Impact of Digital Technology on Supply Chain management during the COVID-19 Pandemic Restriction

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Copyright Declaration

Abstract

Background: The COVID-19 epidemic has caused unprecedented hurdles to the global supply chain. Supply chain management procedures have been re-evaluated because to this crisis's exposure of network vulnerabilities. Digital technology has become essential for supply chain resilience and agility in the face of disruptive occurrences. Understanding the pandemic, supply chain dynamics, and digital technology is crucial for post-pandemic strategic decision-making.

Research objective: This research objective to examine the impact of the COVID-19 pandemic on global supply chains and the role of digital technologies in enhancing resilience during crises. This study analyses disruptions, operational issues, and digital solutions to help organisations manage supply chains in turbulent circumstances.

Research Method: A systematic literature review based research is conducted that analysed the effects of COVID-19 on global supply chains and the use of digital technology to alleviate disruptions. Peer-reviewed articles, reports, and case studies were analysed to identify pandemic-related supply chain management themes, trends, and best practices. Literature synthesis helped explain the intricate linkages between the pandemic, supply chain operations, and digital change.

Findings: The study found COVID-19 pandemic disturbances in global supply chains. Logistics, labour shortages, demand fluctuations, and inventory management caused organisations to struggle. Using big data analytics, IoT, cloud computing, and AI has helped companies address these challenges. Supply chain visibility, agility, and risk management improve with real-time data, predictive analytics, and optimisation.

Conclusion: This study showed that digital technology improves supply chain resilience and business continuity amid crises. Digital transformation and supply chain collaboration help develop resilient supply chains that can withstand disruptions. This research can assist practitioners and policymakers strengthen supply chains post-pandemic.

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Chapter 1

Introduction

1.1 Background

The onset of the COVID-19 in 2020 had a profound and devastating impact on supply systems worldwide (Sharma, Adhikary and Borah, 2020). The event transpired in an unforeseeable manner during the year 2020, manifesting in successive surges over various geographical areas. The pandemic revealed several weaknesses in supply networks, leading to a unique combination of simultaneous interruptions that created ripple effects and other types of severe disturbance (Dolgui, Ivanov and Sokolov, 2018). Epidemic outbreaks, like COVID-19, present a unique type of risk to supply chains. They disrupt supply, demand, and logistics infrastructure, and supply chain (known as the ripple effect) and the spread of the epidemic within the population (Ivanov and Dolgui, 2020). The COVID-19 pandemic has significantly altered the operating circumstances of several companies and supply chains to an unparalleled extent (Queiroz et al., 2022). Companies have been compelled to acquire the skills necessary to function in a profoundly volatile and capricious setting (Mehrotra et al., 2020). Amidst the epidemic, corporations have extensively grappled with the notion of resilience, which has emerged as a pivotal perspective in supply chain management (Paul and Chowdhury, 2021). In the starting months, the COVID-19 epidemic has disrupted global supply lines, stalled economies, and posed challenges to environmental sustainability (Ivanov, 2021a).

Supply of raw materials, intermediates, and finished products has been disrupted. Global supply chains, formerly known for their strong durability and ability to withstand various disturbances in recent years, are now really undermined (Ullah, 2021). Amidst the global coronavirus pandemic, leaders are urgently striving to formulate effective responses. There is a growing body of study being conducted to address this extraordinary catastrophe that humanity has never encountered previously (Xu et al., 2020). In the 21st century, there has been a significant technological breakthrough known as Industry 4.0, as well as a worldwide epidemic called COVID-19. Nevertheless, contemporary supply chains were formulated at a period of efficient management and worldwide integration, and they currently confront the obstacle of adjusting to these ground-breaking advances (Dolgui, Ivanov and Sokolov, 2020). These supply networks are primarily characterised by fixed architecture and lack the flexibility to withstand and adjust to challenges (Ivanov, 2021b).

However, the changes have already started and need careful analysis to influence the development of future supply networks. Given the COVID-19 pandemic, there has been a growing focus among researchers and practitioners on the significance of digital technologies in achieving complete visibility throughout supply chains. These technologies have the potential to enhance resilience (Dubey et al., 2021).

1.2 Rationale

This study will employ a thorough literature review. It involves finding and selecting relevant studies, assessing their contributions, analysing and synthesising the data, and presenting the evidence in a way that allows clear conclusions about existing knowledge (Denyer and Tranfield, 2009). A systematic literature review updates practitioners on management information. This knowledge can be used to limit options and make informed decisions (Tranfield, Denyer and Smart, 2003). This study aims to justify the research by examining how digital technology affects supply chain management during the COVID-19 pandemic. The study examines the complex relationship between the COVID-19 and digital technology's impact on global supply chains and their management.

Hald and Coslugeanu (2022) examined the COVID-19 pandemic's effects on global supply networks and their management. They seek to understand the COVID-19 pandemic's causes, effects, and solutions for global supply networks. The main goal is to demonstrate how digital technology defined and managed global supply chain disruptions during the COVID-19 pandemic. A systematic review of published works underpins their analysis. Their work provided a new theoretical understanding of the COVID-19 disruption's collective supply chain effects. The study finds six supply chain weaknesses, six resilience capabilities, and seven technological clusters that can mitigate COVID-19 disruptions. Their study also offers management decision-making tips for overcoming future disruptions. The purpose is to incorporate this study into the reasoning to explore how digital technology affects pandemic supply chain management. This study focused on understanding, examining, and expanding Hald and Coslugeanu (2022)'s knowledge of global supply chains and their digital changes during a pandemic.

Problem statement

The problem statement of this study is to evaluate the effectiveness of digital technology in mitigating the disruptions and enhancing the resilience of supply chain management during the COVID-19 pandemic.

1.3 Aim

The main aim of this study is to evaluate the impact of Digital Technology on Supply Chain management during the COVID-19 Pandemic.

1.4 Objectives

I. To assess the effects of the COVID-19 pandemic on worldwide supply systems, including interruptions and the ability to recover.
II. To analyse the operational issues in the supply chain during the COVID-19 pandemic, while identifying significant obstacles and necessary adjustments.
III. The objective is to find out how much digital technology improved supply chains to endure and recover from the COVID-19 pandemic's unique challenges.

1.5 Research questions

I. What were the effects of the COVID-19 pandemic on global supply networks, including disruptions and resilience capabilities?
II. What were the operational hurdles encountered in supply chains during the pandemic?
III. How did digital technology improve supply chain resilience during the COVID-19 pandemic?

1.6 Significance of research

The COVID-19 in 2020 had a profound impact on worldwide supply networks, leading to significant disruptions in supply management. Various operational obstacles were encountered during this period. The unprecedented and capricious character of the pandemic has emphasised the necessity for a thorough comprehension of how supply networks have managed these problems and the insights they have acquired in the course of action. In order to understand these issues and their corresponding solutions, this study will conduct a thorough analysis of the pandemic's influence on supply chains. It will specifically examine the interruptions, operational obstacles. This study seeks to clarify the complex connection between the pandemic and supply chain dynamics by analysing existing knowledge in a systematic literature review. The goal is to provide practical insights that will help decision-making and strengthen supply chains in the face of future uncertainties.

1.7 Research methodology and scope

The study evaluates the role of digital technology during the COVID-19 pandemic in the supply chain management through a literature review method that is systematic. This section discusses

interruptions, operational challenges, and adaptability through perusing the existing literature in order to clarify the nuances that exist between the COVID-19 pandemic, digital technology, and supply chain dynamics. The strategy consists of formulating the research questions, developing the search strategy, selecting the studies matching the set criteria, compiling and summarizing the data, and presenting the results. The primary objective is to investigate how digital technology shaped the resilience of supply chain in pandemic times applying a systematic model. It aims to help in understanding of the theory and practice of supply chain management.

1.8 Underpinning Theory

The underlying theories of digitalization are crucial for understanding the relationships that exist between the digitization initiatives and the supply chain outcomes of performance when considering digital transformation and the specialty field of supply chain management (SCM). The cornerstone of our research is the resource-based view (RBV) (Barney, 2001), which essentially serves as our technical glasses through which we can observe the ways in which the unique digital resources and capabilities firms possess ensure their competitiveness and ultimately the superiority of their supply chain (Barney, 2001; Hitt, Xu and Carnes, 2016; Q In this digital era, businesses need to employ digital technologies in alignment with the supply chain`s specific requirements to ensure that they are in good standing with the niche (Teng, Wu and Yang, 2022). RBV comes in handy through examination on which companies are able to stand out and employ digital tools within the supply chain to improve coordination, speed up processes and create value, whilst others might struggle to utilize these benefits (Nandi et al., 2020).

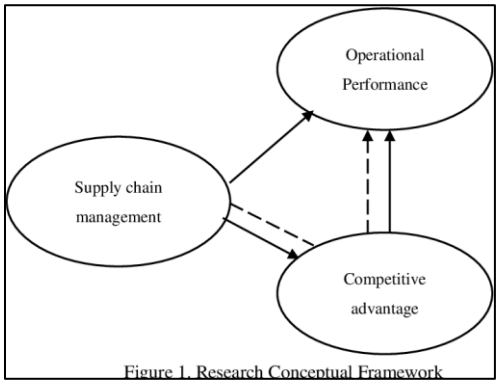

Figure 1. Research Conceptual Framework

1.9 Project structure

I. The first chapter, serving as the introduction, encompasses all the significant aspects related to the subject matter. The objective of this section is to establish the foundation for the upcoming research study by presenting pertinent background information and knowledge. This section of the study provides an overview of the background, rationale, objectives, research query, and importance of the study.

II. This chapter will be followed by a comprehensive review of relevant literature. This section will expound upon an objective that was previously discussed in the preceding chapter, utilising a range of previously published studies. By utilising academic search engines, all relevant literature will be gathered and organised.

