ISSN 1980-5411 (On-line version)
Production, 34, e20230076, 2024
DOI: 10.1590/0103-6513.20230076

Research Article

Developing dynamic supply chain resilience capabilities: a study of Irish firms' response to the COVID-19 pandemic

Abubakar Ali[a], **Ashraf Labib**[b,c], **Paulo Afonso**[d], **Amr Mahfouz**[a*]

[a] Technological University Dublin, Faculty of Business, 3S Research Group, Dublin, Ireland

[b] University of Portsmouth, Portsmouth, Hampshire, United Kingdom of Great Britain and Northern Ireland

[c] Bucharest University of Economic Studies, Bucharest, Romania

[d] Universidade do Minho, Centro Algoritmi, Departamento de Produção e Sistemas, Guimarães, Portugal

*amr.mahfouz@tudublin.ie

Abstract

Paper aims: This study is grounded in the supply chain resilience (SCRES) capabilities literature and the dynamic capabilities theory (DCT), which is used to develop a framework of dynamic SCRES capabilities for global supply chain disruptions.

Originality: This study explores firms' adapting, responding, and learning capabilities in the initial outbreak of the coronavirus pandemic 2019 (COVID-19) in the Irish context.

Research method: The research methodology was based on semi-structured interviews with supply chain leaders of international operations, extending between Ireland and the UK. Data analysis utilises a hybrid thematic analysis approach that integrates inductive codes with deductive priori-driven constructs.

Main findings: Five significant impacts of COVID-19 on supply chain operations are revealed: capacity and resource constraints, supply issues, demand spikes, supply chain skills shortages, and human resource factors. Furthermore, firms' high-order SCRES capabilities during a pandemic are related to their adaptation, response, and learning capabilities. Operational capabilities and resilience practices support these high-order capabilities. However, the empirical evidence indicates that resilience practices overlap across SCRES capabilities.

Implications for theory and practice: The connection between SCRES and dynamic capabilities is emphasized by demonstrating that operational capabilities and resilience practices are integral building blocks of high-order SCRES capabilities. We distinguish between dynamic and operational capabilities and present an integrative framework to elaborate the theory of dynamic SCRES capabilities. Moreover, valuable insights into developing dynamic SCRES capabilities are highlighted by adapting to changes, seizing opportunities, coordinating tasks, and engaging in learning routines in response to a pandemic disruption. Firms that harness SCRES elements and practices to enhance their adaptability, response, and learning capabilities share similarities with the dynamic capabilities processes of adapting & seizing, coordinating, and learning.

Keywords

Dynamic capabilities. Supply chain resilience capabilities. Supply chain disruptions. COVID-19.

How to cite this article: Ali, A., Labib, A., Afonso, P., & Mahfouz, A. (2024). Developing dynamic supply chain resilience capabilities: a study of Irish firms' response to the COVID-19 pandemic. *Production*, *34*, e20230076. https://doi.org/10.1590/0103-6513.20230076.

Received: Oct. 4, 2023; Accepted: Apr. 11, 2024.

1. Introduction

The impact of COVID-19 has highlighted the intricate relationship between pandemics and supply chain management (SCM), and its severe consequences have exposed the vulnerabilities of product and service supply chains on a global scale in contemporary times (Choi, 2020; Craighead et al., 2020; Ivanov, 2020). As a result,

practitioners and researchers have called for re-evaluating supply chain strategies and advocated for more research on supply chain resilience (SCRES) to address pandemics (Ivanov & Dolgui, 2020; Miroudot, 2020; van Hoek & Dobrzykowski, 2021). Building SCRES is a vital strategic capability that enables businesses to adapt and flourish while maintaining competitiveness. Despite the growing interest in SCRES strategies, there is limited understanding of what constitutes resiliency at the firm and supply chain levels and what measures can be taken to enhance system resilience (van Hoek, 2020; Wieland & Durach, 2021). Furthermore, early SCRES studies on COVID-19 disruptions revealed an inadequate comprehension of capabilities associated with anticipation and recovery (Ivanov & Das, 2020), response (van Hoek, 2020), and Learning (Zhu et al., 2020) to alleviate pandemic disruptions. The pandemic's magnitude and impact, and the limited prior knowledge regarding its characteristics and implications, made it understandable that there was a lack of awareness about anticipation and recovery during the initial phase of COVID-19 (Ivanov & Das, 2020). Accordingly, scholars have argued that the pandemic has presented an opportunity to grasp and apply the SCRES concept to bridge the gap between research and practice (van Hoek, 2020).

