COVID-19. It is unknown whether companies faced with such a significant worldwide vulnerability would still decide to follow one of the above strategies.

2.2. The Key Impacts of COVID-19 on the Supply Chains of Multinational Enterprises. While the previous sub-section focused on key theories describing the elements of supply chains that could be affected by COVID-19, the following discussion centers on the projected impacts of the global pandemic on the supply chains of multinational manufacturers. Specifically, Karadayi-Usta and Asan (2014) suggested that vulnerabilities to global supply chains threatened demand stability. In the UK, customers facing COVID-19 may choose to purchase many medical supplies or semi-professional medical equipment (e.g., face masks with improved protective coverings and air valves) to avoid infection (Armani et al., 2020). Subsequently, multinational medical equipment manufacturers may lack raw resources to fully address such a surge in demand, leading to product shortages and decreased recycling rates of used products (Armani et al., 2020; Rizou et al., 2020). In contrast, food manufacturers selling their products to hospitality outlets may experience a significant decrease in demand caused by restrictions on people's movements, leading to increased rates of raw material perishability and threatening the ability of such enterprises to transform inputs into commercial outputs (Rizou et al., 2020; Hasan et al., 2022a; 2022b).

Neither Armani et al. (2020) nor Rizou et al. (2020) formally acknowledged that vulnerabilities threatening supply chains depended on the types of products manufactured by multinational firms and the governmental response to the pandemic. For instance, if a country mandates involuntary remote work as a consequence of restrictions on people's movements, manufacturers may be forced to temporarily cease operations at one or more of their sites, threatening the stability of product deliveries to retailers and other centers of distribution (Remko, 2020; Guan et al., 2020). The financial losses incurred by the pandemic may also threaten the implementation of valuable activities that typically benefit supply chain resilience. As an illustration, manufacturers that rely on environmentally sustainable but cost-intensive sources of renewable energy (e.g., processed hydrogen) could decide to reduce their supply chain costs by switching to cheaper fossil fuels or similar means of generating energy (Sarkis, 2020). In the UK, nonetheless, both above factors were also influenced by Brexit, which threatened the stability of the UK economy and challenged buyer-supplier relations between firms in the UK and Europe due to the absence of formal trade agreements following the Brexit referendum (Ryan, 2021). Neither Guan et al. (2020) nor Sarkis (2020) clarified how such factors affected manufacturers' reactions in the UK to COVID-19.

Continuing the theme of Brexit, based on the implications made by Ryan (2021), the present research project suggests that this geopolitical process may reduce the resilience of UK-based multinational enterprises, leading to these companies struggling to overcome the impacts of the COVID-19 pandemic and recover by introducing appropriate changes to their supply chains (e.g., by delivering directly to the end consumers instead of relying on physical retail). Other impacts of COVID-19 compound this negative effect. For example, if a firm's logistics personnel become infected with COVID-19, the company will temporarily lose its ability to produce timely deliveries to retailers or the end consumers (Goel et al., 2021). If an organization fails to procure enough protective equipment for its workers, this enterprise may become the subject of a

legal inquiry. If the government chooses to mandate the attainment of high worker health and safety targets during the pandemic (Nikolopoulos et al., 2021). The government decided to implement strict lockdowns and enforced restrictions on people's movements in the UK. It means that all five of the core supply chain activities of multinational manufacturers had to be downscaled or changed to react to such conditions (Ryan, 2021). Nonetheless, other authors (Remko, 2020; Sarkis, 2020) have failed to clarify how UK-based firms reacted to the above vulnerabilities.

As a core part of their operations, manufacturers transform raw materials into products for subsequent commercial usage; as a result, manufacturers' supply chains typically incorporate several providers of raw inputs necessary for the stable production of goods (Armani et al., 2020). As a result, the COVID-19 pandemic may significantly reduce the availability of raw resources for manufacturers, incur logistics delays and, in some cases, be the cause for some manufacturers' suppliers to cease their operations entirely (Aday and Aday, 2020; Mahajan and Tomar, 2020). Such disruptions could mean that some manufacturers may choose to down-size their operations by closing manufacturing sites, reducing the size of their labour force (e.g., delivery drivers), and eliminating unprofitable logistics channels from their supply chains (Luckstead et al., 2021). This argument ignores the claim that the impacts of COVID-19 on supply chains may also motivate manufacturers to improve the resilience of their supply arrangements by implementing cost-effective supply chain arrangements and tools, such as drone deliveries and using additive manufacturing to reduce raw material requirements for production (Mahajan and Tomar, 2020).

Continuing the above argument, while some authors (Remko, 2020; Sarkis, 2020) suggested that COVID-19 introduced significant disruptions to the supply chain processes of multinational manufacturers, researchers such as Guan et al. (2020) and Wang et al. (2020) acknowledged that the manufacturers were able to recover shortly after the lifting of restrictions on people's movements. As shown by Guan et al. (2020), in some cases, longer lockdowns were more beneficial to Chinese manufacturers compared to shorter lockdowns. Such strict measures significantly reduced the possibility of contagion in the workplace, allowing manufacturers to avoid significant risks to employee health and safety (Guan et al., 2020; Golan et al., 2020). On the other hand, none of the above findings have been verified in the context of UK-based manufacturers. There is no empirical evidence that would unambiguously state whether manufacturing companies in the UK were able to follow the example of Chinese firms when recovering after the lifting of nationwide lockdowns (Guan et al., 2020; Golan et al., 2020).

2.3. Conceptual Framework of the Study. The following figure outlines the study's conceptual framework by outlining the key impacts of the COVID-19 pandemic on the supply chains of multinational manufacturers. Similarly, to authors such as Remko (2020) and Armani et al. (2020), Magableh (2021) highlighted demand volatility as a notable impact of the COVID-19 pandemic. Subsequently, demand volatility reduced profits, introduced new risks to manufacturers (e.g., increasing inventory perishability rates in the food manufacturing sector), and contributed to delays in distributions. Acknowledging the findings of Aday and Aday (2020) and Mahajan and Tomar (2020), the above framework also includes supply disruptions, such as fluctuations and increases in the prices of raw materials required for manufacturing various goods. Continuing the discussion of Guan et al. (2020), the framework also incorporates governments' responses to the pandemic, including imposing restrictions on people's movements, introducing additional health and safety checks at international borders, and mandating specific labour arrangements (e.g., remote working).
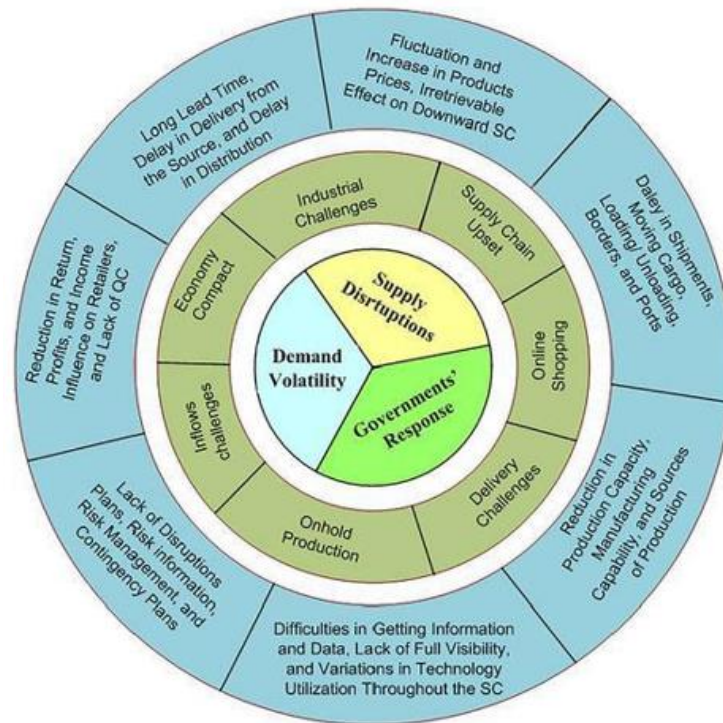
Figure 5. Framework of the Study

Source: Magableh (2021, p.4)

Summarising the results of the literature review, the conceptual framework demonstrates that COVID-19 constituted a significant challenge to the supply chain management of UK-based multinational manufacturers. Nonetheless, Magableh (2021) model failed to refer to the concept of supply chain resilience. According to Hanke and Krumme (2012), if companies attain balanced resilience, supply chain vulnerabilities may serve as sources of positive change of supply chain arrangements. For example, manufacturers who had previously delivered their products only to retailers may add new distribution channels directly to the end consumers to address low patronage figures of physical retail stores during national lockdowns. Nonetheless, none of the studies reviewed in this literature review applied the above findings to the UK context, in which the impacts of the COVID-19 pandemic were also amplified by Brexit and the resulting supply chain disruptions between the EU and the UK.

3. Methodology

3.1. Research Strategy and Data Collection. The study follows the mixed methods strategy by gathering the following data (Saunders et al., 2016; Creswell, 2014).

➢ Qualitative data about supply chain managers' perceptions of the key impacts of the COVID-19 pandemic on supply chain arrangements.

➢ Quantitative data about the key differences in supply chain arrangements before and during the COVID-19 pandemic.

Both qualitative and quantitative data are typically used in state-of-the-art research on supply chain management during the COVID-19 pandemic (Remko, 2020; Sarkis, 2020). This strategy allows for comparing human perceptions of this event (qualitative data) to numeric data about supply chain managers encountering challenges, such as demand unpredictability or supply chain disruptions. A purely qualitative study would not establish statistically significant differences in supply chain arrangements before and during the global pandemic. A quantitative project, alternatively, would lack any consideration of the subjective rationale for implementing specific responses to the spread of COVID-19, such as providing all workers with personal protective equipment (Saunders et al., 2016).