III. The third section of the study comprises the research methodology. In this particular chapter, the researcher will acquire knowledge about the diverse methodologies that will be employed to effectively accomplish this study. The course will encompass topics such as data extraction, data synthesis, research methods, research types, and other related components.

IV. Chapter 4 will include an examination and conversation about data analysis. The subsequent discourse pertains to the objectives that will be achieved. This chapter will present the data that has been extracted from specific research. The discussion will primarily focus on the correlation between the literature review and the analysis.

V. Ultimately, this is where the study will present its final and comprehensive conclusion. This section will address the study's potential for future development, establish a correlation between the objectives and the recommendations, and provide a concise summary of the study.

1.10 Timing Plan

Chapter	**Timing**
Introduction	5 February
Literature review	26 February
Methodology	26 February
Findings and analysis	15 March
Conclusion	25 March
Proofreading	5 April
Submission	12 April

Chapter 02

Literature review

2.0 Introduction

Chapter 02 delves into an extensive examination of Supply Chain Management (SCM). The journey commences by examining the underlying principles of Supply Chain Management (SCM), clarifying its core concept as the integration of various business activities with the goal of providing value-added products, services, and information to end-users. After that, we explore the efficacy of supply chain management (SCM) strategies, emphasising their contribution to improving productivity, responsiveness, and flexibility. Then we explore the interruptions and problems faced by global supply chains during the COVID-19 pandemic, examining the many implications and the need for resilience mechanisms. The chapter also highlights the crucial importance of digital technology in supply chain management (SCM), demonstrating its ability to significantly enhance supply chain resilience and agility, particularly in the face of disruptive events such as the COVID-19 pandemic. In this chapter, we combine academic knowledge, providing readers with a guide to traverse the complex field of supply chain management in today's corporate world.

2.1 Supply Chain Management

According to Galaskiewicz (2011), supply chain management (SCM) is the process of coordinating company operations between initial suppliers and end users to provide products, services, and information that provide value for clients. According to Lalonde (1998), this holistic strategy involves a network of diverse enterprises involved in the production and distribution of goods, such as manufacturers of raw materials and components, product assemblers, wholesalers, retailers, merchants, and carriers. Supply chain management (SCM) encompasses a wide range of operations aimed at optimising the flow of commodities, information, and resources along the whole supply chain network. According to Tan, Kannan, and Handfield (1998), these efforts include forming partnerships with suppliers, contracting out processes, reducing cycle times, optimising workflows, and encouraging the exchange of information and technology. In order to effectively and financially meet customer expectations, supply chain management (SCM) also includes managing the integration and coordination of supply, demand, and connections. According to Kouvelis, Chambers, and Wang (2006) and

Mentzer et al. (2001), it also entails strategically planning and coordinating across companies, encouraging internal collaboration between functions, and coordinating the manufacturing, logistics, materials, distribution, and transportation functions within organisations.

2.2 Effectiveness of Supply Chain Management

The efficacy of supply chain management (SCM) techniques is determined by their capacity to improve the productivity, responsiveness, and flexibility of supply chain activities. A variety of activities are included in effective supply chain management practices, such as performance measurement and supplier assessment to find gaps and put improvement plans into action. These plans usually include performance goals, site visits, supplier product and process certification, measurement of delivery, quality, and cost performance (Krause and Scannell, 2002). Furthermore, aspects like integration, information sharing, client service traits, physical proximity, and just-in-time inventory management capabilities are prioritised in successful supply chain management practices (Chen and Paulraj, 2004). Additionally, by integrating suppliers in the planning and problem-solving processes for products and services, strategic supplier partnerships are essential for attaining long-term benefits, guaranteeing cost effectiveness, and successfully managing customer relationships (Stuart, 1997) In the end, efficient SCM procedures help to preserve good customer relations by quickly resolving client issues and offering prompt solutions to suit their requirements (Tan, Lyman and Wisner, 2002). In short, Supply Chain Management (SCM) emphasised its crucial role in promoting corporate performance in the modern interconnected global environment. SCM, or supply chain management, is essential for organisations in various industries as it helps optimise operations, promote collaboration, and drive innovation. It is a key factor in achieving sustainable growth and gaining a competitive edge. By adopting efficient supply chain management (SCM) processes and fostering strategic alliances, firms may successfully negotiate intricate supply chain environments, fulfil growing client requirements, and prosper in a dynamic global market.

2.3 Supply chain management during COVID-19

Supply Chain Management in the Context of the COVID-19 Pandemic and Economic Downturn is a multi-disciplinary body of work. First, theoretical works that resemble traditional supply chain disruption research suggest models that describe COVID-19 as a combination of external shocks that impact the volume of supply, producer productivity, and

the final demand mix (Baqaee and Farhi, 2020; Ivanov and Das, 2020; Paul and Chowdhury, 2021). Nevertheless, the lack of empirical data in these theoretical models limits their practical applicability.

Empirical studies, on the other hand, estimate how the pandemic will affect supply chains; these studies specifically focus on medical supplies, PPE, and the supply chains for food and agriculture (Gray, 2020; Armani *et al.*, 2020; Aday and Aday). Some supply chains, such as the apparel supply chain in South Asian nations, are severely disrupted, whereas the agricultural and food supply chains demonstrate resilience (Majumdar, Shaw and Sinha, 2020; McMaster *et al.*, 2020). There is no guarantee that mitigation techniques like social distancing in factories, agile supply chains, and sustainable sourcing will be effective.

Because there is a lack of realistic data, disruption impacts are often analysed through simulations (Ivanov and Das, 2020; Ivanov, 2020; Guan *et al.*, 2020; Singh *et al.*, 2021). Unlike previous research, ours uses operational data from JD.com to highlight issues in retail supply chains. Furthermore, we go beyond the analysis of pandemic effects to examine the resilience of supply chains and companies' tactical resilience plans in the context of COVID-19. This study is the first to concentrate on the strategies and practical resilience indicators of a particular firm during the pandemic. We also look at different industries that are part of the retail supply chain, expanding the analysis beyond the industries that were only looked at in earlier research.

2.4 Impact of COVID-19 on Global Supply Chains

Since the announcement of COVID-19 as a pandemic in March 2020, lockdowns have been put in place to decrease the spread of illnesses. Isolation of symptomatic individuals, home-based professional practice, and universal social distancing measures were all put into place. The COVID-19 pandemic has had a substantial impact on 86% of the world's supply networks. Markus, A.; Birkel, H. Industry 4.0's impact on supply chain resilience: The COVID-19 pandemic has prompted a thorough evaluation of the relevant literature. The prospect of shortages caused consumers to engage in hoarding behaviour, as they stocked up on canned goods, toilet paper, and disinfectant cleaning supplies. Hoarding caused headaches for shoppers and wreaked havoc on supply and pricing networks (Li et al., 2021). Problems became worse when government lockdown tactics to prevent the spread of illnesses led to a decrease of staff

and a shortage of necessary resources. The suppliers did not follow through on their delivery promises, production dropped as a result of idle factories, and the demand from customers was highly unpredictable. According to Li et al. (2021), the majority of global supply networks lacked the resilience that was deemed desirable.

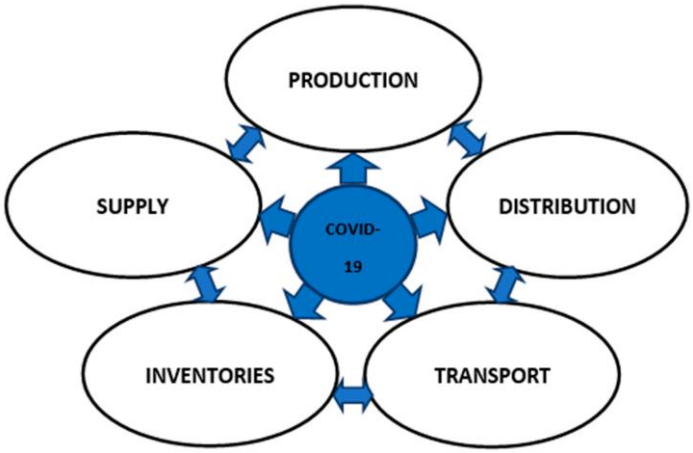

Figure 2: COVID-19 affected the supply chain (AGENDA, 2022)

Xu et al. (2020) examined how COVID-19 affected global supply chains and emphasised how the pandemic affected raw resources, intermediate commodities, and final products globally. The study highlighted the necessity of improving supply chain resilience through redesigned strategies emphasising resilience and responsiveness in order to lower vulnerability in post-COVID-19 global supply networks. With an emphasis on trade between Turkey and China, Kazancoglu et al. (2023) assessed the sectoral implications of COVID-19 on global supply chains. The study emphasised the detrimental effects of pandemic-induced lockdowns and disruptions on supply chains, production, and exports from Turkey to China in industries like mining, chemicals, and food. To effectively handle disruptions, the study stressed the significance of comprehending the cause and effect relationships of trade parameters, supply chain parameters, demographic data, and logistical data (Kazancoglu et al., 2023).

The automotive industry has been significantly impacted by the COVID-19 outbreak, as have worldwide supply chains. The World Economic Forum's research demonstrates how automakers, such as Toyota, have modified their supply chain procedures to address the difficulties posed by the pandemic. To guarantee a steady supply of vital components, car companies have started hoarding vital items, including semiconductors and batteries, and abandoning just-in-time (JIT) procedures. This change is indicative of a larger trend in the sector that places more emphasis on resilience and adaptation to successfully manage disruptions than on cutting costs and preserving business continuity (AGENDA, 2022).