In response to such calls, this study examines the adapting, responding, and learning capabilities of firms during the initial outbreak of the COVID-19 pandemic. Drawing on the SCRES capabilities literature (e.g., Ali et al., 2017; Scholten et al., 2019) and dynamic capabilities theory (DCT) (Teece et al., 1997; Teece, 2007), a framework of dynamic SCRES capabilities was developed in response to pandemic disruptions. The argument is that SCRES and dynamic capabilities (DC) share similar competencies in uncertain and evolving environments and, thus, can be considered equivalent in this context. DC is a high-order competency that allows firms to modify their operational capabilities to maintain a competitive advantage (Helfat et al., 2007). Similarly, SCRES capabilities refer to bundles of practices that enable supply chains to manage disruptions effectively (Birkie et al., 2017; Dabhilkar et al., 2016). Consequently, SCRES capabilities can be classified as dynamic capabilities (Stadtfeld & Gruchmann, 2023). Therefore, dynamic SCRES capabilities were defined as high-order capabilities that alter low-order operational capabilities to ensure business continuity and maintain a competitive advantage (Helfat et al., 2007; Winter, 2003).

Therefore, DCT serves as the lens through which we examine how a firm's ability to adapt, respond and learn enables them to adapt to changes, seize opportunities, coordinate tasks, and learn routines supported by operational capabilities during the initial COVID-19 pandemic disruption. The study focuses on Irish firms and the uncertainties and challenges they faced during this time. Despite the strategic importance of logistics and SCM to the Irish economy, few empirical studies have explored the challenges and impact of the pandemic in this context. Thus, this study investigated the dynamic SCRES capabilities exhibited by firms during the initial outbreak to mitigate disruptions. In doing so, the study addressed the following research questions (RQs):

RQ1: What supply chain challenges did Irish firms experience during the COVID-19 pandemic disruptions? And what was the impact on supply chain operations?

RQ2: How did Irish firms exhibit Dynamic SCRES capabilities to mitigate COVID-19 pandemic disruptions?

Our contributions to the current discussions on SCRES capabilities and pandemics are as follows. First, the research differentiated between dynamic and operational capabilities in SCRES research, which sets us apart from most studies that have employed DCT in this field. This study expands our understanding of DCT in SCRES studies by illustrating how operational capabilities and resilience practices are the building blocks of higher-order SCRES capabilities. These higher-order capabilities explain how firms adapt to changes, seize opportunities, coordinate tasks, and learn routines to adapt, respond, and learn from pandemic disruptions. In doing so, better theory building and testing in SCRES studies were facilitated by clearly distinguishing the relationship between DCT and SCRES capabilities. Second, this study emphasised the significance of a firm's ability to adapt, respond, and learn in cultivating dynamic SCRES capabilities to comprehend the challenges and impact of COVID-19 on SC operations and to explore mitigation strategies. The research presented a dynamic SCRES capabilities framework with which firms can apply, adjust, and manipulate variables to suit their operations during future disruptions.

2. Theoretical background

2.1. Supply Chain Resilience (SCRES) capabilities

The SCRES concept offers insights into how firms and supply chains persist, adapt, and transform in the face of adversity by employing various coping mechanisms to address unpredictable and disruptive events (Wieland et al., 2023). Capabilities can exist at different levels (Schilke, 2014) and are a collection of routines, which are patterns

of behaviour founded in part on tacit knowledge (Winter, 2003). Therefore, SCRES capabilities refer to bundles of routines that enable supply chains to manage disruptions effectively (Birkie et al., 2017; Dabhilkar et al., 2016). The SCRES literature proposes various capabilities that are tailored to different disruptive events and are categorised into three phases: before, during, and after disruptions, as well as proactive, concurrent, and reactive strategies (Ali et al., 2017; Chowdhury & Quaddus, 2016). However, the hierarchical conceptualisation of SCRES capabilities and their relationships with relevant SCRES elements and practices is inconsistently applied, leading to a fragmented literature that employs diverse terminologies (Ali et al., 2017; Hohenstein et al., 2015).

To elaborate on SCRES capabilities, the study considers a broader view of SCRES and defines it as the ability to prepare, adapt, respond, recover, learn, and grow from disturbances (Ponomarov & Holcomb, 2009; Scholten et al., 2019). This definition emphasises the need for several capabilities during various phases of disruption. For instance, readiness, preparedness, and anticipation capabilities are necessary in the pre-disruption phase (Chowdhury & Quaddus, 2016). Similarly, adaptation or responsive capabilities are crucial during the disruption phase (Adobor, 2020; Kochan & Nowicki, 2018), while recovery, learning, and growth capabilities are vital in the post-disruption phase (Hohenstein et al., 2015). These capabilities are supported by various SCRES elements and managerial practices, which highlight different hierarchical levels of competencies needed to build SCRES in each phase (Ali et al., 2017). Therefore, SCRES capabilities are considered high-order capabilities supported by low-order operational capabilities such as SCRES elements of flexibility, redundancy, agility, and collaboration (Scholten & Schilder, 2015; Shekarian et al., 2020; Zsidisin & Wagner, 2010), as well as practices like flexible order fulfilment, excess capacity in production, and collaborative planning (Christopher & Peck, 2004; Pettit et al., 2013; Sheffi & Rice, 2005).