Qualitative data is gathered via interviews with supply chain managers employed by UK-based enterprises; quantitative information is attained by distributing a self-administered questionnaire survey among the same target population. Justifying the choice of these means of data collection, Modgil et al. (2021) and Grida et al. (2020) similarly used interviews and questionnaire surveys to evaluate the impacts of COVID-19 on

global supply chains. The Appendix includes a full copy of the questionnaire survey and the interview questions. Both means of data collection are based on Magableh (2021) framework and explicitly reference specific supply chain vulnerabilities, such as demand uncertainty. The questionnaire survey encourages participants to evaluate how these challenges have affected their supply chains before and during the pandemic. The interview focuses on how the interviewees have chosen to address such issues. Interviews and surveys lack adequate means of fully eliminating participant bias, most notably social acceptability and desirability biases (Saunders et al., 2016). To address this issue, both the questionnaire survey and the interview questions include "face-saving" clues (Larson, 2019, p.634). For example, the questionnaire survey avoids linking supply chain vulnerabilities to the respondents' supply chain management choices; instead, the participants are asked to evaluate the degree to which different challenges have affected their supply chains.

3.2. Sampling and Recruitment. Sim et al. (2018, p.619) stated that determining the sample size of prior qualitative studies constitutes "an inherently problematic approach". Continuing this discussion, Gaciu (2020) indicated that the minimum sample size for statistical variance tests, such as the Friedman test, equaled at least 12 participants. According to this requirement, the study recruits 12 supply chain managers currently employed by UK-based multinational enterprises. The following table summarizes the sample inclusion criteria.

Table 1. Sample Inclusion Criteria

Criterion	Elaboration
Position of employment	Participant is currently working as a supply chain manager for a UK-based multinational manufacturer.
Job experience	Participant has been working as a supply chain manager or a similarly senior supply chain specialist for at least three years
Knowledge of COVID-19	Participant has been working as a supply chain manager since the start of lockdowns in the UK (February – March 2020).

Source: Created for the study

The study uses the non-probability purposive sampling strategy to recruit the participants who fit the above criteria (Saunders et al., 2016). While this approach lacks any means for ensuring the subsequent generalization of the results to the entirety of the target population, the use of non-probability sampling improves the feasibility of this research project, particularly given that in-person contact with the participant may constitute a health risk due to the continued spread of COVID-19.

The research project uses the following channels to recruit the participants.

➢ LinkedIn: Direct messages are sent to the researcher's LinkedIn contacts that fit the above inclusion criteria. The messages include a link to a Google Form version of the questionnaire survey and an invitation to participate in the qualitative interviews.

➢ Reddit: The researcher posts links to the digital questionnaire survey on relevant sub-forums such as 'r/Manufacturing' and 'r/SupplyChain'.

Of the 16 people who clicked on the Google Forms questionnaire link, only 12 chose to proceed with the questionnaire survey. Only three participants chose to participate in qualitative interviews.

3.3. Data Analysis. The study uses the non-parametric Friedman test (Gaciu, 2020) to analyze quantitative data and establish statistically significant differences between the participants' pre-pandemic and current supply chain arrangements. While this test lacks statistical power compared to ANOVA, the Friedman test can be successfully applied to small samples and does not assume the independence of observations (Gaciu, 2020). The study uses the thematic analysis to analyze qualitative data from semi-structured interviews. This approach involves assigning semantic codes to discrete units of analysis, such as sentences or phrases; subsequently, codes are grouped under higher-order themes (Maguire and Delahunt, 2017). For example, if several participants state that their supply chains faced demand unpredictability during the first few months of the pandemic, the study would assign the 'COVID-19 as a challenge to demand forecasting' code and attribute this code to the 'Key negative impacts of COVID-19 on supply chains' theme. Although thematic analysis is a valid tool for assigning meanings to qualitative units of analysis, this method lacks inter-rater reliability (Saunders et al., 2016; Maguire and Delahunt, 2017). Different researchers could assign various codes to the same interview transcripts; to address this threat to reliability, the study shares the final interview codebook with the interviewees.

4. Analysis and Discussion

4.1. Respondent Background. Most of the respondents belonged to the age group of 21 to 49 years old, with only one person being older than 50. It is generally in line with the selection criteria, implying the need only to include sample members having three or more years of employment as a supply chain manager before the COVID-19 pandemic, which implies five or more years of prior recruitment in this position total.
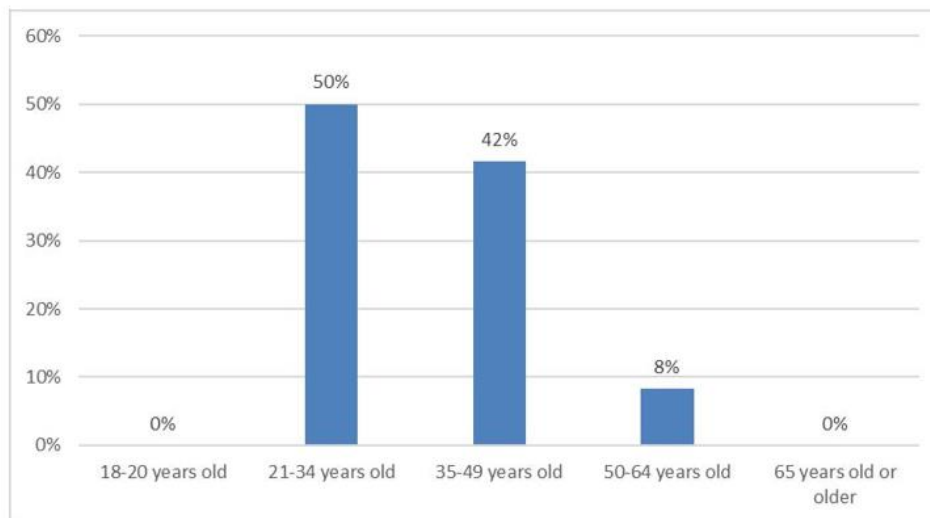

Figure 6. What is Your Age? (%)

Source: Compiled by the authors

8 out of 12 respondents were males, potentially distorting the equal representation of genders in the analysis (Dobscha, 2019). However, the studied phenomena do not relate to personal lived experiences or other topics where this parameter could provide any meaningful contribution or affect the respondent answers, according to Chrisler and McCreary (2016).
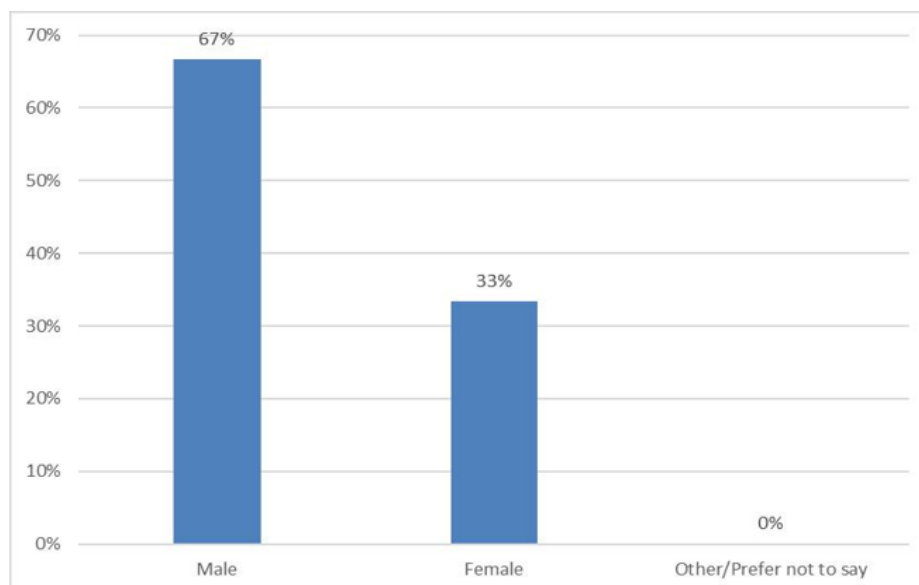

Figure 7. What is Your Gender? (%)

Source: Compiled by the authors

The same requirements were reflected in the employment duration of the sample members. Most of them occupied their positions for 3-7 years, with 25% (3 persons) being employed for a longer period, which allows them to possess sufficient knowledge of the studied sphere (Barry et al., 2016). The responses related to the evaluated degree of supply chain resilience to the impacts of COVID-19 were generally negative, with only 8% of the respondents appraising it as 'high' or 'very high'. These findings are in line with the results of the conducted thematic analysis (Appendix A) and statistical analysis, where many participants confirmed that their resilience measures were insufficient for the magnitude of the current crisis.
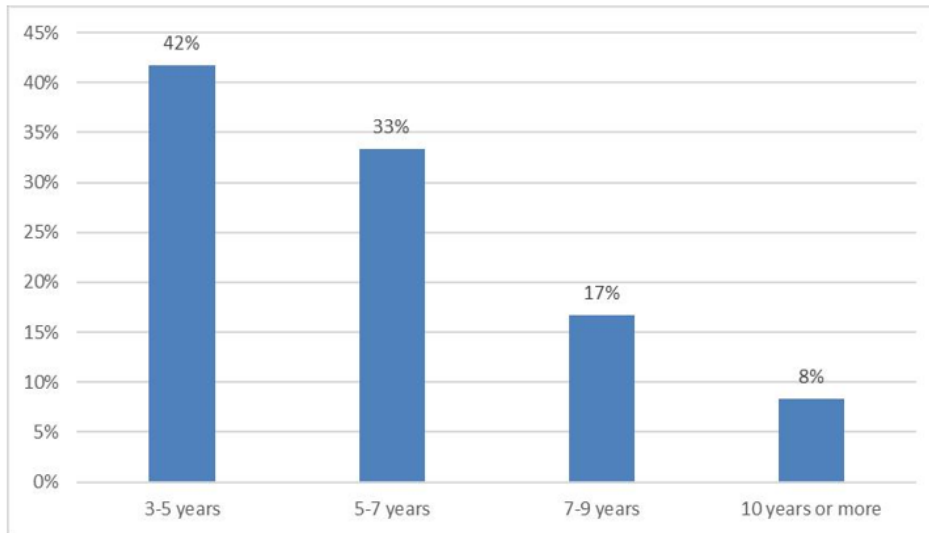
Figure 8. For How Long Have You Been Employed as a Supply Chain Manager in the Manufacturing Industry? (%)