The pandemic caused extraordinary demand and logistical difficulties in China, according to Shen and Sun, (2023). Despite these problems, JD.com controlled its supply chain by quickly modifying delivery practices. The Chinese market was controlled by stakeholder collaboration and government initiatives. Practical operational indicators are crucial for supply chain resilience assessment, and the study recommends greater flexibility and collaboration across supply chain boundaries (Shen and Sun, 2023).

2.5 Disruptions and Challenges Faced by Supply Chains During the Pandemic

An unprecedented number of diseases have emerged in recent decades, posing serious problems for commercial enterprises. The magnitude of the problems these groups face is directly proportional to the intensity of the epidemics in issue. Businesses and supply networks are particularly vulnerable to the devastating effects of epidemics and pandemics. It has the potential to reduce efficiency and performance (Guan et al., 2020; Ivanov and Das, 2020) and to disrupt supply chains, which can impact their resilience and sustainability (Ivanov, 2022; Ivanov and Das, 2020). More than 1,438 epidemics were documented by the World Health Organisation (WHO) from 2011 to 2018, a substantial amount of severe disease outbreaks that have lately impacted supply chains (Hudecheck et al., 2020). The COVID-19 pandemic, however, is unique. As compared to previous epidemics, such as the 2003 SARS and 2009 H1N1 outbreaks, their consequences have been more severe, diverse, and dynamic (Haren and Simchi-Levi, 2020; Koonin, 2020). Even before the World Health Organisation categorised the COVID-19 outbreak as a pandemic on March 11, 2020, a report from February 21, 2020, in Fortune magazine, claimed that 94% of Fortune 1000 companies were facing supply chain disruptions due to the CONGO pandemic. In addition, the flow of the supply chain has been greatly interrupted because, unlike previous outbreaks, this pandemic has affected all participants and ties in the chain simultaneously (Gunessee and Subramanian, 2020; Chowdhury et al., 2021). Ventilators, dry and canned goods, and PPE are just a few examples of the essentials that are in high demand. Production, transportation, and supply are all constrained by various issues. According to Chowdhury et al. (2021) and Amankwah-Amoah (2020), they include measures such as border closures, supply market lockdowns, manpower shortages, disruptions to international trade and vehicle movements, and the preservation of physical distance in manufacturing facilities. According to Duong and Chong (2020), the pandemic is likely to negatively affect global trade due to its complicated implications on

supply chains and other financial and economic challenges. As an example, in 2020, global trade could fall by 13-32% because to the Covid-19 dilemma, according to the World Trade Organisation (WTO) (WTO, 2020).

The pandemic caused supply chain problems for Ford, which resulted in production halts at multiple sites in North America and Europe. Amid the obstacles provided by the pandemic, the corporation had to implement steps to safeguard worker safety and modify production schedules in order to maintain operational continuity (Harapko, 2023). Marine supply networks have been severely disrupted as a result of the increase in consumer demand and logistical difficulties. For example, as container ships lined up to dock and discharge their goods, the Port of Los Angeles, one of the busiest ports in the world, faced congestion and delays. Due to COVID-19 outbreaks among truck drivers and port workers, there was a labour shortage that made the congestion worse. There was also a lack of cargo containers. Lockdown tactics also caused manufacturing capacity to be decreased and transportation networks to be interrupted in a number of countries, which further hampered the flow of commodities. These disruptions had an effect on manufacturers, merchants, and consumers in a variety of industries. Retailers had to deal with a lack of inventory and lengthier lead times to replenish their shelves, and manufacturers had difficulty obtaining the components and raw materials needed for manufacturing. Due to rising transportation costs, customers occasionally saw price increases and delays in getting their orders (UNCTAD, 2023). Distribution, economic, and supply-and-demand difficulties were the most pandemic challenges for Amazon enterprises, according to Tadaiesky et al., (2022). These issues affected supply chain operations, showing the region's supply chains' vulnerability to external disturbances (Tadaiesky et al., 2022).

2.6 Resilience Strategies Adopted by Companies to Navigate COVID-19 Disruptions

Examining Supply Chain Resilience Techniques in the Context of COVID-19 The research domain of disruptions is complex and multifaceted (Ali, Mahfouz and Arisha, 2017). Many attempts have been made to identify its contributing factors. Crucial components include collaboration, risk management culture, agility, flexibility, visibility, and information sharing (Jüttner and Maklan, 2011; Hosseini, Ivanov and Dolgui, 2019). These elements are essential for assessing and analysing real-world supply chain resilience. They are also known as supply chain resilience principles (Kamalahmadi and Parast, 2016).

According to Lee (2004), supply chains that function at the highest level must be flexible, agile, and aligned in order to quickly bounce back from unforeseen setbacks. Data and cooperative connections are emphasised as being crucial for creating an agile supply chain. Snyder *et al.* (2006) synthesised multiple models for building robust supply chains, emphasising tactics like improving adaptability, generating redundancy, cultivating cooperative partnerships, and boosting supply chain nimbleness (Tukamuhabwa *et al.*, 2015).

The definition of resilience using operational data is a challenge for empirical research. Challenges arise with resilience metrics, which are commonly classified as recovery time, recovery level, and profit loss during recovery (Behzadi, O'Sullivan and Olsen, 2020). Resilience was measured by Baghersad and Zobel (2021) as the total system performance loss following a disruption; however, this metric is difficult to use, particularly when considering the intricate dynamics of retail supply chains. Prediction accuracy is further complicated by the COVID-19 pandemic's prolonged disruption, which makes it difficult to calculate these indicators. Accordingly, a relevant research challenge is still the practical analysis of supply chain resilience (Katsaliaki, Galetsi and Kumar, 2021).

2.7 Role of Digital Technology in Supply Chain Management –

Modern manufacturing processes require supply chain management to include digital technology. Using cutting edge technologies like artificial intelligence (AI), big data analytics (BDA), and the Internet of Things (IoT), manufacturing organisations have recently changed some areas of their supply chain processes (Addo-Tenkorang and Helo, 2016). These technologies offer a wide range of benefits throughout the supply chain, from scheduling and planning to procurement and logistics (Arunachalam, Kumar, and Kawalek, 2018). To manage logistics and warehousing operations and to provide real-time production process monitoring, for example, IoT is widely employed in transportation and manufacturing systems (Chan et al., 2018). IoT device data, when combined with other supply chain data, offers a wealth of opportunities to leverage AI and BDA to generate commercial value. Better inventory control, demand forecasting, resource optimisation, supply chain management, and supplier relationship management may result from this (Boone, Skipper, and Hazen, 2017). Furthermore, as stated by Ceipek et al. (2021), these digital technologies are altering whole value chains, business models, and industrial frameworks in addition to processes and products.

Because of this, using digital technologies to navigate disruptive occurrences like the COVID-19 pandemic is now even more important. In summary, the incorporation of digital technology is an essential feature of modern supply chain management, allowing companies to increase output, optimise workflows, and adapt to the constantly shifting demands of the global market—especially during difficult periods like the COVID-19 pandemic. We will now discuss the impact of digital technology on the supply chain in the context of the COVID-19 pandemic.

2.8 Digital Technology Adoption During the COVID-19 Pandemic

The COVID-19 epidemic has shown how important digital technology is in supply chain management. The use of new technology has also greatly affected supply chain resilience and performance. Kumar (2021) and Nandi et al. (2021) observed that block chain technology might reduce theft, increase transparency, and improve transactional efficiency. Ray and Nguyen (2020) demonstrate how 5G-IoT integrated drones can support medical deliveries and other healthcare activities, demonstrating the adaptability of digital solutions to emergency scenarios. According to Shen, Yang, and Gao (2020), manufacturing technologies like IoT and cloud computing have increased supply chain transparency and collaboration, allowing swift adaptability to changing market conditions and demand fluctuations. Hopkins (2021) emphasises the transformative potential of digital technologies in boosting operational agility and responsiveness and industry 4.0 technology in improving supply chain efficiency, with larger enterprises being more ready to embrace. Hopkins (2021) emphasises the importance of big data analytics in enhancing supply chain agility and properly forecasting demand, as well as data-driven decision-making in unexpected circumstances. AI solves challenging challenges creatively to optimise supply chain processes, despite its unpopularity. Additive manufacturing has helped produce medical supplies, showing the revolutionary capacity of digital technology to enable speedy innovation and flexibility in response to changing consumer needs, according to Arora et al. (2021). Kumar (2021) noted operational obstacles like flexibility and trust, which industry 4.0 adoption has addressed to improve supply chain resilience and performance. To achieve significant results, technical expenditures must connect with strategic goals. Digitization has made supply networks more flexible, agile, and resilient, ensuring timely delivery of essentials during interruptions. This shows how digital technology may alter supply chain management.

Amazon saw unprecedented demand for its e-commerce services during the outbreak as more people used social networks and online purchasing. Amazon accelerated the integration of AI and ML technology into its supply chain to manage manpower constraints, changing consumer behaviour, and this demand spike. Amazon's AI-powered robotic fulfilment centres have enhanced warehouse operations by automating inventory management, picking, packaging, and shipping. By helping humans, these robots enhance productivity, reduce errors, and reduce workplace virus spread. Amazon's demand forecasting methods use AI to better predict customer demand and modify inventory levels. Amazon analyses prior sales data, website traffic patterns, and external elements like weather and economic indicators to predict demand changes and adjust its supply chain in real time to meet consumer requests (Jenkins, 2023).