Consequently, a firm's high-order SCRES capabilities can be considered strategic abilities that leverage and integrate low-order capabilities to cope with disruptions and enhance the resilience of supply chains (Dubey et al., 2023; Sawyerr & Harrison, 2023). Based on this logic, a firm's ability to anticipate, adapt, respond, recover, and learn (Ali et al., 2017) is referred to as high-order SCRES capabilities supported by low-order capabilities, which are their essential building blocks to function effectively in building resilient supply chains, See Figure 1.

2.2. Theoretical lens: dynamic capabilities theory

The Dynamic Capabilities Theory (DCT) posits a framework for understanding firm-level competitive advantage in conditions of deep uncertainty (Teece, 2014) and explains how organisations adapt to such conditions (O'Reilly III & Tushman, 2008). Dynamic capabilities (DC) enable firms to alter their initial position and strategic path (Zollo & Winter, 2002). The effectiveness of DC is influenced not only by supporting processes and practices but also by their compatibility with the firm's external and internal environments. This "fit" determines the usefulness of DC as a mechanism for adapting to, exploiting, and creating changes in business climate (Helfat et al., 2007). DCT is still in its early stages of development (Di Stefano et al., 2010), with fragmented literature containing multiple concepts and relationships (Ambrosini et al., 2009). However, recent research has advanced the theory by exploring measures of DC (Danneels, 2016), developing an integrated framework for DC (Schilke et al., 2018), and examining how DC transform ordinary capabilities (Schulze & Brusoni, 2022).

In DC literature, a significant debate centres on the distinction between dynamic and operational (or ordinary) capabilities (Helfat & Winter, 2011; Schriber & Löwstedt, 2020). Although both capabilities are a collection of routines, they differ in their purpose and intended outcomes (Helfat & Winter, 2011). Operational capabilities enable a firm to function in the present, focusing on doing things right (Teece, 2014; Winter, 2003), and can be benchmarked internally or externally against industry best practices using measures such as labour productivity, inventory turns, and time to completion (Teece, 2014). Operational capabilities are also referred to as ordinary, substantive, day-to-day activities, low-order, or zero-order capabilities (Collis, 1994; Pavlou & El Sawy, 2011; Zahra et al., 2006). In contrast, dynamic capabilities allow firms to change their operations (Eisenhardt & Martin, 2000). DC encompass managerial practices and organizational processes that facilitate learning, integration, reconfiguration, and transformation as the market changes (Helfat et al., 2007; O'Reilly III & Tushman, 2008). As a result, a firm's DC can impact its performance, competitive advantage, position, and strategic path (Helfat et al., 2009; Pavlou & El Sawy, 2011) by allowing firms to engage in continuous or semi-continuous sensing, seizing, and transformation to stay consistent with the environment (Teece, 2007). DC is built through investments in discovery, knowledge generation, and Learning (Teece, 2019) and is a source of sustained competitive advantage (Eisenhardt & Martin, 2000). Hence, DC is referred to as high-order or first-order capabilities supported by ordinary or low-order capabilities (Schilke, 2014). Unlike ordinary capabilities, DC cannot be bought in the market, which explains why intangible assets such as a firm's collective knowledge and capabilities are scarce and difficult to imitate (Teece, 2017).