Source: Compiled by the authors
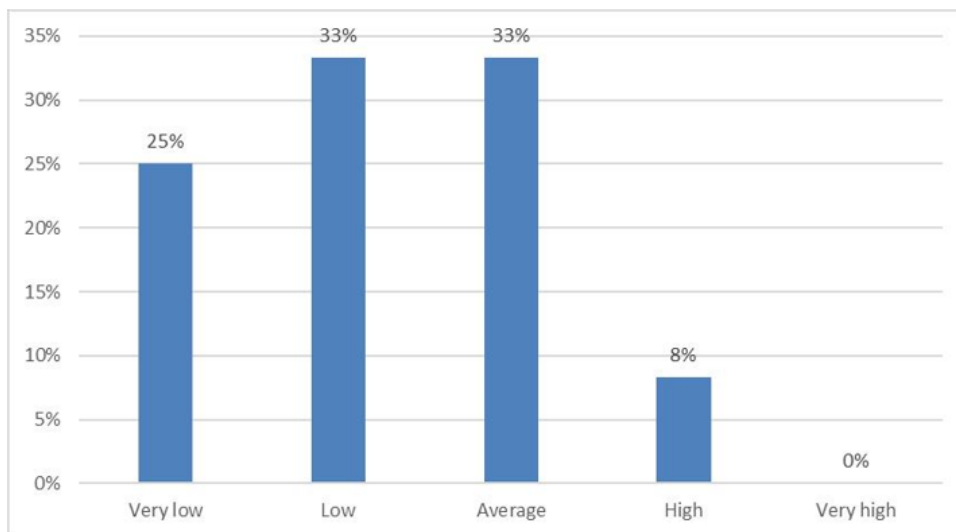
Figure 9. How Would You Evaluate the Degree to Which Your Supply Chain Has Withstood the Impacts of the COVID-19 Pandemic? (%)

Source: Compiled by the authors

These assumptions are also confirmed by the fact that more than half of the respondents appraised the possibility of complete restoration to the previous status quo as highly unrealistic in the next two-three years. These results strongly suggest that COVID-19 significantly impacted the integrity and effectiveness of international supply chains, which confirms the assumptions voiced by Remko (2020) and Sinha et al. (2020).

Figure 10. How Would You Estimate the Probability that Your Supply Chain Would Return to Its Pre-Pandemic Arrangement in the Next Two-Three Years? (%)
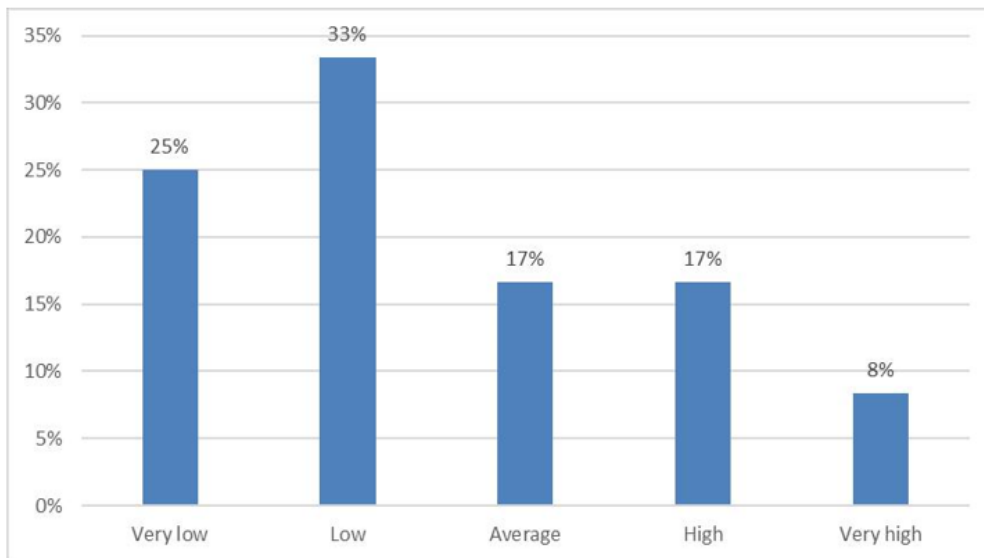
Source: Compiled by the authors

4.2. Supply Chain Resilience before COVID-19. Most respondents appraised their planning quality as high since this factor reportedly had little or no impact on supply chain disruptions during the studied period. It may be in line with the findings of Ivanov and Dolgui (2020) and some of the qualitative statements made by the interviewees that implied that many UK firms were preparing for a hard Brexit. These advance measures ensured their readiness for potential supply chain disruptions associated with border closures or additional delivery delays (Sarkis, 2020).

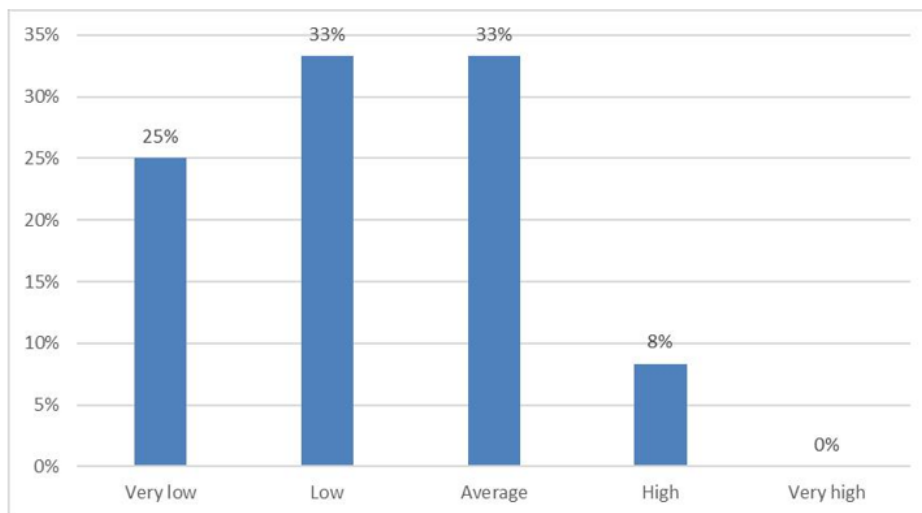**Figure 11. A Lack of Effective Plans for Addressing Supply Chain Disruptions (%)**

Source: Compiled by the authors

Similar results were reported in the field of lead times and delays in delivery. Most of the managers taking part in this study stated that their firms ensured minimal disruptions in this sphere prior to the COVID-19 outbreak, which was in line with the insights provided by Butt (2021).
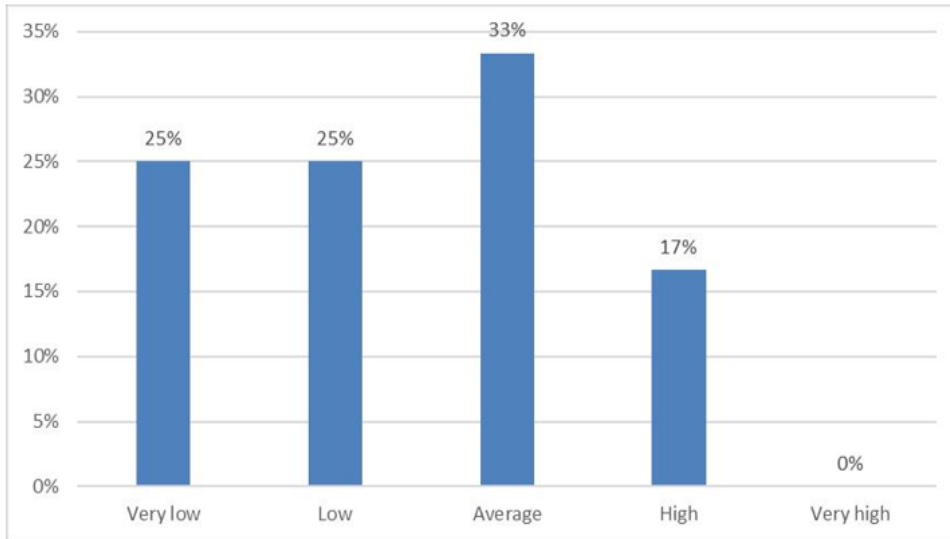
Figure 12. Long Lead Times and Delays in Delivery (%)

Source: Compiled by the authors

On the contrary, raw material prices demonstrated medium levels of fluctuations, despite the provisions taken by the analyzed firms prior to the pandemic. This situation could be partially explained by the factors mentioned by Flynn et al. (2021) and Udofia et al. (2021), such as the increasing economic instability, pound depreciation, and the escalating China-US trade war that affected the procurement stability of UK firms.
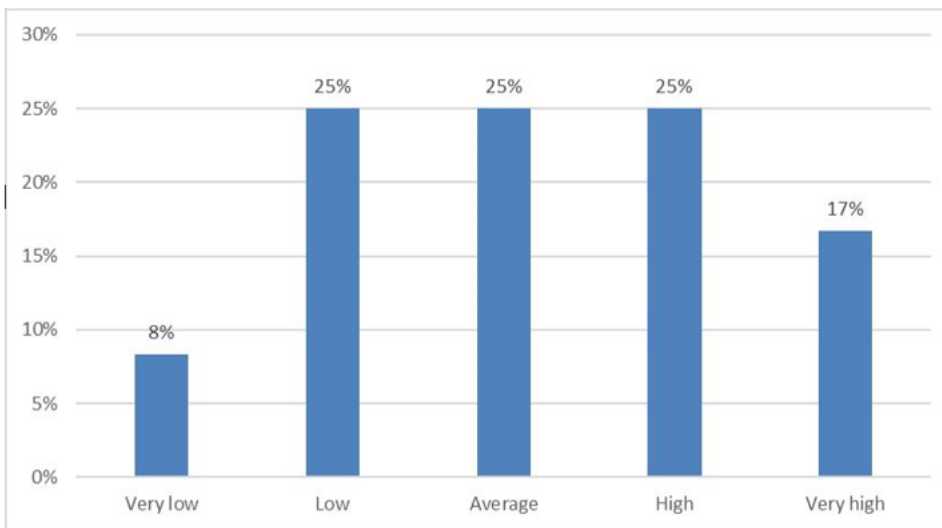
Figure 13. Fluctuations and Increases in Raw Material Prices (%)