Teladoc Health, a leading virtual health provider, enables consumers chat with doctors via messaging, video conferencing, or phone calls. Due to congestion, staff shortages, and infection control regulations, telemedicine became vital for pandemic medical care and virus prevention. Teladoc Health's telemedicine services were in high demand during the pandemic as consumers sought non-traditional healthcare without visiting clinics or hospitals. Teladoc Health used digital technology to provide fast and easy access to medical specialists for general medical advice, mental health therapy, COVID-19 screening, and chronic illness monitoring. Telemedicine has improved healthcare access for underserved groups, rural communities, and persons with mobility or transportation issues while relieving healthcare systems. Telemedicine solutions like Teladoc Health use AI to triage patients, do virtual exams, and provide customised treatment regimens (Bouabida, Lebouché, and Pomey, 2022).

2.9 Forward Planning

This project will now concentrate on resolving the problem by assessing the efficacy of digital technologies in reducing interruptions and improving the resilience of supply chain management during the COVID-19 pandemic. The research is focus on specific objectives following thus: analyzing the impacts of the pandemic on global supply systems, uncovering the challenges encountered by supply chains, and considering the achievement in supply chain resilience through digital technologies. It will be done by building relevant research questions that, in their turn, will help to understand the influence of the pandemic on supply networks, define operational challenges that should be struggled with and identify the role of digitalization in reshaping supply chain resilience. This study aims at bringing out the gist of

what the modern day supply chain management entails during the period of crisis as a whole. It is aimed at providing tangible policies, strategies and outlooks for the management and stakeholders who are gravely hit by disruptions in the global economy of today.

2.10 Conclusion

The present literature review includes in-depth analysis of SCM, which provides both an introduction to its fundamentals and the challenges brought by COVID-19 pandemic. The chapter dealt with the fundamental concepts of SCM (Supply Chain Management) and underline its position in delivering goods and services which generate value. Furthermore, it also accentuates the importance of developing resilience strategies to tackle the effects of disruptions. Not just this, technology has brought about the important development that supply chains can cope up and recover quickly. On the other hand, this chapter gives the audience a different perspective on the complexities of supply chain management (SCM) and prepares them with the necessary information to go through the continuously changing environment of modern supply chains today.

Chapter 03

Methodology

3.1 Research Methodology

In this study, a systematic literature review was chosen which was used for the comprehension of the total impact of digital technologies on the supply management during the COVID19 pandemic. This selection method is based on its capability of systematically covering the existing stock of information in the research area under focus while simultaneously addressing the research questions in question with a relatively high level of detail as well as precision (Tranfield, Denyer, and Smart, 2003). Through the systematic gathering of evidence and the interpretation of past articles a literature review will generate a base for the research gathered on the various effects of the pandemic on global supply network operations, digital technology's role in the resilience of supply chain and the operational issues faced by the latter (Wong et al., 2013). To begin with, a systematic literature review offers a structured and transparent way for data collecting and analysis; this method, apart from making the results reliable, ensures the possibility of replicating the findings (Davis et al., 2014; Moher et al., 2010). Such a rigorous methodology is extremely important in the instance of COVID-19, in which an emergency is on the rise leading to quickly changing conditions around the globe that require a unified approach for the evaluation, systematisation, and comprehension of the information. The study is based on the guidelines concerning conducting systematic reviews, like defining eligibility criteria, conducting exhaustive literature search, and appraising the contributing studies carefully (Davis et al. 2014; Moher et al. 2010). This practice assures that the original research on the matter is the right one and helps in eliminating the existing bias. In addition, the literature review system has the benefit of integrating overwhelming evidences of various forms, for instance, empirical, conceptual and expert opinions (Torraco, 2005). This comprehensive strategy of a unified vision for the study theme helps to develop among all participants a very complex and comprehensive approach which is required to understand the effect of digital technology on supply chain management in a holistic manner during pandemics. Based on the aggregation of findings from different studies, systematic review techniques identify a wider context of the approach, therefore research gaps are removed guiding future research direction and theoretical developments. Through a systematic review

of the literature, this study aims to generate valuable insights that can inform decision-making processes, guide policy development, and contribute to the advancement of theory and practice in supply chain management.

3.2 Data collection

This study utilises the research process which involves the analysis of literature about the effect of digital technology on supply chain management during the COVID-19 pandemic. This approach is based on the use of search engines, adequately selected keywords, and selection criteria for the identification and collection of proper articles. The systematic search for scholarly databases by means of choosing accurate search terms like digital technology, supply chain management, and COVID-19 pandemic alongside of specific digital terms like Digital technology, IoT, block chain, artificial intelligence yields relevant records only.

3.2.1 Research Strategy

Google Scholar, the superior search engine, will be utilised in this study for conducting a comprehensive literature search. This platform offers a straightforward method to conduct comprehensive searches for academic publications. Within a certain location, you have the ability to explore a wide range of academic fields and resources, including articles, theses, books, and abstracts. This search engine facilitates the discovery of pertinent scientific literature from throughout the global scientific community. Google Scholar allows users to narrow down search results by specifying criteria such as title, author, publication source, publishing date, and other filters (Samadzadeh, Rigi and Ganjali, 2013).

Just need to input keywords or search phrases into the search engine to locate articles. Phrase searching enables the user to refine the search results by locating precise and pertinent research related to the topic (Gusenbauer and Haddaway, 2020). Digital Technology, supply chain disruptions, and the COVID-19 pandemic have had an influence on digital innovations, chain management, and the incorporation of digital technology into global supply chains. Pandemic and supply chain flexibility, digital solutions and difficulties posed by the coronavirus, and global supply management are all interconnected. Supply chains must adapt to technology-driven resilience in the era of COVID-19.

3.2.2 Selection criteria

Only studies that satisfy the selection criteria—which have a significant impact on the significance, calibre, and focus of the research—will be included. Clearly defined criteria will ensure that the information that is gathered is directly related to the research questions. This will stop irrelevant or poor quality content from being included (Hynes, 1986). As a result, there was less bias and greater consistency in the selection process. The selection criteria will streamline the use of resources by aiding in decision-making, which will ultimately result in time and cost savings. They will improve the study's source or data selection process to make it easier to understand and more transparent (Rawlinson, 1999).

Inclusion criteria

- Research should focus on analysing the effects of the COVID-19 pandemic on worldwide supply chains, specifically examining disruptions and resilience.
- Research should examine the use and impact of digital technologies like IoT, block chain, AI, data analytics, automation, or similar technologies in supply chain management during the COVID-19 pandemic.
- Studies written in English, accessible through academic databases

Exclusion criteria

- Research that does not specifically focus on the effects of the COVID-19 pandemic on worldwide supply chains, such as interruptions and ability to recover, will not be considered.
- Studies that do not address the use or impacts of digital technologies like IoT, block chain, AI, data analytics, automation, or similar technologies in supply chain management during the COVID-19 pandemic will be disregarded.
- Studies not written in English or not accessible through academic databases will be excluded to maintain consistency and accessibility.

3.2.3 Study Selection Process

When doing a systematic review using the PRISMA criteria, the process of selecting studies is carried out in a systematic and methodical manner, following a sequence of phases. Following the establishment of defined study questions and objectives, the framework for succeeding stages was constructed. A comprehensive review methodology is established to guarantee transparency and replicability, outlining the search strategy, criteria for including or excluding information, and procedures for extracting data (Sarkis-Onofre *et al.*, 2021). The literature

search encompasses many databases using predetermined search phrases, and the found papers undergo a meticulous screening procedure based on their titles and abstracts. After eliminating duplicate entries, comprehensive evaluations are carried out, using strict inclusion/exclusion criteria to find pertinent research. The report follows the PRISMA principles, including a flow diagram that depicts the process of selecting the research and a detailed narrative (Moher *et al.*, 2010). Participating in a peer review process further improves the dependability and accuracy of the systematic review. This methodical technique guarantees a strong and clear procedure of choosing studies that aligns with the PRISMA recommendations.

3.3 Data Extraction

The data extraction process within this research involves the systematic gathering of required information from articles that are chosen. The well-organised fashion of this system allows to register all the academic material in a logical manner, making the robust analysis and presentation of outcomes possible. It is done by evaluating the study bias at the stage of individual studies and by prioritising their relevance to the research topic. We leverage on the structured data extraction forms to capture deemed relevant information from sampled publications. Forms are tailored to collect accurate details relevant to the research, such as the methods applied, major findings and main conclusions (Schmidt et al., 2023) To examine these aspects, quality assessments are performed to discover the level of soundness and details. Data extraction involved me in finding the information about the digital technology effects during the supply chain management in the time of COVID-19. This is the part which includes the use of digital technologies, ways they impact the supply chain resilience and the operational efficiency, with any challenges or opportunities realised in the process. By the process of collection all necessary data is gathered from literature for future categorisation and further analysis. By using a structured model, the results become more reliable and the validity of the study is maintained, which translates into solid conclusions about what effect the pandemic had on digital supply chain dynamics.

3.3.1 Quality Assessment

The Critical Appraisal Checklist for Qualitative Studies that was adopted for quality assessment in this research is appropriate because its criteria assess clearly consecut different methodological rigors and credibility of qualitative research studies (Treloar & et al., 2000). This inventory is a very comprehensive tool to check the efficacy of qualitative studies. That

is perfect for studying the influence of digital technology on supply chain agents during the pandemic of the COVID-19. Checklist question items which concern important aspects of qualitative research methodology, analysis, and the relevance to the topic of the research (See Appendix A). The questions were specifically focusing on issues such as goals of study articulation, planned research structure, tools applied in data collection, and the type of information that will be presented to the audience. The checklist can be used as a tool that ensures that the impact and relevance of each qualitative study are evaluated fully in its relationship with the research objectives (Patterson and Dawson, 2017). This checklist list checks whether the research questions are in sync with the study objectives as well as the value of the research in exploring the effects of digital technology on supply chain management during and after the pandemic to ensure that only quality research studies are included for analysis The critical appraisal checklist for qualitative studies made it the best option by its systematic and rigorous approach for quality assessment, which elevates the validity and reliability of the scopy of the study. The structured format planning helps to show consistency and transparency in the bold of digital technology on supply chain management during the COVID-19 pandemic. As a result, strong conclusions can be made that digital technology played a prominent role in supply chain management..