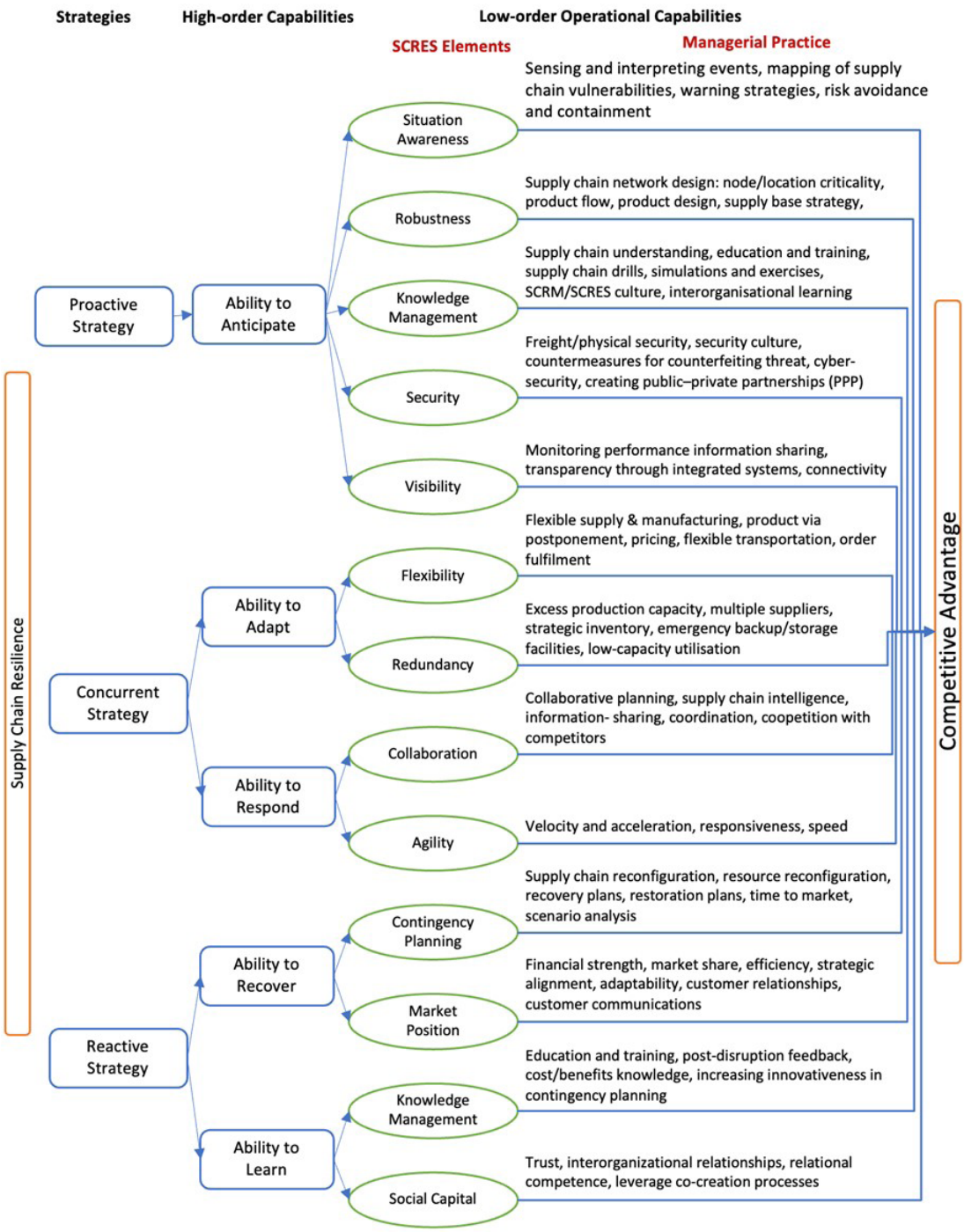

Figure 1. SCRES Conceptual Mapping (Ali et al., 2017).

2.3. SCRES capabilities and dynamic capabilities: conceptualising dynamic SCRES capabilities

Building on previous discussions, DC and SCRES capabilities exhibit similar responses in uncertainty and an evolving business environment. Therefore, a theoretical synthesis of DC and SCRES capabilities was proposed by identifying the commonalities between their high-order and supporting low-order capabilities. The aim is to develop a conceptual framework for dynamic SCRES capabilities grounded in theoretical foundations and practical insights gained from

the initial COVID-19 pandemic disruptions. This study defines Dynamic SCRES capabilities as high-order capabilities that alter low-order operational capabilities to ensure business continuity and maintain a competitive advantage (Helfat et al., 2007; Winter, 2003). The term 'dynamic' refers to the changing business environment or disruptive events faced by supply chains. The term 'capabilities' emphasises a firm's or SC network's collection of practices and resources that enable them to manage disruptions or changing environments effectively. In conceptualising dynamic SCRES capabilities, the study adopts Eisenhardt and Martin's (2000), p. 110) the perspective that "dynamic capabilities comprise identifiable and specific routines that have been the subject of extensive empirical research".

In the context of SCRES, several empirical studies have identified specific low-order SCRES elements and managerial practices that support the high-order capabilities of anticipation, adaptation, response, recovery, and learning in recent years (e.g., (Chowdhury & Quaddus, 2016; Scholten et al., 2019). In strategic management and DCT literature, sensing, seizing and reconfiguring (Teece, 2007), adaptive, absorptive, and innovation (Wang & Ahmed, 2007), coordinating (Pavlou & El Sawy, 2011) and Learning (Eisenhardt & Martin, 2000) are considered high-order capabilities supported by low-order capabilities to sustain a firm's competitive advantage. For instance, adaptation as a high-order capability is supported by the flexibility of resources, the positioning of these resources, and the firm structure and changing needs of the business environment (O'Reilly III & Tushman, 2008).

The high-order DC, such as sensing, seizing, reconfiguring, coordinating, and learning, are similar to SCRES capabilities in terms of anticipating, adapting, responding, recovering, and learning from disruptions. For example, in the SC disruptions context, sensing threats occurs before a disruption, and seizing opportunities takes place before or during disruptions (Hendry et al., 2019). Adapting to changes, coordinating tasks, and reconfiguring resources and assets occur during a disruption, and learning from failures and successes can occur before, during and after a disruption. Therefore, high-order DCs emphasise opportunities, which supports the idea that building SCRES capabilities is a strategic competence enabling firms to survive and thrive from disruptive events (Seville et al., 2015). However, one source of ambiguity in using the DCT in SCRES studies is the lack of distinction between operational and dynamic capabilities (Eftekhar et al., 2017; Lee & Rha, 2016). Therefore, a clear distinction in using the DCT is required to facilitate better theory building and testing in SCRES studies.