Source: Compiled by the authors

Similar results were reported regarding shipment delays and cargo processing operations. The aggregate shares of positive and negative appraisals only differed by 8%, with more respondents stating that problems in this field existed before the pandemic. They could be potentially traced back to the uncertainty related to the UK's participation in the Single EU Market, as well as the insular state of the country hindering the physical transportation of finished products and raw materials (Pujawan and Bah, 2021). On the contrary, only one respondent stated that their firm experienced reductions in manufacturing or production capacities before COVID-19. These statements indicate that the studied organizations maintained sufficient stocks of raw materials and semi-finished products to ensure continuous operations with minimal or no standstill periods in the manner described by Akintokunbo and Adim (2020) and Rizou et al. (2020).

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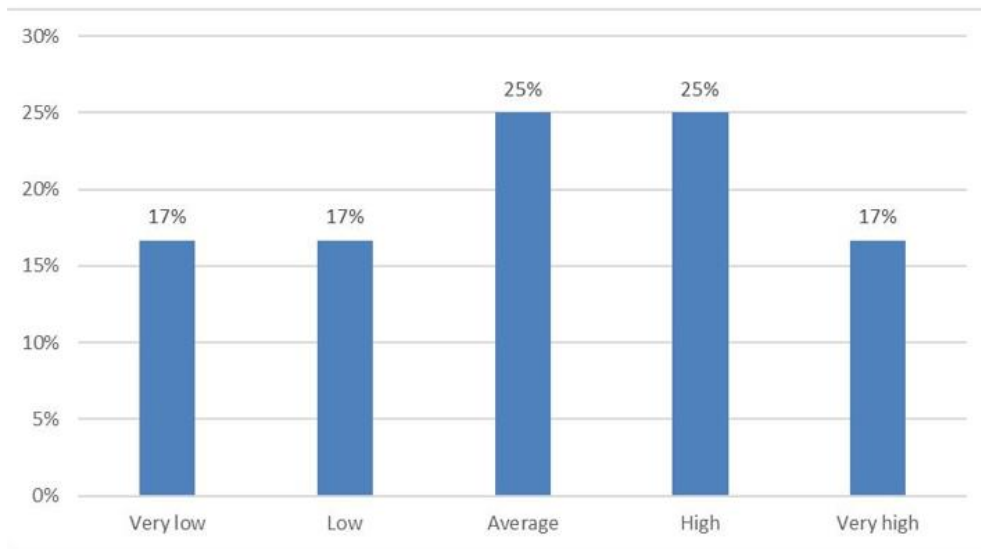
Figure 14. Delays in Shipments and Moving Cargo Processes (%)

Source: Compiled by the authors
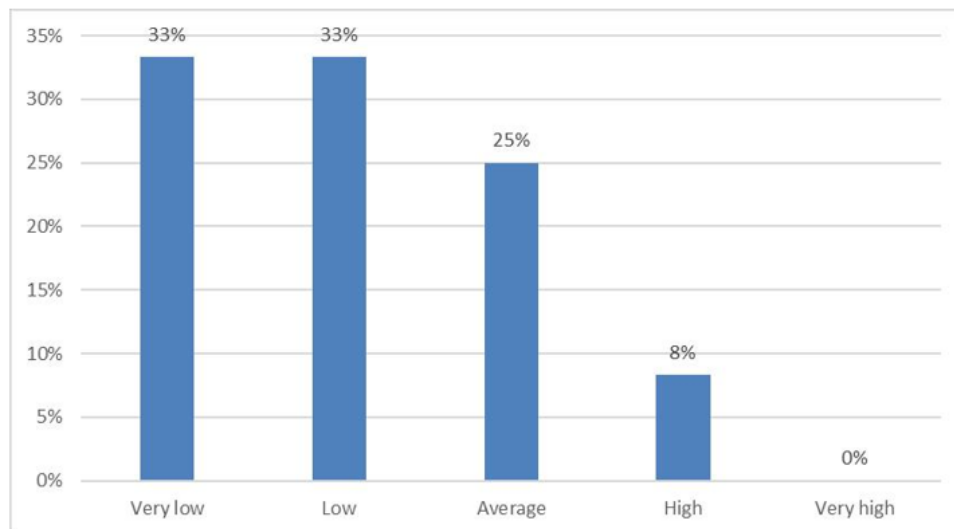
Figure 15. Reductions in Production or Manufacturing Capacities (%)

Source: Compiled by the authors

Minimal problems were also reported in the field of supply chain information availability. As noted by Sharma et al. (2020b), these generally positive results could be linked with increasing online connectivity facilitating all forms of communication between different stakeholders within global networks.

Figure 16. Difficulties in Getting Information and Data about Supply Chain Arrangements (%)

Source: Compiled by the authors

Similarly, only a single respondent noted that they encountered unexpected reductions in profits and returns before COVID-19. The analyzed qualitative responses suggest that these results could be attributed to the practices mentioned earlier by Belhadi et al. (2021) and Paul et al. (2021), such as long-term contracts with fixed prices or the use of relationship management minimizing supplier intentions to change the pricing for their loyal wholesale consumers.

4.3. Supply Chain Resilience after COVID-19. The table below indicates that the complexity of planning for achieving supply chain resilience has increased substantially. This is reflected in substantially higher mean values, as well as the greater maximum score and percentiles.
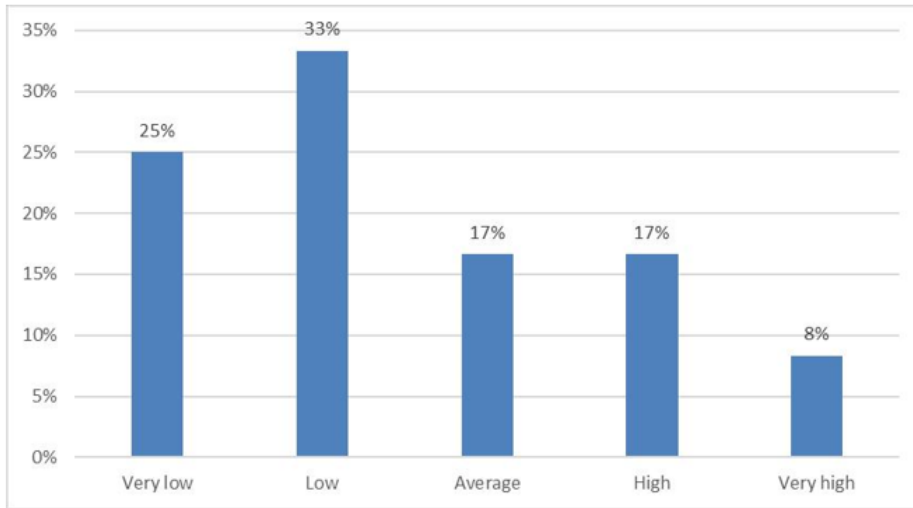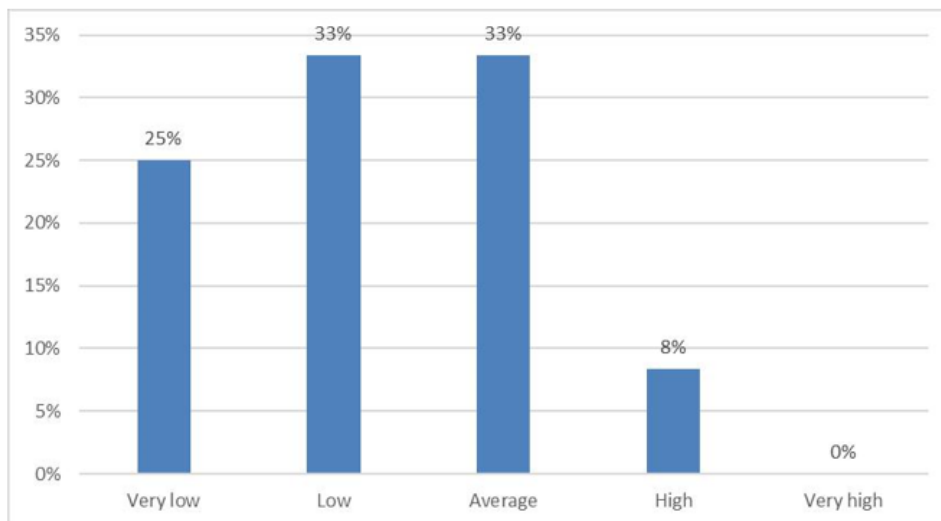

Figure 17. Unexpected Reductions in Returns and Profits (%)

Source: Compiled by the authors

Table 2. A Lack of Effective Plans for Addressing Supply Chain Disruptions (Descriptive Statistics)

	N	Mean	Std. dev.	Min	Max	25th Percentile	Median	75th Percentile
VAR00001	12	2.2500	0.96531	1.00	4.00	1.2500	2.0000	3.0000
VAR00008	12	3.2500	1.21543	1.00	5.00	2.2500	3.0000	4.0000

Source: Compiled by the authors

The Friedman test also reveals a borderline significant p-value of 0.046, lower than 0.05. It suggests that the perceived difficulty of planning for addressing supply chain disruptions has increased over the studied period at the level of the whole sample, which is in line with the assumptions of Mollenkopf et al. (2020).