3.4 Data Synthesis

The literature study applies merging selected studies in order to get remarkable insights on how the operations of supply chain management evolve during the COVID-19 crisis. Among the stages of synthesis this one includes a systematic approach to organize, summarize, and analyze the qualitative data collected for the purposes of revealing the central themes, patterns, and relations. The thematic analysis could be used as the main analytical technique in the data synthesis. Thematic analysis helps to apply a structured approach to recursively detect and interpret emerging themes in qualitative data. Through this approach, common items and sub-items are spotted using the thematic analysis of qualitative data thus developing a proper framework for arranging and presenting the findings (Braun and Clarke, 2012). In the initial move to perform thematic analysis we take out crucial data from every qualitative study into consideration. It covers the tasks like determination of recurring patterns, concepts, and ideas in the data. Processed data are subsequently themed and patterned based on their prominence to the research goals and objectives.

Having themes detected as the first step, this is then followed by the analysis of how the connections and relationships between them work. This comprises of reviewing resulting studies to compare and contrast them on specific issues that center on digital technology in terms of supply chain management impact. Thematic analysis is such an approach that allows the identification of major themes and subthemes. This way the researcher acquires a deep cognition of the research topic (Joffe, 2011). The synthesis process is an endeavor of positioning the findings within the bigger framework of Theoretical Underpinnings of Supply Chain Management (SCM) and Digital Technology. It is a point of reference and an enhancement of technicality in the reporting of the results. The result of the synthesis is usually structured and systematically presented in the summary through a systematic review that supervise the main themes, sub-themes as well as the relationships.

3.5 Ethical consideration

Ethics is still a key factor even when there is no direct involvement of patient participants in systematic reviews. Confidentiality and data extraction from published studies anonymity should be protected at all times during the process. Privacy of the individuals involved originally in the experiment is preserved by anonymizing any identifiable information. Being alert towards the publication bias is recommended because it can bias the results of the systematic review (Gajjar, 2013). Transparency and reproducibility are fundamental ethical principles in systematic review research. Completely articulating the research strategy, the inclusion criteria and the data extraction process increases the review's reproducibility. Moreover, declaring any potential conflicts of interest will be necessary to preserve the reliability of the research. This includes disclosing any financial interests, personal connections, or institutional affiliations that may influence the research process or findings. It is important to follow the relevant ethical norms and standards. Through their consideration of these ethical factors, systematic reviews can be conducted in an ethical and responsible way, and that ensures the accuracy and dependability of the research results without compromising ethical standards in research (Hasan et al., 2021).

3.6 Conclusion

This chapter has described a research methodology and data collection process that have been applied to evaluate the impact of the digital technologies on supply chain management in face

of the CORONA crisis. The main task of this investigation is to use a well-developed systematic review approach to collect the relevant scientific data in the field. This research aims at tackling certain research topics of high importance and carrying it out with the highest level of precision and accuracy (Tranfield, Denyer & Smart, 2003). This review will thus give a sound background for the comprehension of the pandemic's impact on the global supply networks; the challenges experienced by supply chains and the role of technology in the enhancement of the chain's resiliency. This will be achieved through the careful gathering and examination of the previous research (Wong et al., 2013). Also the approach not only focuses to collect data, but the process as well by strategically choosing keywords and search terms that will connect the publications that are related to the topic. It also addresses issues of research selection which will include some and leave out the others. The systematic nature in which the literature review was carried out translates to the reliability and replicability of the outcomes achieved which is essential for appropriately reacting to the changing scenarios as well as making sense of conflicting research findings on the COVID-19 pandemic. Furthermore, this approach should weigh and fully consider ethical aspects of the process, like confidentiality and openness, with the purpose of protecting and defending the whole research process (Gajjar, 2013). This study has a value to the area of supply chain management facing the problems linked with the COVID-19 Pandemic as well as through systematic and ethical ways of dealing with it.

Chapter 04

Finding and Discussion

4.1 Introduction

In this chapter fact-finding was announced by focusing the three main research questions related to how the pandemic changed global supply chains and how digital technology helped to sustain supply chain resilience (Spieske and Birkel, 2021). The impact that the pandemic had on the supply networks was the initial thing in the research which I conducted. Our research also incorporates a look at the disruptions that businesses faced, as well as the resilience that they added to combat the problems. After this, a comprehensive investigation was conducted to unravel the supply chain challenges that showed problems during the pandemic. Some of these problems were not directly related to production difficulties but were mainly based on transport problems, labour shortages, and product demand fluctuations. An investigation that was comprehensive was done in the end to enable us to get an understanding of what digital technology is and how it enables enhancement of the resilience of supply chains. On the other side, the research centred on deterring interruptions to business operation and instant responses to varied conditions. A thorough evaluation of original research articles was conducted to meet the aim of summarising key points, significant underpinning facts, and trends, which are relevant to the research question. The study finally came up with a detailed analysis of how the pandemic affects the supply networks owing to synthesis. These suggestions were partnered with implementable ideas and practices that are useful to relevant parties like policy makers and process managers that play key roles in the supply chain management.

Areas of discussion

My chapter's content section is crucial for several reasons. The authors are first researching secondary concerns related to the COVID-19 pandemic's impact on global supply chains and how digital technology has improved them. In addition, the study covers operational concerns during the epidemic, including distributor challenges. Finally, the film depicts how innovative companies adopt digital technologies. To conclude, the debate yielded valuable insights and recommendations for stakeholders and policymakers' supply management.

4.2 Effects of the COVID-19 Pandemic on Global Supply chain

Due to the sudden occurrence of the COVID-19 pandemic globally, immense supply network disruptions took place around the planet and created the so-called "new era," where corporations faced both challenges and opportunities. The disruptions were crippling across the supply chain operations in manufacturing, transport, logistics, and material procurement. Global supply chains (GSCs) encountered colossal disturbances in the form of abnormal disruptions, and uneven demand volatility which brought about the test of supply chain resilience and urgent moves towards digitalisation.

With the outbreak of the pandemic, some of the vulnerabilities within supply chains have come to light, causing companies to quickly mitigate the risks and maintain the usual level of operation. The pandemic of COVID-19 had revealed issues related to supply chains and had made the inefficiency of single sourcing and an effective inventory management more obvious, which was evidenced by Reza et al. (2021). Due to the lockdowns, restriction of travelling, and labour shortage, the production was interrupted, inventory depleted, production delays and bottlenecks on distribution took place. The aforementioned disruptions, hence, did not act as one time only factors but had long-term impacts on multiple industries thus causing disruptions within supply chains and affecting businesses' capacity to service their customers.

Similarly, Chowdhury et al. (2022) emphasize the devastating short-term consequences of the COVID-19 pandemic on businesses in the food and beverage sector, for instance, defaulter products, problem in generating capital funding, and the reduced capability of distributors to operate among others. Apart from this study, policies that will subdue the negative effects should be implemented as well, so that the sector can cope with the shocks of the climate change successfully. Another key message from Chervenkova and Ivanov, from 2023, is that supply chain disruptions which occurred due to the pandemic as LED the automotive industry to the new paradigm, and adaptive properties, viability of the supply chain by repurposing, as well as, development strong intertwined networks are keys to the resilience and stability of the automotive industry.

The concept of a digitized world, an integrated supply chain and being agile were, as implied by Li et al. (2022), the essential tools that should be applied to efficiently handle disruptions and, thus, make a business resilient during crises. They insisted on the harnessing of technology

in conjunction with collaborative strategies just so that the arising logistics challenges can be effectively dealt with. They argued the necessity to put forward the preventive measures aimed at hastening the development of such readiness to unpredictable situations in particular. While this, according to Cui et al. (2023), it showed that the COVID-19 outbreak led to the increase instability of demand that sometimes led to demand changes, which in turn lead to the change of consumer behaviour and market demand. Excessive buying, overflow of supplies, and rapidly changing characteristics among consumers were referred to as some of the factors instigating an out of control demand and resulting in shortages in different breadth of goods. The management of inventories became paramount due to the inability of organizations to predict accurate levels and failure of effective control measures which further widened the gap between supply and demand as well as increased disruptions across the whole supply chain.

Yin, Tsai, and Lai (2072) suggested that organisations must be prepared to withstand any debilitating conditions and increase their resilience complexities to reduce any risks associated with business operations disruptions. Consequently, firms are reviewing their risk management approaches, seeking alternative suppliers and, more and more, involving their suppliers and partners in the operations. Companies have worked towards building supply chains that are agile and flexible which will allow them to efficiently adjust to ever-changing market conditions as well as to unexpected disruptions. According to Pimenta et al. (2022), the significant impact of Industry 4.0 technologies and the application of digitalisation resources to enhance supply chain performance was evident in the face of uncertainty. They shed light on the importance of proactive strategy adaptation and the savvy use of technology to minimise disruptions and maintain efficient operation in an ever-changing world. Arji et al. (2023) underlined the major role of data analytics, Internet of Things (IoT), and real time monitoring in the pinpointing and mitigation of supply chain vulnerabilities that have been direct negative effects of pandemic. The mentioned measures show that to reduce risks and to make it possible to have more transparent monitoring, it is important to have a strong supply chain in unpredictable situations. It is this which underlines the indispensability of using data-driven insights to foresee and manage disruptions effectively.