Building on previous SCRES studies that ground DC as a high-order capability (Hendry et al., 2019; Scholten et al., 2019), the study elaborates on a theory of dynamic SCRES capabilities at a firm-level in the context of the COVID-19 pandemic disruptions. Specifically, we differentiate between high-order and low-order capabilities based on prior SCRES studies that distinguish between dynamic and operational capabilities (Dubey et al., 2023), and classify DC as high-order capabilities (Sawyerr & Harrison, 2023). Further, (Ali et al., 2017) SCRES capabilities framework, Figure 1, was used as a theoretical basis for the theory elaboration because of its integrative approach to SCRES capabilities, elements, and managerial practices. It captures the hierarchical view of DC to differentiate between high-order and low-order capabilities. Three of the five SCRES capabilities proposed by Ali et al. (2017) were examined for this study: the ability to adapt, respond, and learn. The aim was to gain a deeper understanding of the SCRES capabilities demonstrated by firms during the first wave of pandemic disruptions.

Consequently, evaluating a firm's ability to anticipate and recover from the initial pandemic was excluded, as claims of full preparedness and recovery at that time were unrealistic. Furthermore, while Ali et al. (2017) categorised learning capabilities as pre- and post-disruption competence, Scholten et al. (2019) emphasised that learning mechanisms occur throughout all phases of disruptions – before, during, and after. Therefore, the study sought to understand a firm's ability to learn during pandemic disruptions.

To enhance understanding of firms' resilience during the initial stages of the pandemic, the SCRES capabilities of adapting, responding, and learning were aligned with the DC processes of adapting and seizing, coordinating and learning. The firm's higher-order DC processes are supported by lower-order operational capabilities that enable them to adapt to changes, seize opportunities, coordinate tasks, and learn from failures and successes during disruptions. By aligning these DC processes to the high-order SCRES capabilities, the links between the firm's high-order SCRES capabilities and low-order operational elements (e.g., flexibility, collaboration) and their managerial practices (flexible supply, information sharing) will be clarified. By leveraging these high- and low-order SCRES capabilities, firms can adapt, coordinate, and learn how to endure and prosper in the face of COVID-19 disruptions and maintain their competitive edge.

3. Research methodology

3.1. Research design

A multiple-case study approach was adopted to explore the phenomenon in depth. Given the global and intricate nature of COVID-19, the case research approach was deemed suitable, as it enabled the investigation

of the why, what, and how questions (Yin, 2009). The research aims to identify the resilience capabilities that equip participating firms to surmount the initial disruptions caused by the COVID-19 pandemic. To this end, the unit of analysis was defined as the disruptive event (COVID-19) in the supply chain and pinpointed the competencies necessary to develop dynamic SCRES capabilities in the early stages of pandemic disruptions. The study seeks to achieve a broader theoretical understanding of the impact of COVID-19 and responding strategies. It draws on the literature on SCRES capabilities and practices to elucidate commonalities with the dynamic capabilities rooted in the nuances of contextual empirical evidence. Hence, this research adopts a theory elaboration approach to case research (Ketokivi & Choi, 2014). A research strategy grounded in the abductive logic of reasoning is applied to refine the theory by integrating the logic of SCRES capabilities and DCs with empirical data (Ketokivi & Choi, 2014; Niiniluoto, 1999) and to advance the dynamic SCRES capabilities concept.

3.2. Data collection

Our primary data source was a semi-structured interview conducted in July 2020 amidst the COVID-19 social distancing mandates. The interviews were conducted with companies with significant operations in Ireland and extended supply chains to the UK and Europe. Using purposive sampling, twenty professionals from various industries and supply chains were selected based on their knowledge and experience in supply chain management during disruption and their expertise in the firm's internal and external processes. Due to the restrictions imposed by the lockdown, it was necessary to conduct the interviews online. In total, eight Interviewees were available for a 90-minute discussion; see Table 1. Following Eisenhardt's (1989) observation, eight cases were seen as sufficient sample to capture the situation's complexity while facilitating the information's cognitive process. The interview protocol was developed based on a literature review, providing a framework for data collection. The overarching goals of the interviews were to 1) describe the impacts and challenges of COVID-19, 2) understand the demonstrated capabilities of SCRES in adapting and responding to the initial pandemic disruptions, and 3) explore the learning initiatives and lessons learned. The interview questionnaire comprised open-ended questions and probes to encourage detailed responses on the specific aspects of the three main areas of the questions, as outlined in Appendix A.

Table 1. Interviewee Overview: Positions and Experience.