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Table 3. A Lack of Effective Plans for Addressing Supply Chain Disruptions (Friedman)

N	12
Chi-square	5.444
df	1
Asymp. Sig.	0.020

Source: Compiled by the authors

The second studied factor demonstrated an even higher increase in mean values, minimum and maximum values, and percentiles. Respondent statements strongly suggest that the length of lead times and the number of delays in delivery have sufficiently increased for all studied firms, which is in line with the findings of Sharma et al. (2020b) analyzed earlier.

Table 4. Long Lead Times and Delays in Delivery (Descriptive Statistics)

	N	Mean	Std. dev.	Min	Max	25th Percentile	Median	75th Percentile
VAR00002	12	2.4167	1.08362	1.00	4.00	1.2500	2.5000	3.0000
VAR00009	12	4.0000	0.95346	2.00	5.00	3.2500	4.0000	5.0000

Source: Compiled by the authors

Similarly, Friedman test results demonstrated a similar statistically significant increase of the studied values, which implies that the effect of COVID-19 on this dimension of resilience can be appraised as substantial.

Table 5. Long Lead Times and Delays in Delivery (Friedman)

N	12
Chi-square	7.364
df	1
Asymp. Sig.	0.007

Source: Compiled by the authors

The fluctuations in raw material prices have changed moderately, as shown by the descriptive statistics below. As suggested previously by respondent answers and the qualitative quotes in the thematic analysis, problems in this sphere were already present before the global pandemic. It implies that the resilience measures utilized by the studied firms have kept their performance in this dimension at approximately the same level as before the crisis (Mahajan and Tomar, 2020).

Table 6. Fluctuations and Increases in Raw Material Prices (Descriptive Statistics)

	N	Mean	Std. dev.	Min	Max	25th Percentile	Median	75th Percentile
VAR00003	12	3.1667	1.26730	1.00	5.00	2.0000	3.0000	4.0000
VAR00010	12	3.5833	1.24011	1.00	5.00	3.0000	4.0000	4.7500

Source: Compiled by the authors

These assumptions are confirmed by the Friedman test results revealing no statistically significant changes of the studied indicator.

Table 7. Fluctuations and Increases in Raw Material Prices (Friedman)

N	12
Chi-square	1.333
df	1
Asymp. Sig.	0.248

Source: Compiled by the authors

On the contrary, substantial changes were noted in shipment and moving cargo processes, with the minimum reported value changing from 1 to 3, which was accompanied by similar increases in mean values and percentiles. It confirms the concerns Swanson and Suzuki (2020) voiced about the systemic nature of the emerging problems.

Table 8. Delays in Shipments and Moving Cargo Processes (Descriptive Statistics)

	N	Mean	Std. dev.	Min	Max	25th Percentile	Median	75th Percentile
VAR00004	12	3.0833	1.37895	1.00	5.00	2.0000	3.0000	4.0000
VAR00011	12	4.0833	0.79296	3.00	5.00	3.2500	4.0000	5.0000

Source: Compiled by the authors

These results were further supported by the Friedman test below, demonstrating a p-value lower than 0.05, indicating a statistically significant change in shipment and cargo processing delays. Taking into account the pre-pandemic problems associated with Brexit, the US-China trade war, and other disrupting factors, it suggests that the actual impact of COVID-19 on supply chain resilience in this sphere was stronger than all of these factors due to its systemic nature minimizing the capability to transfer, mitigate, or avoid the emerging risks (Lau, 2020).

Table 9. Delays in Shipments and Moving Cargo Processes (Friedman)

N	14
Chi-square	4.500
df	1
Asymp. Sig.	0.034

Source: Compiled by the authors

Moderate changes were also noted in production or manufacturing capacities reduction. According to mean values, maximum values, and percentiles, most of the studied firms encountered increasing problems in this sphere, which is in line with the findings of Black and Glaser-Segura (2020) and Weber (2021), as well as the qualitative statements made by the interviewees.

Table 10. Reductions in Production or Manufacturing Capacities (Descriptive Statistics)

	N	Mean	Std. dev.	Min	Max	25th Percentile	Median	75th Percentile
VAR00005	12	2.0833	0.99620	1.00	4.00	1.0000	2.0000	3.0000
VAR00012	12	3.0833	1.24011	1.00	5.00	2.0000	3.0000	4.0000

Source: Compiled by the authors

These assumptions were confirmed by the Friedman test results shown below that demonstrate the p-value of 0.34 being lower than 0.05, which suggest a statistically significant increase of the studied indicator.

Table 11. Reductions in Production or Manufacturing Capacities (Friedman)

N	12
Chi-square	4.500
df	1
Asymp. Sig.	0.034

Source: Compiled by the authors

On the contrary, the changes in the sphere of information and data availability were relatively low, as shown by the descriptive statistics table below. This result is generally in line with the qualitative statements of the respondents, as well as the findings of Azzi et al. (2019) and Ivanov (2020). The increasing global connectivity of commercial firms makes it easy to obtain all relevant information on a 24/7 basis, which has not changed substantially since the start of the pandemic.

Table 12. Difficulties in Getting Information and Data about Supply Chain Arrangements (Descriptive Statistics)

	N	Mean	Std. dev.	Min	Max	25th Percentile	Median	75th Percentile
VAR00006	12	2.5000	1.31426	1.00	5.00	1.2500	2.0000	3.7500
VAR00013	12	3.2500	1.21543	1.00	5.00	2.2500	3.0000	4.0000

Source: Compiled by the authors

The results of the Friedman test also demonstrated the p-value of 0.058 being higher than 0.05.

Table 13. Difficulties in Getting Information and Data about Supply Chain Arrangements (Friedman)

N	12
Chi-square	3.600
df	1
Asymp. Sig.	0.058

Source: Compiled by the authors

Finally, the most substantial change was registered in unexpected reductions in returns and profits. According to the results below, minimum values, mean values, and all percentiles have changed substantially, reflecting a significant increase in the studied indicator. It is in line with the statements made by Interviewees 1 and 3, as well as the studies of Baz et al. (2021) and Remko (2020). As noted by these

sources and the qualitative data provided by the respondents, COVID-19 has a systemic effect on multiple stakeholders along the supply chain. At a practical level, it means that commercial firms suffer from the simultaneous influence of delays, consumer refunds due to failed deliveries, increasing prices of suppliers, higher transportation costs, and greater operational costs in general due to the need to maintain social distancing and other complex provisions while attempting to retain the similar levels of profitability.

Table 14. Unexpected Reductions in Returns and Profits (Descriptive Statistics)

	N	Mean	Std. dev.	Min	Max	25th Percentile	Median	75th Percentile
VAR00007	12	2.2500	0.96531	1.00	4.00	1.2500	2.0000	3.0000
VAR00014	12	4.2500	0.75378	3.00	5.00	4.0000	4.0000	5.0000

Source: Compiled by the authors

The identified change was confirmed by the Friedman test results shown below, where the p-value was 0.004, which is substantially lower than 0.05. These outputs indicate the most considerable change among all studied factors in this section, which is in line with the assumptions voiced earlier by Kwon (2020).

Table 15. Unexpected Reductions in Returns and Profits (Friedman)

N	12
Chi-square	8.333
df	1
Asymp. Sig.	0.004

Source: Compiled by the authors

Overall, most of the studied resilience dimensions were substantially affected by COVID-19. It is also confirmed by the results of the thematic analysis provided in Appendix A. All interviewees reported the same sets of problems, including the inability to fulfill their obligations to customers in full and on time, the difficulties associated with procurement from unique suppliers or specific geographic regions, and the financial challenges of additional risk management measures with additional health and safety requirements. As Armani et al. (2020) and Rizou et al. (2020) noted, these activities usually require additional expenses that may be difficult to find in a crisis. Additionally, some interviewees highlighted the existing lock-in effects associated with some regions, countries, or suppliers. These problems have existed in multiple industries since they were mentioned by the manufacturers of electronic products and textile manufacturers. Both respondents noted that they could only procure some raw materials or semi-finished components from a limited number of providers mainly located in China. Moreover, the outsourcing of many production operations to Asian markets has created major dependencies, as described by Interviewee 3,

"In my opinion, the UK manufacturing sector is affected by systemic large-scale problems that cannot be effectively resolved by a single company. We have been outsourcing the production of many components to China for decades. If you are in a medium-to-large-scale manufacturing business working with all sorts of consumer electronics, you cannot avoid the likes of Foxconn and TSMC. There is nothing wrong with that until you face a global crisis such as this one when you can only purchase some parts from a single manufacturer that cannot produce them due to severe lockdowns creating a global semiconductor shortage."

Another substantial challenge emerged as transportation and stock inventory management problems. On the one hand, the insular state of the UK created a natural hindrance to supply chain resilience since both the products from China and those from continental Europe had to be delivered by air freight shipping or sea freight shipping. As noted by Xu et al. (2021), the first option is costly, while the second frequently requires waiting times of 45-50 days on average. It makes the development of redundancies within supply chain networks a problematic measure since high delivery costs make procurement from adjacent countries or regions financially sub-optimal. On the other hand, all respondents mentioned high warehousing costs, citing this strategy as the only viable option for preventing the negative impact of COVID-19 or similar systemic disruptions (Tardivo et al., 2021). Unfortunately, most of the interviewees noted that their companies could not possibly afford such expenses or transfer them to their clients via increased pricing.