The pandemic did not only hasten the implementation of digital transformation in supply chains but also made it possible for leaders to adopt digital technology and new methods to ensure transparency, agility, and responsiveness in their operations. Thanks to data analytics, AI, IoT, and blockchain, real-time monitoring, predictive analytics, and supply-chain optimization has

now become a reality. In order to uplift operational efficiency, to optimise inventory management, to communicate and to collaborate efficiently within supply chain networks, companies deployed digital platforms and cloud-based solutions strategically.

Affecting the operation of the global supply chains, the COVID-19 pandemic caused conflicts in the business of the companies globally (Reza et al., 2021; Cui et al., 2023; Ye et al., 2022; Sharma et al., 2022). The pandemic was the time of trials and chances; it was the time of vulnerability and opportunity; it was a time that will be remembered through tears and smiles, but it was also a time that changed supply chain forever. In order for enterprises to be adept and endure through the impending disruptions and consequently remain successful within the rapidly changing business environment they must continue channelling their resources to efforts that reinforce resilience, employ digital transformation, and build an atmosphere of collaboration.

4.3 Operational Hurdles Encountered in Supply Chains During the Pandemic

The unexpected epidemic of COVID-19 brought a lot of problems for supply chains along with it. These problems tested the already existing frameworks of supply chain management and left the professionals with no alternative but to promptly make adjustments in the whole process in order to potentiate the operational environment. Spieske and Birkel (2021), Li et al. (2022), Arji et al. (2023), and Cui et al. (2023) suggested that there have been operational difficulties in logistic processes in supply chains because of the pandemic that related to both its complexity and scale. Because of this, the environment in which global trade did take place was disrupted and the management of the supply chain was made to cross the limits which would otherwise not be necessary for traditional supply chain management techniques. By unveiling the stumbling blocks which supply chains must grapple with, analysing the necessary alterations that have to be implemented, and exploring the difficulties that must be overcome to accomplish the shift to the new production paradigm, this study was conducted using practical data.

Sharma et al. (2022) disclosed the complex and vast obstacles the supply chains encountered during the pandemic. The implementation of the quarantine restrictions, border closure rules and the restriction of workers halted the movement of goods via the transportation system in

addition to the limitation of the movement of commodities as a whole. This, however, accounted for the backlog of shipment which appeared to be significant as there were logistics delays which were significant on delivery. Due to the fact that there was a limitation in the operating hours of the manufacturing facilities and distribution centres which was as a result of strict health and safety laws, the problem of production delays and labour shortages was made even worse. The report discussed the role and the relevance of such problems in today's supply chains. It highlighted the significance of having supply chains that can respond to various disruptions and remain reliable even in the face of the interruptions that might affect business operations. During the very period, supply chains were subject to the multiple operational challenges. The problems embedded was in the areas where logistics process was interrupted; personnel shortage, demand fluctuations, as well as operations inside the supply chain. The study by Spieske and Birkel (2021) reported that the imposition of lockdown regulations coupled with closure of borders and travel restrictions in order to impede the spread of the virus caused the disruption of the network transport and the restriction of movement of goods. Among these results were higher transportation prices, delivery delays and breaking down of logistics chain progress. Not only have the implementation of the health and safety regulations in manufacturing and distribution areas been constraining the production operations due to shortage of labour, making the labour force issue worse but also added more operational constraints to inventory management and order fulfilment processes. Following these protocols, those negative impacts were a result.

Consumer behavior was the most concerned, which caused random buying and had no pattern at all, which became volatility in demand patterns that was the biggest operational issue (Li et al., 2022). Challenges such as shortages of stock, stock outs, and hard coordination of supply chain and inventory planning are very common for the companies that do not able to precisely predict demand and match it with the production level which is fluctuating according to the market dynamics. Arji et al. (2023) revealed, the disruptions in the global supply chains were a major factor that exacerbated these problems, which led to the interruption of access to raw materials and the connection with suppliers and an increase on the supply chain's vulnerability. Supply chains were immediately adjusted in order to minimize risks and overcome challenges that could stop operations, so the production continued (Ye et al., 2022). The range of strategies employed by the organisations included amongst others the diversification of supply sources, the improvement of supplier's engagement, as well as the use of efficient risk management practices. By adopting agile and flexible approaches in production and inventory management,

organisations were timely adjusted to the dynamic market conditions, changing production volumes, and improving inventory levels to be in sync with the new customer behaviour (Ye, et al., 2022).

However, whilst these initiatives have alleviated some of the challenges of supply chains, significant barriers still exist for supply chains to adjust to the new operational environment (Cui et al., 2023). It has been problematic to combine data, system racism restricted the advances due to outdated systems, and cybersecurity threats created obstacles hampering progress in the digital transformation to enhance supply chain visibility and agility. (Cui et al., 2023) The rate of change in the technological field brings along such problems as the need to always be abreast of the digital developments and ensuring that they are in line with the organisational goals. A research done by Sharma et al. (2022) shows the multifaceted nature of the digital transformation process that aims to enhance supply chain operations with technology advancements. Digital technology integration represents an extremely difficult task for organizations because the challenges are manifold, including data integration problems, constraints due to legacy systems, and security breaches. Staying on top of necessary digital capabilities that are aligned with achieving business objectives is one of the challenges brought on by the fast pace of technological developments, and it is an ongoing issue as well (Sharma et al., 2022).

In short, Covid-19 introduced unique supply chain logistics. These challenges came with generation magnitude and high complexity as characteristics and they were caused by the disease. Although there has been enough advance of organisations in their ability to adapt to the shifting platform of operations and in equipping them to manage challenges, more efforts have to be made to address the complex and unpredictable systems every global supply chain is grappling with at the moment. Digitalization adoption, functioning approaches which are strengthening resilience and promoting collaboration or partnership are methods in which supply chains build their resilience and strength during the post-pandemic time.

4.4 Impact of Digital Technology on Supply Chain Resilience During the COVID-19 Pandemic

Digital technology's integration has, however, made supply matching more robust during the informationally complex COVID-19 phenomenon. Organisations have been given with high-

tech solutions to meet difficult situations, to increase effectiveness of operational activities, and to ensure stability of supply chains in the period of disruptive events through use of the latest technologies and platforms. Nabipour and Ülkü (2021), elucidated about the disruptive force of digital technologies enforced on physical supply chains including big data, cloud, and IoT. These technological advances, which made it possible to process real-time data, focus on predictive and machine learning algorithms, as well as on risk management and decision-making systems, have been critical for companies to address and respond to disruptions effectively. By melding and examining the complete data from the different sources, organizations can possibly achieve the best results, take corrective actions, optimize the inventory level and quickly adapt production schedules to assimilate with the tricky market conditions and customer demand patterns.

Spieske, and Birkel (2021) pointed out that the integration of digital tools such as cloud computing, IoT, blockchain, and big data analytics has contributed significantly to the improvement of the supply chain visibility, collaboration and agility of organizations. These digital tools helped to manage the availability of assets in real-time and facilitate the replenishment of inventory as well as responded to any disruptions that may occur timely, and this was made easy through the facilitation of efficiency of the process (Spieske and Birkel, 2021). The in big pond of digital technology implementation on the resilience of supply chains came to light in the COVID 19 period and was reported by Cui et al. (2023). Digital technologies such as big data analytics, IoT (Internet of Things), cloud computing, artificial intelligence, and blockchain have tremendously improved supply chain functions thereby they have been proved to be strong enough to overcome disruptions. The government is capable of identifying, monitoring, and analysing the supply network activities in real-time through the use of technology, thus enables it to make informed decisions and manage risks. The employment of internet-of-things sensors allowed capturing and processes of information such as inventory levels, production processes, and transportation routes, hence the enhancement of commitment and risk contention. In addition to that, the technology called blockchain which has backed secure and transparent transactions has also built trust in the supply chain while making traceability easier because of the fact that every step i s clear. According to Ye et al. (2022), the application creates an aggregated platform and collaboration tools that the supply chain stakeholders could use to increase the efficiency of their operations, particularly when working remotely or adhering to social distancing measurements. Enterprises has shifted gears and maintain seamless presence even during the downtime of human dynamics and physical

limitations by shifting to cloud-hosted services and virtual channels of telecommunications. The role played by supply chain agility is accentuated to higher levels with the faster sharing of information and communication between stakeholders, the changing market conditions and the varied customer needs.

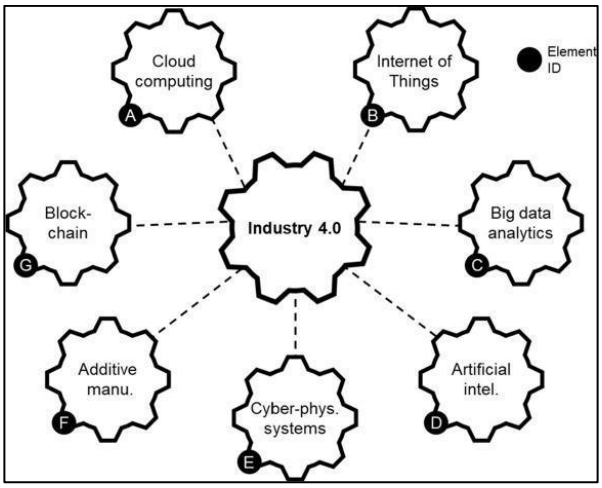

Figure 3: Types of digital technologies in supply chain (Nabipour and Ülkü, 2021)

Moreover, the digitalisation of process as pinpointed by Cui et al. (2023) also contributed enlargement of the flexibility and adaptiveness of supply chains by automation production processes, optimisation of inventory management, and dissemination of distribution platforms. From predicting customer behavior to optimising product supply chain activity, companies used AI-based forecasting and optimization techniques to update their inventories and stay ahead of changing demand. The introduction of automated solutions and robots took place to increase operational performance and overcome the need for manual actions, which further reduced the effects of worker shortages and cases of production stops.