Interviewee	Position and Organisation	Experience	Company's Overview
A	Customer SC Manager	10 Years	An international FMCG in the consumer staples sector with more than 500 employees located in Ireland
B	Senior SC & Resourcing Manager	10 Years	An international FMCG in the food industry with more than 50 employees located in Ireland
C	Head of Ocean Freight	15 Years	An international forwarder with locations in 220 countries. The Irish branch employs more than 500 employees.
D	National Transport & Logistics Manager	20 Years	An Irish Food Wholesaler/Retailer employs more than 1,000 employees and enjoys a network of 1,000 partners and stakeholders
E	Owner of SCM Consultations	15 years	The company specialises in procurement, supply chain and logistics, offering training, business process outsourcing and project management services.
F	Owner of SC Training and Consultation	20 years	A leading promoter of education and training in supply chain and operations management in Ireland
G	Leader in SC Education & Training	30 Years	A freelance consultant and educational expert in supply chain modelling and optimisation.
H	Owner of SCM Consultations	15 years	An Ireland-based consultancy company offering a wide range of SC process improvement and people development services in collaboration with Enterprise Ireland and IDA Ireland

Further, permission to record the discussions was requested, with a transcribed copy sent to each interviewee to verify the transcripts' accuracy and maintain the findings' validity. To ensure the rigour of the research, the interview findings were triangulated and validated by reviewing secondary data sources such as industrial reports and government documents (Perry et al., 2015). These resources strongly supported the interview outcomes, lending confidence to the research findings.

3.3. Data analysis

A hybrid thematic analysis approach combining data-driven inductive and deductive a priori codes was used to analyse the data (Fereday & Muir-Cochrane, 2006). This approach integrated data-driven codes from

Interviewees with a priori theory-driven constructs based on the SCRES and DCT literature (Barratt et al., 2011). By employing prior constructs, the researcher gained a substantial empirical foundation for ground-emergent theories (Eisenhardt, 1989). This study adhered to the guidelines for qualitative data analysis outlined in Miles et al. (2014) and Saldana (2016). The analysis began by condensing the transcripts into relevant sentences, quotes, and paragraphs before engaging in the first and second-cycle coding processes. In the first cycle, descriptive and process coding was used to derive the SCRES practices described by the Interviewees, resulting in the emergence of codes from the empirical data. In the second cycle, the codes that emerged from the first cycle were deduced searching for resilience practices that could be grouped into categories of SCRES elements (e.g. flexibility) using pattern coding to provide meaningful analysis units based on the literature. The data-driven codes were then linked to their relevant high-order SCRES capabilities. Finally, based on the abductive logic of reasoning of the empirical evidence, the high-order SCRES capabilities and their associated elements were associated with similar DC processes based on the literature. This transition from empirical data to a priori theoretical categories and their linkages to SCRES capabilities and DC processes enables a theory-elaboration approach to the case research (Ketokivi & Choi, 2014).

Two researchers who were not involved in the coding process evaluated inter-coder reliability. They assessed the coherence and validity of the codes and themes derived and their alignment with predefined theoretical codes of DC processes. This iterative process was repeated several times to ensure internal consistency and reflexivity, minimise researcher bias, and ensure internal triangulation. The analysis focused on the data structure that demonstrated dynamic relationships among emerging concepts to explain the phenomenon and link relevant data to theory (Gioia et al., 2013). Additionally, the data analysis involved a cross-case analysis to compare patterns and categories derived from the data and existing literature. The cross-case analysis confirmed that the emerged practices are not unique and are, therefore, transferable to other contexts within the Interviewees' companies (Miles et al., 2014). Finally, to maintain a systematic and consistent approach to managing the data analysis process, analytic data tools were used to organise and manipulate the data, with features such as search, filter, and pivot tables to identify similar codes and derived themes in the analysis.

4. Findings and discussion

4.1. Challenges and impact of COVID-19 disruptions

The first research question sought to understand the initial impact of the COVID-19 pandemic on Irish supply chains within four months. Hence, *what supply chain challenges did Irish firms experience during the COVID-19 disruptions, and what was the impact on supply chain operations?* Interviewees reported various challenges categorised into five groups: capacity and resource constraints, supply issues, demand spikes, supply chain (SC) skills shortage, and human resource factors. Figure 2 summarises the critical challenges collated by the Interviewees.

The capacity and resource constraints category refers to ongoing challenges experienced by most Irish firms in their supply chain operations, exacerbated by the COVID-19 pandemic. For example, challenges relating to warehouse space and port capacities. These challenges were highlighted by the head of ocean freight (Interviewee C) in the below quote:

> *We saw equipment shortages on the ocean freight sites relating to container imbalances, particularly with export brokers and pallets stacking up in warehouses that could not ship. In particular, temperature control cargo such as foods and pharma where warehouse space is already full in Ireland. Also, we have had much stockpiling with organisations getting ready for Brexit. So, warehouse space was already full, and suddenly, exporters could not send their products because of the lockdown. Also, port capacity was an issue regarding clearing non-essential goods to make room for essential goods.*

Similarly, the transport manager of the local wholesaler/retailer (Interviewee D) echoes Ireland's warehousing space and capacity issues.