4.4. Discussion. The resilience to the pandemic was generally appraised as low or very low, which is in line with the findings of Mollenkopf et al. (2020) and Sharma et al. (2020b). The systemic nature of the crisis mentioned by the interviewees implies that a single firm could not fully prepare for the magnitude of emerging risks, entirely avoid them, or transfer them to third parties. Overall, the analyzed qualitative responses differed in their appraisals of the situation, depending on the specific characteristics of the multinational supply chain rather than specific company preparations. For example, one interviewee noted

that their firm had to procure most of its inputs as semi-finished products from countries such as China and Portugal, which were among the regions affected by COVID-19 to the most significant degree (Alves et al., 2021). Hence, it could not implement any financially feasible precautions other than to purchase large amounts of such items in advance and store them on its premises. On the contrary, the company from the consumer electronics segment effectively implemented this measure due to the smaller size of individual assembly components and the capability to source them from multiple regions, including Europe and the US.

These considerations suggest that a 'one-size-fits-all' approach to building resilience may not be practical since even the limited number of the studied firms varied substantially in terms of their resources, available procurement sources, and customer readiness to accept greater delays or higher prices. It also explained the generally pessimistic predictions of recovery rates among the survey respondents. They are mostly in line with the predictions of financial experts, such as Song and Zhou (2020) and Verschuur et al. (2021), who assume that the overall impact of the pandemic has been distributed across multiple industries and economy segments, which makes it almost impossible for a single firm to improve its financial indicators if the whole ecosystem surrounding it has been severely disrupted. These assumptions were generally confirmed by the analysis of planning effectiveness before and after the pandemic. The results of the conducted Friedman test and survey findings suggest that the perceived capability of such activities to mitigate the encountered risks has decreased substantially over the studied period. It implies a highly pessimistic scenario in which practitioners cannot fully appraise, avoid, or mitigate future risks due to the unprecedented levels of uncertainty in global markets (Sharma et al., 2020b).

This uncertainty was identified in some spheres reflecting the complexity of the current situation. On the one hand, the reported fluctuations in raw material prices were medium. As explained by Remko (2020) and Ryan (2021), UK firms were already affected by Brexit-related uncertainty and other macro-environmental factors, preparing them for potential price fluctuations and forcing them to be more resilient in this dimension. On the other hand, delivery delays, delays in shipments, and cargo processing delays have all increased substantially. This dimension is affected by political regulations, inter-governmental tensions, customs workloads, the closure and opening of national borders, the workloads experienced by international transportation firms, and many other constituent factors. Most of them are beyond commercial firms' reasonable locus of control due to the force-majeure situation in the global market (Flynn et al., 2021). Similarly, many respondents noted substantial reductions in production or manufacturing capacities. According to the interviews, this problem is directly linked to warehousing costs.

For example, an interviewed representative of a textile manufacturing enterprise noted that they could not physically produce raw materials or semi-finished components locally or source them from multiple contractors. They were effectively locked in on two or three countries where specific crops were grown and processed in large quantities. With these markets being severely affected by COVID-19, it was nearly impossible to find alternative procurement sources, which led to major supply chain disruptions (Rizou et al., 2020). Moreover, several interviewees mentioned the challenge of keeping risk management costs at reasonable levels. On the one hand, most analyzed firms could not directly influence the sources of emerging threats, making threat avoidance and reduction less realistic (Nikolopoulos et al., 2021). Hence, they are left with risk acceptance and risk transfer options. The first implies unexpected losses in the worst-case scenario, while the second leads to high costs necessary to mitigate or insure all potential threats.

The earlier mentioned manager from a textile manufacturing company stated that keeping a stock of raw materials sufficient for avoiding the supply chain disruptions of 2020 would make their business unprofitable. Additionally, most of their customers came from the hospitality industry, severely affected by the restrictions. It made price increase a highly unsuitable option since many buyers could not afford to pay extra considering the already incurred financial losses. It created a lose-lose situation for multiple stakeholders within the supply chain, with whole ecosystems and economic sectors unable to resist the systemic impact of COVID-19 without external support from the government (Ivanov and Dolgui, 2020). Additionally, most interviewees noted that unexpected reductions in returns and profits were almost inevitable due to the current situation, which was entirely in line with survey results and the findings of Armani et al. (2020) and Goel et al. (2021). The scope of the crisis could be appraised as extreme in many industries, considering the uncertainty associated with the emergence of new strains and continued restrictions on global transportation in many areas (Flynn et al., 2021). In addition to cargo processing problems, the sourcing of many electronic components was reported as highly problematic due to the reduced production of many semiconductor products and the closure of such plants as MLCC Japan that produce electrolytic capacitors and other items that are in high demand in many industries.

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5. Conclusion

Objective 1 sought to establish the main risks posed by COVID-19 to the existing supply chains established by multinational manufacturers in the UK. The literature analysis and the evaluation of primary quantitative and qualitative data revealed threats such as the difficulty of planning under uncertainty, longer lead times and delays and delivery, fluctuations in raw material prices, and several others (Aday and Aday, 2020; Mahajan and Tomar, 2020). These risks were not unique to the pandemic and were encountered to various degrees by most companies in the market, according to such researchers as Sinha et al. (2020) and Udofia et al. (2021). It informed the need to compare pre-and post-COVID resilience capabilities in the same firms to see how they managed to overcome the encountered problems. The performed analysis revealed that the identified risk dimensions accurately conveyed most of the existing threats associated with supply chain disruptions in the global context (Appendix A).

Objective 2 intended to evaluate whether multinational manufacturing businesses in the UK can learn from challenges faced during the COVID-19 pandemic by referring to the concept of supply chain resilience. The results of the performed thematic analysis and survey data analysis can be viewed as mixed. On the one hand, the respondents noted that the resilience strategies implemented before the pandemic due to the existing threats of hard Brexit and other macro-environmental challenges were generally effective in limiting the impact of COVID-19 on the business operations of their firms. On the other hand, all interviewees agreed that the magnitude of the encountered problems was beyond the reasonable control of individual companies. Inconsistent government actions and policies and the systemic nature of supply chain disruptions effectively made it impossible to avoid or transfer the encountered risks in many situations (Luckstead et al., 2021). Objective 3 was to provide practical recommendations to multinational manufacturers in the UK on how the critical impacts of COVID-19 could be overcome and leveraged as a source of new knowledge in supply chain management. It will be addressed in the following section.

The first research question appraised the key impacts of COVID-19 on the supply chains of UK-based multinational manufacturers and the ways to categorize and define them. The analyzed literature suggested many potential categories, such as planning risks, the risks of delays, reduced production risks, and several others that were defined individually at the Literature Review level and were summarized in the conceptual framework of this study (Remko, 2020; Sarkis, 2020). The second research question investigated how manufacturing firms in the UK leveraged the resilience of their supply chains to react to the global pandemic in supply chain management. The analysis findings suggest that the studied organizations used such strategies as planning, supplier communication, redundancy procurement options, and several others to prepare for Brexit and other potentially disruptive macro-environmental trends (Guan et al., 2020; Wang et al., 2020). While these activities were practical to a certain degree, they could not fully mitigate the impact of the global pandemic on the supply chains of these firms. The third research question sought to identify the essential means and areas of improvement that multinational manufacturers should prioritize in the UK following the COVID-19 pandemic. As suggested by the recommendations section, the main spheres requiring adjustment were procurement choices, inventory management, and customer agreements. However, the insular state of the UK, as well as existing dependencies on China as the sole provider of some raw materials and components, make it challenging to implement effective mitigation strategies for the identified risks in the case of some industries and sectors of the UK economy (Akintokunbo and Adim, 2020; Weber, 2021).

References

1. Aday, S. and Aday, M. (2020). Impact of COVID-19 on the food supply chain. *Food Quality and Safety*, *4*(4), 167-180. [Google Scholar] [CrossRef]
2. Akintokunbo, O. and Adim, C. (2020). COVID-19 and Supply Chain Disruption: A Conceptual Review. *Asian Journal of Economics, Business and Accounting*, *1*(1), 40-47. [Google Scholar] [CrossRef]

3. Alves, J., Soares, P., Rocha, J., Santana, R. and Nunes, C. (2021). Evolution of inequalities in the coronavirus pandemics in Portugal: an ecological study. *European Journal of Public Health*, *1*(1), 1-10. [Google Scholar]

4. Armani, A., Hurt, D., Hwang, D., McCarthy, M., and Scholtz, A. (2020). Low-tech solutions for the COVID-19 supply chain crisis. *Nature Reviews Materials*, *5*(6), 403-406. [Google Scholar] [CrossRef]

5. Azzi, R., Chamoun, R.K., and Sokhn, M. (2019). The power of a blockchain-based supply chain. *Computers & Industrial Engineering*, *135*(1), 582-592. [Google Scholar] [CrossRef]

6. Bairagi, V. and Munot, M. (2019). Research Methodology: A Practical and Scientific Approach. London: CRC Press. 320 p. [Google Scholar]

7. Barry, M., Skinner, J., and Engelberg, T. (2016). Research handbook of employment relations in sport. London: Edward Elgar Publishing. 424 p. [Google Scholar]

8. Baz, E., Rusl, A., and Salomee, R. (2021). Can supply chain risk management practices mitigate the disruption impacts on supply chains' resilience and robustness? Evidence from an empirical survey in a COVID-19 outbreak era. *International Journal of Production Economics*, *233*(1), 1-10. [Google Scholar] [CrossRef]

9. Belhadi, A., Kamble, S., Jabbour, C., Gunasekaran, A., Ndubisi, N., and Venkatesh, M. (2021). Manufacturing and service supply chain resilience to the COVID-19 outbreak: Lessons learned from the automobile and airline industries. *Technological Forecasting and Social Change*, *163*(1), 1-12. [Google Scholar] [CrossRef]

10. Black, S. and Glaser-Segura, D. (2020). Supply Chain Resilience in a Pandemic: The Need for Revised Contingency Planning. *Management Dynamics in the Knowledge Economy*, *8*(4), 325-343. [Google Scholar]