Meanwhile, the exploitation of digital technology has evidently been the main factor in the excelling of supply chain risk management and mitigation (Ye et al., 2022). The advantage that lies in organisational learning through advanced analytics and predictive modelling comes in handy when it comes to rapidly identifying, ranking, and resolving problems by mimicking and testing several scenarios, and thus creating contingency plans. Through enhanced capabilities of their decisions-making, proactive actions can be taken to mitigate risks down the line which strengthen supply chain resiliency. Li et al. (2022), Arji et al. (2023), and Sharma et al. (2022) revealed that power of supply chain integration with partners and collaboration through digital platforms ensured resilience in pandemic period. Digital platforms and advanced communication tools account for improved communication, collaboration and responsiveness

within supply chains, providing prompt and efficient exchange of information with suppliers, consumers and business counterparts. To add further, the study of Pimenta et al. (2022), Gebhardt et al. (2022), Zhu, Chou, and Tsai (2020), and Queiroz et al. (2022) has found the key operations problems by supply chains amid Covid-19. These obstacles consist of the hurdles in transportation and logistics, problems associated with the procurement of raw materials and other difficulties, which refine the management of inventories. In the middle of all those challenges, the organisations managed to rethink and put their digital tools to the best use, enabling the necessary business continuity and overcoming the operational barriers.

Subsequently, both studies by Cao et al. (2020) and Ye et al. (2022) demonstrated the intrinsic role of electronic technology in the supply chain resilience given its high adoption rate during the pandemic period. Eventually the enterprises that realize the value of the AI, VR, machine learning would be able to address the interruptions, lessen the risks and make sure seamless business operations in real-time. With the support step, supply chain resilience can now bear any uncertainty that has been caused by the pandemic.

4.5 Theoretical Framework

To properly depict the conversation, supply chain management theories were chosen. The application of digital and information technologies to Supply Chain Resilience (SCR) and Resource-Based View (RBV) theories is utilized to find out how organisations will take due advantage of these technologies to build-in resilience and thereby gain competitive advantage (Spieske and Birkel, 2021). Summarising the theory derived the key concepts of technology positioning in supply chain management, supply chain variability, and supply chain integration and collaboration presented. Consequently, leaders who would devote increasing attention to the management of technologies should establish a clear alignment between the technological capital of their firms and their strategic competencies, in order to achieve the greatest advantages on the market. Besides, data analytics was exploited to inspire organizations into investing in digital infrastructures including training their human workforce in digital skills and collaboration with supply chain partners. Theory was no longer a vague concept of supply chain management but rather became something real, transferable, and practical as a result of case studies, that is supported by lessons for researchers and practitioners that will help them to manage the supply chain in digital times. Being linked with an academic institution, such practice will make their work more effective.

4.6 Discussion

In the discussion, the main points which had been considered in the earlier chapters were clearly outlined together with the research questions. As an opportunity to evaluate the conclusions, establish general patterns, and measure their impact on the notions, procedures, and purposes of the studies, it played a role. The present section has served as a basis for analytical integration of the empirical evidence, complete evaluation of the identified strengths and drawbacks, and, finally, providing valuable insights that can be applied in setting up supply management practices. The dialog looked to shed light into the emerging patterns, identify the areas that required improvement and create the foundation for the future inquiry in this field of study by fully exploiting the existing literature.

The endeavour to enhance our initial research inquiry was to probe into the multifaceted effects of the pandemic that ravaged the global supply chain. The report presented in detail, an in depth analysis of the disruptions which took place, institution's resilience, and the overall ramifications of the situation for supply chain management practices. The COVID-19 pandemic that has taken place throughout the world has led to drastic changes of global supply chains which caused transformation of the current commercial space. These disruptive consequences of the COVID-19 pandemic on global supply chains were displayed by Pimenta et al. (2022), Zhu, Chou, and Tsai (2020), and Arji et al. (2023) The studies showcase the complex issues that the organisations may face, for instance interruptions in transportation, shortage of labour, and intense fluctuation of demand. The multiple factors, including those in transportation and labour shortages were all highlighted by the Baqaee and Farhi (2020), the Ivanov and Das (2020) and the Paul and Chowdhury (2021). Hereafter, Arji et al. (2023) state that the aggregate impact of governmental measures and policy-making is also crucial in streamlining chain interruption. In addition, Grey (2020) did an observation on the disruption of garment supply chains in South Asian countries where the one-and-a-half-page introduction was provided for enterprises operating in this area that showed the present problems. Supply disruption is not limited to the healthcare sector. The studies by Armani et al. (2020) and Aday and Aday brought to light the shortages of medical supplies and lack of personal protective equipment (PPE) which can be seen as a reflection of the challenges in other industries. And unlike their assessment of supply chain resilience using pandemics, which was demonstrated in Li et al. (2022) and Reza et al. (2021), their studies focused more on supply chain agility. Agility, adaptability and reactivity of an organisational were highlighted as an important tool

to deal effectively with the disruptions and provided for a seamless continuation of a business operation. To Majumdar, Shaw, and Sinha (2020), agricultural and food supply chains are seen to be resilient on the ground as empirical data shows their capacity to bounce back despite difficulties as witnessed in some segments.

Second research question we addressed was to get a clear overview of the operational problems supply chains were faced with during the COVID-19 pandemic. There was a discussion on the supply chain supply disruption, labour shortage and demand fluctuations which challenged the supply networks' sustainability. Gebhardt et al. (2022), Queiroz et al. (2022), and Ülkü (2021) pointed to the different difficulties, among others the wide-spreading workforce disruption, inventory management problems, and the misrest in demand forecasting. In their latest paper, Nabipour and Ülkü (2021) presented major effects of wide scale panic buying and hoarding cases which can be summed up with dramatic increase in supply shortages and adverse working efficiency of supply chains. More so, Spieske and Birkel (2021) and Sharma et al. (2022) are a researcher’s who focus of the types of strategies that the companies have put in place to beat these barriers of operations. Supply chain resilience enhancement strategy includes collaboration, digitalization, and risk mitigation in the field of supply chain as one of the vital factors to consider. As digital technology is emerging as one of the most important tools in the realm of supply chains, organisations have been abler to make their supply chains transparent and adaptable to changes, even unplanned ones. Ceipek et al. (2021) emphasised in their study the large role played by the digital technologies into furthering the supply chain management practices.

The following research question was focused on the effect of advanced technologies and the risks which come with it, business operations and processes, and collaboration within global networks to address the third research question. Cui and Ye (2023) are doing significant progress in the research of how supply chain resilience might benefit from digital technologies during the still continuing pandemic. The mentioned technological fields, in particular, big data analysis, Internet of Things (IoT) and cloud computing, have the ability to significantly enhance the observability, adaptability and risk management capability of the supply chains. As a result of the syntheses of different answers it became apparent that complex relations between the supply chain issues, resilience-building attempts, and digital transformation during the COVID-19 pandemic. In order to strengthen their resilience in confronting with constant interruptions, such as the current COVID-19 pandemic, organisations can introduce a suite of

technologies encompassing big data analytics, IoT, and cloud computing. These technological innovations, in turn, empower improved visibility, manageability and risk management capabilities within supply chains.

This research shows how much COVID-19 affects global supply networks. It addresses production, shipping, logistical, and order issues. Supply chain networks can handle logistics obstacles, manpower shortages, and demand variations, demonstrating their resilience and flexibility. Digital technologies like large-scale data analysis, IoT, cloud technology, and artificial intelligence are highlighted as key tools for supply chain resilience. Partnerships create chain synergies and explore resilience-building steps. The major theme is Digital technology that is crucial to stabilising supply chains in this age of pandemics, therefore it can be used to establish strong supply chains.

4.7 Conclusion

In this chapter, we thoroughly went over the career that the corona disease had on global supply chains and the usage of digital technology in improving the resistance of these supply chains. The investigation was centred on three primary research questions: the pandemic's effect on supply chain, operations particular pressure, and how digital technologies helped. The research found that there are cases of extreme disruptions where the companies employ the adaptability and learn to recover. It was further discovered that some of the challenges in normal operations include the logistical disturbances. Finally, it was established that Information communication technology plays a huge role in improving resilience via real-time monitoring, predictive analytics and improved communication techniques. The text ended by highlighting the role of allocating funds to those initiatives that reinforced resilience, introduced digital transformation, and fostered collaboration in order to keep move forward under the pressure of changing company landscapes.

Chapter 05

Conclusion

5.1 Conclusion

In conclusion, this study examined how the COVID-19 pandemic has affected global supply networks and how digital technology has strengthened them. This research has shed light on how the pandemic affected supply chains and how digital solutions can transform them by carefully reviewing the literature and empirical data. The main research goals were to examine COVID-19 pandemic disruptions in supply chains, operational challenges, and how digital technologies might improve supply chain resilience. A comprehensive examination of scholarly literature and empirical studies illuminated supply chain issues and solutions.

Objective 1: Assessment of the Impact of the COVID-19 Pandemic on Global Supply Chains

A synthesis of Reza et al. (2021), Cui et al. (2023), and Spieske and Birkel (2021) findings revealed supply chain challenges and solutions. COVID-19 caused unprecedented disruptions in global supply chains, affecting manufacturing, logistics, and distribution. Supply chain vulnerabilities caused production interruptions, inventory shortages, and logistical issues. Supply chain diversification and supplier engagement helped organisations survive these disruptions.

Objective 2: Evaluation of The global epidemic Operational Challenges

The pandemic caused logistical disruptions, labour shortages, and demand fluctuations for supply chains, according to the investigation. Quarantine and travel restrictions disrupted transportation networks, while manufacturing restrictions caused production delays and inventory management issues, according to Spieske and Birkel (2021) and Sharma et al. (2022). Despite these challenges, organisations adopted agile production methods and used digital technologies to improve efficiency.