> *The COVID crisis caused empty shelves across the board as the FMCG supply chains are very fragile. We have our fast-moving lines, but our warehouses are not big enough to hold six to seven weeks of that type of stock.*

The supply issues category relates to raw materials shortages impacted by the closure of the supply base and manufacturing during the pandemic. For instance, some Interviewees reported that cost-efficient approaches in supply management, such as just-in-time (JIT) and over-reliance on single suppliers, amplified supply risks during the pandemic. As explained by Interviewee C,

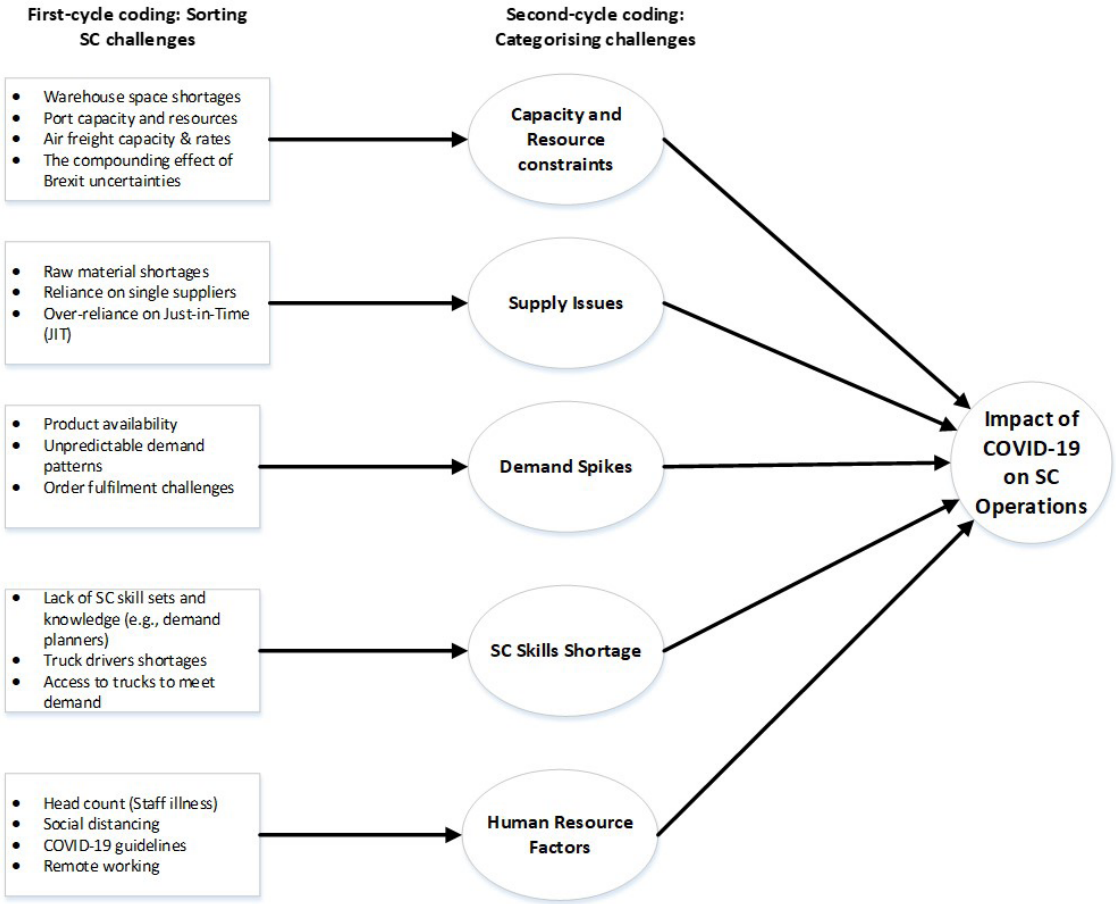

Figure 2. Overview of SC Challenges.