11. Bryman, A. and Bell, E. (2015). *Business Research Methods*, 5th ed., Oxford: Oxford UP. 708 p. [Google Scholar]

12. Butt, A. (2021). Strategies to mitigate the impact of COVID-19 on supply chain disruptions: a multiple case analysis of buyers and distributors. *The International Journal of Logistics Management*, *1*(1), 1-10. . [Google Scholar] [CrossRef]

13. Chrisler, J. and McCreary, D. (2016). Handbook of gender research in psychology, Berlin: Springer. [Google Scholar] [CrossRef]

14. Creswell, J. (2014). Research Design, London: SAGE. 273 p. [Google Scholar]

15. Dobscha, S. (2019). Handbook of Research on Gender and Marketing, London: Edward Elgar Publishing. 352 p. [Google Scholar]

16. Du Toit, D. and Vlok, P. (2014). Supply chain management: A framework of understanding. *South African Journal of Industrial Engineering*, *25*(3), 25-38. [Google Scholar] [CrossRef]

17. Fielding, N., Lee, R., and Blank, G. (2016). The SAGE Handbook of Online Research Methods, London: SAGE. 684 p. [Google Scholar]

18. Flynn, B., Cantor, D., Pagell, M., Dooley, K., and Azadegan, A. (2021). From the Editors: Introduction to Managing Supply Chains Beyond Covid-19-Preparing for the Next Global Mega- Disruption. *Journal of Supply Chain Management*, *57*(1), 3-6. [Google Scholar] [CrossRef]

19. Gaciu, N. (2020). Understanding Quantitative Data in Educational Research, London: SAGE. 376 p. [Google Scholar]

20. Goel, R., Saunoris, J., and Goel, S. (2021). Supply chain performance and economic growth: The impact of COVID-19 disruptions. *Journal of Policy Modeling*, *43*(2), 298-316. [Google Scholar] [CrossRef]

21. Golan, M., Jernegan, L., and Linkov, I. (2020). Trends and applications of resilience analytics in supply chain modeling: systematic literature review in the context of the COVID-19 pandemic. *Environment Systems and Decisions*, *40*(1), 222-243. [Google Scholar] [CrossRef]

22. Grida, M., Mohamed, R., and Zaied, A. (2020). Evaluate the impact of COVID-19 prevention policies on supply chain aspects under uncertainty. *Transportation Research Interdisciplinary Perspectives*, *8*(1), 1-14. [Google Scholar] [CrossRef]

23. Guan, D., Wang, D., Hallegatte, S., Davis, S., Huo, J., Li, S., Bai, Y., Lei, T., Xue, Q., Coffman, D., and Cheng, D. (2020). Global supply-chain effects of COVID-19 control measures. *Nature Human Behaviour*, *4*(6), 577-587. [Google Scholar] [CrossRef]

24. Hanke, T. and Krumme, K. (2012). Risk and resilience in sustainable supply chain management – Conceptual outlines. *Proceedings of the 10. International Logistics & Supply Chain Congress*, 379-388. [Google Scholar]

25. Hasan, F., Hasan, Md. Z., and Islam, M. R. (2022a). COVID-19 movement control effect on the socio-economy: evidence from Bangladesh manufacture industry. *International Journal of Critical Accounting, 12*(6), 531-553. [Google Scholar] [CrossRef]

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26. Hasan, F., Islam, M. R., and Siddique, M. (2022b). Management challenges analyses and information system development in SMEs due to Covid 19 fallout: Prescriptive case study. *International Journal of Critical Accounting*. (In Press). Available at: [Link]

27. Ivanov, D. (2020). Viable supply chain model: integrating agility, resilience and sustainability perspectives − lessons from and thinking beyond the COVID-19 pandemic. *Annals of Operations Research*, *4*(1), 1-21. [Google Scholar] [CrossRef]

28. Ivanov, D. and Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, *58*(10), 2904-2915. [Google Scholar] [CrossRef]

29. Jawaad, M. and Zafar, S. (2020). Improving sustainable development and firm performance in emerging economies by implementing green supply chain activities. *Sustainable Development*, *28*(1), 25-38. [Google Scholar] [CrossRef]

30. Karadayi-Usta, S. and Asan, S. (2014). A framework for service supply chain management literature. *Joint International Symposium on CIE'44 and IMSS'14*, 1-14. [Google Scholar]

31. Kaushik, V. and Walsh, C. (2019). Pragmatism as a research paradigm and its implications for social work research. *Social Sciences*, *8*(9), 1-17. [Google Scholar] [CrossRef]

32. Kwon, O. (2020). How is the COVID-19 Pandemic Affecting Global Supply Chains, Logistics, and Transportation? *Journal of International Logistics and Trade*, *18*(3), 107-111. [Google Scholar] [CrossRef]

33. Larson, R. (2019). Controlling social desirability bias. *International Journal of Market Research*, *61*(5), 534-547. [CrossRef]

34. Lau, L. (2020). The Impacts of the Trade War and the COVID-19 Epidemic on China-U.S. Economic Relations. *China Review*, *20*(4), 1-38. [Google Scholar]

35. Luckstead, J., Nayga Jr, R., and Snell, H. (2021). Labor issues in the food supply chain amid the COVID-19 pandemic. *Applied Economic Perspectives and Policy*, *43*(1), 382-400. [Google Scholar] [CrossRef]

36. Magableh, G. (2021). Supply Chains and the COVID-19 Pandemic: A Comprehensive Framework. *European Management Review*, to be published. [Google Scholar]

37. Maguire, M. and Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education*, *9*(3), 3353-33514. [Google Scholar]

38. Mahajan, K. and Tomar, S. (2020). Here Today, Gone Tomorrow: COVID-19 and Supply Chain Disruptions. *Forthcoming, American Journal of Agricultural Economics*, to be published. [Google Scholar]

39. Modgil, S., Gupta, S., Stekelorum, R., and Laguir, I. (2021). AI technologies and their impact on supply chain resilience during COVID-19. *International Journal of Physical Distribution & Logistics Management*, to be published. [Google Scholar]

40. Mollenkopf, D., Ozanne, L., and Stolze, H. (2020). A transformative supply chain response to COVID-19. *Journal of Service Management*, *32*(2), 190-202. [Google Scholar] [CrossRef]

41. Nikolopoulos, K., Punia, S., Schafers, A., Tsinopoulos, C., and Vasilakis, C. (2021). Forecasting and planning during a pandemic: COVID-19 growth rates, supply chain disruptions, and governmental decisions. *European Journal of Operational Research*, *290*(1), 99-115. [Google Scholar] [CrossRef]

42. Paul, S., Chowdhury, P., Moktadir, M., and Lau, K. (2021). Supply chain recovery challenges in the wake of COVID-19 pandemic. *Journal of Business Research*, *136*(1), 316-329. [Google Scholar] [CrossRef]

43. Pujawan, I. and Bah, A. (2021). Supply chains under COVID-19 disruptions: literature review and research agenda. *Supply Chain Forum: An International Journal*, *1*(1), 1-15. [Google Scholar]

44. Remko, V. (2020). Research opportunities for a more resilient post-COVID-19 supply chain – closing the gap between research findings and industry practice. *International Journal of Operations & Production Management*, *40*(4), 341-355. [Google Scholar] [CrossRef]

45. Rizou, M., Galanakis, I., Aldawoud, T., and Galanakis, C. (2020). Safety of foods, food supply chain and environment within the COVID-19 pandemic. *Trends in Food Science & Technology*, *102*(1), 293-299. [Google Scholar] [CrossRef]

46. Sarkis, J. (2020). Supply chain sustainability: learning from the COVID-19 pandemic. *International Journal of Operations & Production Management*, *41*(1), 63-73. [Google Scholar] [CrossRef]

47. Saunders, M., Lewis, P., and Thornhill, A. (2016). Research Methods for Business Students, 7th ed., Harlow: Pearson Education Limited. 872 p. [Google Scholar]

48. Sharma, A., Adhikary, A., and Borah, S. (2020a). Covid-19′s impact on supply chain decisions: Strategic insights from NASDAQ 100 firms using Twitter data. *Journal of Business Research*, *117*(1), 443-449. [Google Scholar] [CrossRef]

49. Sharma, R., Shishodia, A., Kamble, S., Gunasekaran, A., and Belhadi, A. (2020b). Agriculture supply chain risks and COVID-19: mitigation strategies and implications for the practitioners. *International Journal of Logistics Research and Applications*, *18*(1), 1-27. [Google Scholar] [CrossRef]

50. SILO (2021). BAM Code of Ethics and Best Practice [online]. Available at: [Link]

51. Sim, J., Saunders, B., Waterfield, J., and Kingstone, T. (2018). Can sample size in qualitative research be determined a priori? *International Journal of Social Research Methodology*, *21*(5), 619-634. [Google Scholar] [CrossRef]

52. Sinha, D., Bagodi, V., and Dey, D. (2020). The Supply Chain Disruption Framework Post COVID-19: A System Dynamics Model. *Foreign Trade Review*, *55*(4), 511-534. [Google Scholar] [CrossRef]

53. Song, L. and Zhou, Y. (2020). COVID-19 Pandemic and Its Impact on the Global Economy: What Does It Take to Turn Crisis into Opportunity? *China & World Economy*, *28*(4), 1-25. [Google Scholar] [CrossRef]

54. Statista (2021). How have you supply chain operations been affected by COVID-19? [online]. Available at: [Link]

55. Sullivan, S. (2019). Supply Chain Disruption: Aligning Business Strategy and Supply Chain Tactics, London: Kogan Page Publishers. 267 p. [Google Scholar]

56. Ryan, J. (2021). London struggles with Brexit and COVID-19 – despite the vaccines [online]. Available at: [Link]

57. Swanson, D. and Suzuki, Y. (2020). COVID-19 Carves New Facets of Supply Chain Disruption. *Transportation Journal*, *59*(4), 325-334. [Google Scholar] [CrossRef]