Objective 3: Assessment of the Impact of Digital Technology on Supply Chain Resilience

Nabipour and Ülkü (2021) and Pimenta et al. (2022) noted that digital technology helped supply chains survive the pandemic. Big data analytics, IoT, and cloud computing improved supply chain visibility, operations, and risk mitigation. Real-time monitoring and predictive analytics helped businesses respond quickly to disruptions and run efficiently. Digital platforms also helped supply chain stakeholders coordinate and share information.

This study emphasised the need of knowing how the COVID-19 pandemic would affect supply chains and how digital technologies might transform resilience. Digitalization and resilience-building can help organisations overcome disruptive events and create more agile supply chains. To maintain global supply chain continuity and sustainability, stakeholders, governments, and practitioners must prioritise digital solutions and resilience-building activities as the business landscape evolves.

5.2 Implications of Findings

This study has significant implications for supply chain management, policy-making, and technological innovation stakeholders (Reza et al., 2021; Li et al., 2022; Cui et al., 2023).

i. The findings of this study can help supply chain managers improve risk management and resilience. Diversifying supply sources, enhancing supplier collaboration, and embracing agile techniques can help organisations prepare for disruptions (Reza et al., 2021; Li et al., 2022).
ii. Practitioners can profit from the focus on digital technology to enable supply chain resilience. Big data analytics, IoT, and cloud computing can improve inventory management, supply chain monitoring, and decision-making (Cui et al., 2023).
iii. The findings can inform supply chain resilience regulations by policymakers. Governments can strengthen national and global supply chains by encouraging industry stakeholder engagement, digital infrastructure investments, and supply chain technology research and development (Reza et al., 2021; Li et al., 2022).
iv. Disaster preparedness and emergency response agencies can use COVID-19 pandemic lessons into their planning. Agencies can reduce supply chain interruptions and ensure timely delivery of important goods and services by anticipating and preparing for future emergencies (Cui et al., 2023).

v. Technology developers can take advantage of supply chain management innovation prospects. Developers can solve data integration, system interoperability, and cybersecurity issues by creating and deploying sophisticated digital solutions for supply chain stakeholders (Li et al., 2022; Cui, 2023).

vi. To improve supply chain resilience, innovators can use blockchain, AI, and robotics. Innovative pilot projects and collaborative initiatives can accelerate industry-wide change and technology adoption (Reza et al., 2021; Cui et al., 2023).

vii. This study can promote supply chain management research by academics and researchers. Researchers can improve theoretical frameworks and practical guidelines for supply chain resilience by studying risk assessment, finance, and sustainability (Li et al., 2022; Cui et al., 2023). Collaboration between academia and industry can help create knowledge and share best practices. Academic institutions may bridge theory and practice and innovate supply chain management by encouraging interdisciplinary research and industry partnerships (Reza et al., 2021; Li et al., 2022).

The analysis focussed on how active policies, collaboration and technologies that are continually being evolved, can improve the supply chains' resilience as business operations become more intricate and weather volatile markets. The supply chain's inherent supporters, who are at the bottom of the supply chain network, might help build a more sustainable and resistant future by learning from COVID-19 and leveraging digital technologies (Reza et al., 2021; Li et al., 2022; Cui et al., 2023) .

5.3 Recommendations

i. To achieve supply chain visibility, agility, and resilience is the goal, organisations should pay attention to the digital infrastructure such as big data analytics, IoT, and cloud computing (2022; 2023, Cui et al.). Governments, as well as agencies and policymakers, should urge enterprises to employ digital technologies, that would in turn support increasing innovation and technical advancement of supply chain management (Reza et al., 2021, Li et al., 2022).

ii. It is the responsibility of the supply chain partners to team up with the suppliers, the customers, and the rest to improve interactions, coordination and sharing of information (Ye etal., 2022). The knowledge is about supply chains that is shared by specialists

through industry groups and professional networks . The sharing continue with best practices and problem-solving (Reza et.al., 2021; Li et.al., 2022).

iii. Organizations must have risk management strategies inclusive of proper identification, continual assessment, and management of supply chain disruptions. In which it they should (Ye et al., 2022; Cui, 2023). Continuous risk assessments cover geopolitical instability, natural disasters, public health emergencies. In this way, weaknesses in the system are made clear and contingency plans are made (Reza et al., 2021; Li et al., 2022).

iv. Supply chain managers should obtain knowledge in regards to resilience, digital technologies and risk management in order to adapt and navigate complex and difficult circumstances like disruptions (Sharma et al. 2022; Cui et al. 2023). The strategies, processes and technology of supply chain should be constantly revised, evaluated and enhanced by organizations in order to best respond to market changes (Ye et al., 2022; Sharma et al., 2022). Utilising the lessons learned from historic examples of disruption in advance planning and decision-making can push organisations into a more resilient position and foster innovation (Reza et al., 2021; Cui et al., 2023).

These strategies help enhance supply chains, boost disruption resilience, and position companies for long-term success in a dynamic and unpredictable business climate.

5.4 Limitations & STRENGTHS

Strength

i. Spieske and Birkel (2021), and Li, et al. (2022) conducted a comprehensive investigation. The investigation highlighted the influences of the COVID-19 pandemic on global supply chain and the function of electronic technology in making these systems resilient.

ii. The use of structure by frameworks like Supply Chain Resilience and Resource-Based View as a base for the study increases the strength of the theoretical foundation (Spieske et al., 2021).

iii. When research findings are validated and applied in the real world, they provide insights on supply chain management methods and tell us how crucial digitalisation and the building of resilience capacities are (Cui et al., 2023; Sharma et al., 2022).

Limitations

The study used a small number of research papers, which might be too narrow to replicate similar experiences and views.

I. The obtained data from the chosen studies may be quite defective and imprecise to utilise in the synthesised report.
II. The research was related to a specific time period; so, it could be missing the trends of these long-term supply chain dynamics.
III. The outcomes of the research and studies might be specific to a particular field, industry, region or organizations, thus becoming limited in terms of their scalability.
IV. The study may have overlooked aspects like culture, regulation, and organisation structures that are of great significance for supply-chain resilience.

These limitations need to be recognized to realize the situation of the research findings and identify areas that need more attention to improve future research that aim at overcoming such shortcomings.

5.5 Future Research Opportunities

Supply chain management and digital technologies provide a fertile ground for future research opportunities. Here are a few potential directions to think about:

i. **Long-term Effects of the COVID-19 Pandemic:** Another area for future study could be conducting longitudinal studies to determine the long-term repercussions that the economic fallout of the pandemic has worldwide supply chains. By tracking the improvement in supply chain resilience and assessing the consequences of digital system adoptions over time, researchers can enrich their knowledge of adaptive strategies of organisations (Śpiesak and Birkel, 2021).
ii. **Digital Technology and Sustainability:** The digital technology and sustainability associated with supply chain management are yet to be fully explored and hence, the need for research in this area cannot be overemphasized. The implementation of such processes in the future could encompass the usage of new technologies such as internet of things (IoT) and blockchain to instil ecological practices in places like procurement and delivery (Li et al., 2022).
iii. **Collaboration and Digital Platforms:** An intriguing field for further research is the capability of digital systems and networking facilities to increase the effectiveness and flexibility of supply chains. Researchers might run studies that would help determine

which parties should be made to work collaboratively and how digital ecosystems influence supply chain operations. (Cui et al., 2023).

iv. **Integration of new technology:** Also value the other topic that includes exploring the potential issues and prospects of using robotics and AI including other new technology in the course of supply chain processes. To grasp the impact of these technologies intensely, future studies may seek to demonstrate the effects on labour dynamics, operational efficiency, and risk management practices (Sahama et al., 2022).

v. **Socio-economic Implications of Digital Transformation:** Moreover, to understand the deeper impact of digital transformation, further research should be conducted to examine the socio-economic implication associated with these changes in supply chains. We will need to explore such areas as equality in access to technology resources, training skills or job loss. The efforts of researchers to eradicate these drawbacks and devise means which would open way for the store-keepers, employees, suppliers, customers and all involved to benefit from digitization, through improved equity and long-term stability, could be the key contributor to creating more equitable and stable Supply Chain (Spieske and Birkel, 2021).

This study, in addition, showed how serious the blow was to the global supply chain and how important digital technologies are to build a resilient against the shock. Careful examination of the extant literature has permitted us to classify main supply chain problems, operational challenges during a pandemic and the disruptive effect of digital innovations in reducing imbalances and increasing agility. They Pandemic has triggered the chain Glen – to highlight the problems in the establishments but at the same time it has stimulated the innovation and made organisations to have more agile and tech-enabled solutions. Companies can withstand storm epochs and enhance supply chains using ICT transformation and forming partnerships. Moving forward, all actors, including researchers, practitioners and governments should continue striving in discovering new ways of enhancing the resilience of supply chains, resolving remaining challenges, and exploiting innovations for the development of supply chain resilience. As a team and with this research, thus we build supply lines which have a great deal of adaptation and quick adjustment ability in order to bear this uncertainty.

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Appendix A

Critical Appraisal Checklist for Qualitative Studies

	Yes	No	Not clear
Are the objectives of the study clearly stated and aligned with the research question?			
Describe supply chain management and their experiences during the COVID-19 pandemic?			
Are the data collection methods clearly described?			
Does the research question clearly address the impact of digital technology on supply chain management during the COVID-19 pandemic?			
Is the process of data analysis clearly explained?			
Are the findings presented in sufficient detail?			
Are the limitations of the study clearly acknowledged?			
Overall, does the study provide valuable insights into the impact of digital technology on supply chain management during the COVID-19 pandemic?			