58. Tardivo, A., Zanuy, A., and Martin, C. (2021). COVID-19 Impact on Transport: A Paper from the Railways' Systems Research Perspective. *Transportation Research Record: Journal of the Transportation Research Board*, *2675*(5), 367-378. [Google Scholar]

59. Thaiprayoon, K., Mitprasat, M., and Jermsittiparsert, K. (2019). Sustainability Consciousness Dimensions for Achieving Sustainability Performance in Thailand: Role of Supply Chain Resilience. *Int. J Sup. Chain. Mgt Vol*, *8*(5), 622-634. [Google Scholar]

60. Tripathi, S. and Gupta, M. (2021). Indian supply chain ecosystem readiness assessment for Industry 4.0. *International Journal of Emerging Markets*, to be published. [Google Scholar]

61. Udofia, E., Adejare, B., Olaore, G., and Udofia, E. (2021). Supply disruption in the wake of COVID-19 crisis and organisational performance: mediated by organisational productivity and customer satisfaction. *Journal of Humanities and Applied Social Sciences*, *1*(1), 1-20. [Google Scholar]

62. UoY (2021). Research integrity and ethics [online]. Available at: [Link]

63. Verschuur, J., Koks, E., and Hall, J. (2021). Global economic impacts of COVID-19 lockdown measures stand out in high-frequency shipping data. *PLoS One*, *1*(1), 1-16. [Google Scholar]

64. Walliman, N. (2017). Research Methods: The Basics, London: Routledge. 147 p. Available at: [Link]

65. Wang, Y., Wang, J., and Wang, X. (2020). COVID-19, supply chain disruption and China's hog market: a dynamic analysis. *China Agricultural Economic Review*, *12*(3), 427-443. [Google Scholar] [CrossRef]

66. Weber, A. (2021). Responding to supply chain disruptions caused by the COVID-19 pandemic: A Black Swan event for omnichannel retailers. *Journal of Transport and Supply Chain Management*, *15*(1), 1-16. [Google Scholar] [CrossRef]

67. Wieland, A. and Durach, C. (2021). Two perspectives on supply chain resilience. *Journal of Business Logistics*, *42*(3), 1-14. [Google Scholar] [CrossRef]

68. Xu, Y., Li, J., Chu, C., and Dinca, G. (2021). Impact of COVID-19 on transportation and logistics: a case of China. *Economic Research*, *1*(1), 1-20. [Google Scholar] [CrossRef]

69. Zailani, S., Iranmanesh, M., Foroughi, B., Kim, K., and Hyun, S. (2020). Effects of supply chain practices, integration and closed-loop supply chain activities on cost-containment of biodiesel. *Review of Managerial Science*, *14*(6), 1299-1319. [Google Scholar] [CrossRef]

Appendix A

Thematic Analysis		
Categories	**Themes**	**Quotes**
1. Pre-pandemic problems	1.1. Transportation problems	"Like most companies, we experienced some supply chain interruptions from time to time due to contractor problems, warehousing problems or customs clearance problems." (Interviewee 1)
	1.2. Region-specific problems	"While we try to purchase most of our materials from EU suppliers, a lot of them come from China and other markets, which introduces additional delays. They were usually longer during busy periods and national holidays such as the Chinese New Year or the Christmas period in the UK." (Interviewee 1) "Naturally, the first months following the virus outbreak led to a complete standstill in most operations with China." (Interviewee 1)
2. Post-pandemic problems	2.1. Region-specific problems	"Since we primarily use linen and cotton for manufacturing our products, we have to source the majority of our raw materials from such countries as China or Portugal with some items being purchased from European contractors. You can imagine the consequences of the hard lockdown in China and Portugal as the native countries of our main providers." (Interviewee 2) "Well, naturally, the lockdowns and border closures affected both our inputs and outputs. On the one hand, we were unable to receive some previously ordered components from China." (Interviewee 3)
	2.2. Transportation and procurement problems	"As no one knew how COVID-19 was transmitted, all transport companies and customs offices sought to closely inspect all shipments, apply aggressive detergents to their packaging where possible, and store all goods for some time to minimize the risks of COVID-19 transmission." (Interviewee 1) "Our peers involved in other spheres of manufacturing do not have this advantage. I have a colleague working at the Vauxhall Motors factory in Bedfordshire that is presently owned by PSA. They experienced much greater problems due to the inability to stock critical components in sufficient volumes." (Interviewee 3)
	2.3. Problems related to customer obligations	"This had a devastating effect on some of our obligations due to the inability to obtain some critical shipments or even track them effectively in the developing chaos of lost deliveries and increasingly overloaded customs processing systems." (Interviewee 1) "Hence, COVID-19 was a 'perfect storm' to us. We could not purchase the necessary materials, could not meet our obligations, incurred massive reputational damage, and could not establish alternative procurement options since the pandemic stroke most of our partners simultaneously. What is even worse, the hospitality sector was hit even harder with no local or international travelers using their services in 2020. By late 2021, many of our past customers have gone bankrupt while many others are on the verge of joining them." (Interviewee 2) "From our customer standpoint, we informed most of the clients about potential delays reaching 2-3 weeks on average as soon as the crisis broke out. In our practice, early warnings and open communication are critical for avoiding backlash and dissatisfaction. As a result, only several pre-orders were cancelled in 2020." (Interviewee 3)
	2.4. Problems related to political interventions	"This coin also had the other side when the UK strain was discovered. Many countries were angry with the UK due to the harshness of the original measures and introduced similar ones against us, which substantially complicated our deliveries to many countries." (Interviewee 1)
	2.5. Dependence on unique suppliers	"Hence, COVID-19 was a 'perfect storm' to us. We could not purchase the necessary materials, could not meet our obligations, incurred massive reputational damage, and could not establish alternative procurement options since the pandemic stroke most of our partners simultaneously." (Interviewee 2) "There is nothing wrong with that until you face a global crisis such as this one when you can only purchase some parts from a single manufacturer that cannot produce them due to severe lockdowns creating a global semiconductor shortage." (Interviewee 3) "The closure of many factories there effectively means that western manufacturers have no semiconductor components to put into your automotive vehicle, audio system, gaming PC or a new smartphone. You can only stock such parts in advance and go on s shopping spree every time you expect a future shortage. This is the only strategy if your company name is not Intel and you have no spare resources to build or purchase your own manufacturing plant." (Interviewee 3)

3. Supply chain resilience	3.1. Brexit-related preparation	"In my opinion, we did pretty well consider the magnitude of the problem. We were already preparing for potential Brexit-related complications of clearance procedures. This forced us to optimize all of our routes and customs processing practices to get ready for the worst-case scenario such as the hard Brexit with the UK leaving the Single EU Market. While we did not know it then, this prepared us for the COVID-19 turmoil." (Interviewee 1)
	3.2. Stocking of raw materials	"We managed to use our past stocks of materials, rely on some redundant procurement sources, and meet most of our obligations to our end customers." (Interviewee 1) "This is a highly competitive sphere but we had a solid share of the UK market for many years due to the consistently high quality of our offerings. We achieved that by continuously monitoring our partners, sourcing the best materials, and always maintaining a stock of popular products to minimize the risks of non-delivery." (Interviewee 2)
	3.3. Benefits of increased resilience	"This actually won us some new clients as a result since we were more resilient in this aspect than many of our direct competitors who could only offer their clients to wait for an unspecified period of time due to the lack of control over the whole force majeure situation." (Interviewee 1)
	3.4. Alternative procurement options	"...we established contact with our additional suppliers from the EU and negotiated new procurement contracts to replace our Chinese deliveries. This was especially effective considering the further growth of prices caused by the semiconductor crisis of 2020." (Interviewee 1) "This required additional procurement and shipping expenses but this coping measure was not radically different from a regular delivery failure that occurs from time to time. We have measures in place for that." (Interviewee 3)
	3.5. Regulatory compliance	"...we thoroughly studied all compliance documentation published by the UK government and provided in-depth training to all our employees on handling potentially dangerous materials and maintaining social distancing at all times." (Interviewee 1) "As soon as the pandemic started, we followed all state recommendations such as purchasing personal protective equipment, maintaining social distancing or minimizing social contacts where possible." (Interviewee 2)
	3.6. Health and safety provisions	"It literally took our managers several days to read all available medical articles about the problem, make informed procurement decisions, negotiate new deals with our partners, and identify the optimal FFP2 and FFP3 protective masks with the best benefit-cost ratio." (Interviewee 1) "We implemented remote work arrangements for all of our designers, customer service specialists, and sales managers as early as April 2020 to minimize risks and only kept critical production personnel on our premises." (Interviewee 2) "In addition to our traditional measures such as keeping a sufficient stock of all critical components, we introduced additional cleaning and hygiene precautions and set up more shifts to reduce the number of personnel members working on our premises simultaneously." (Interviewee 3)
	3.7. Financial feasibility of greater resilience	"Additional warehousing expenses did not seem like a reasonable expense option then." (Interviewee 1) "I am afraid that no amount of supply chain resilience can prepare the companies such as ours for a systemic crisis of this scope. ... This is economically unviable, especially if you add the costs of warehouse storage for all these items." (Interviewee 2)
4. Role of the government	4.1. Government as a disruptor	"If you want a sincere answer, I think that the UK government has been the main disrupting factor during all these months. I do understand that the whole situation is incredibly unpredictable and extreme by its nature with new facts about COVID-19 emerging every month but there is a fine line between complexity and incompetence." (Interviewee 1)
5. Potential improvements	5.1. Greater inventory stocking and redundancy planning	"Looking back, I would have established a greater number of redundant contracts and would have stocked more critical components and spare parts." (Interviewee 1) "As I have already said, the only possible solution I see is to keep a larger stock of raw materials in the UK. However, this would substantially decrease our profit margins and could be as threatening to our long-term survival as the current situation." (Interviewee 2)
	5.2. Alternative procurement options	"I would probably revise the way our production line operates and negotiate some different procurement conditions." (Interviewee 3)

Source: Compiled by the authors