> *In terms of general inventory, many organisations struggle in terms of getting raw materials and parts. Most are very focused on using one supplier, whether it be in China, and now suddenly that supply chain is completely broken.*

The demand spikes category entails the unpredictable demand patterns on certain products experienced by firms during the pandemic. This challenge was reported by most Interviewees, as evident in the following quote from Interviewee B:

> *The consumer demand is absolutely through the roof. In ...* [global brand]*, we are in the food category. So ... and ...* [famous product lines] *go through us in Ireland. Our regular customers have had six weeks in a row where their orders were like Christmas week, just as all this was kicking off* [lockdown and restrictions]*. So, while the toilet paper got the headlines, huge volumes of other food ranges were consumed in the background, and reacting was challenging.*

The SC skills shortage category describes the lack of practical skill sets and knowledge of global supply chains, which was relevant for most Irish firms during the pandemic. While this is an ongoing global issue, it was prominent during the pandemic that most firms lacked the SC skill sets and knowledge to react to the unprecedented COVID crisis. Several Interviewees raised this ongoing global issue. For example, Interviewee B mentioned:

> *I find it hard to hire good demand planners in Ireland. And now, the good ones have been tied up over the last two years because companies are holding them for Brexit, which makes sense.*

Likewise, the SCM professor concisely summarised this challenge in the below quote:

> *One thing that has become very clear over the last few months is that we have severe skill and knowledge shortages. Especially when it comes to issues like practical skills, tools, and techniques that we need to deploy to reimagine our supply chains.* (Interviewee G).

The human resource category relates to the challenges of remote working and implementing COVID-19 guidelines in supply chain operations. Some of these challenges were internal, while others related to supply chain partners working remotely with varying degrees of adaptation. For instance, Interviewee B reported how certain functions could shift working remotely quicker than some of their supply chain partners internally.

> *So, you find a situation where you are ready to switch working completely one way and geared up to move quickly. Then, our warehouse distribution partner was in a different space where office people were working remotely. However, account managers, shippers, and supervisors who must look after operations on the floor could not. Therefore, they work at a different pace. When relying on products from factories from abroad, it is the third kind of level of complexity that you must keep on top. So, a varying degree of readiness was shown when considering the whole chain.*

Interviewee A, likewise, highlights the workforce challenges of following the COVID-19 guidelines in their supply chain operations.

> *Our warehouses and operations were challenged because of several illnesses, which means the headcount was unavailable to deliver the same service as usual. However, even when the warehouses were functioning, it was a total shift considering social distancing.*

In summary, the COVID-19 pandemic has highlighted new and old challenges that most firms experienced. The new challenges related to remote working and implementing COVID-19 guidelines. While the old entails SC skill sets and knowledge, over-reliance on JIT approaches, and single suppliers. The former has underlined the "new norm", which global supply chains must embrace and instil in their operations. In contrast, the latter has accentuated well-known supply chain vulnerabilities during the COVID-19 pandemic. Indeed, these findings are consistent with the emerging research on the impact of COVID-19 on supply chain disruptions. For instance, supply and demand fluctuations and disruption propagations (Ivanov, 2020; Ivanov & Dolgui, 2020), resource allocation and constraints (Queiroz et al., 2022), SC skills shortage (van Hoek et al., 2020; Zhu et al., 2020) and human resource factors (Mollenkopf et al., 2021). The new norm mindset requires firms to possess capabilities that match such an environment. Indeed, in such conditions, dynamic capabilities are sought in a rapidly changing business environment characterised by uncertainties and volatile markets (Teece et al., 1997; Helfat et al., 2007). COVID-19, therefore, has demonstrated profound interconnections between pandemics and global supply chains, which warrants a thorough investigation. Also, it emphasises the need to build and cultivate SCRES capabilities to cope with such disruptions. Therefore, the following research proposition (RP) was presented:

> ***RP1:*** *Pandemics such as COVID-19 present unprecedented challenges to supply chain operations regarding supply, demand, capacity resources, skills shortages, and human resource factors. Such events can be better mitigated by a firm's proclivity to foster SCRES capabilities to match the environment.*

4.2. SCRES capabilities exhibited in the initial phase of COVID-19 disruption

This section explores the various SCRES capabilities demonstrated by Irish firms during the initial COVID-19 pandemic. Hence, *how did Irish firms exhibit Dynamic SCRES capabilities to adapt, respond to, and learn from COVID-19 disruptions?* In answering this question, SCRES capabilities are examined based on the link between empirical data and the conceptual SCRES construct, as discussed in the literature. The empirical data was induced from the interviewees' responses, and the conceptual construct was deduced from SCRES literature, while both were grounded in DC processes using an abduction logic.

4.2.1. Adapting capabilities

The ability to adapt was defined as a capability required to manage and adjust critical supply chain resources during disruptions (Ali et al., 2017). The interviews identified practices associated with SCRES element of flexibility that enabled firms to continuously adjust critical resources and processes during the initial COVID-19 pandemic to sustain operations. The findings suggested different types of flexibility, including flexible staff management, working environments, manufacturing processes, product design and supply.

The flexible manufacturing process was exhibited in product design reconfiguration as part of the adapting capabilities. Interviewee A explained how shifting the production process enabled them to react to substantial demand spikes on antibacterial products using surplus capacity and the necessary raw materials to facilitate adaptability for altering product designs and configurations, thereby seizing opportunities to respond to changes.

Our demand was beyond extreme. For example, antibacterial liquid hand wash, we sold six months of stock in one week. So, what actions did we take? We looked at alternative routes to markets and different production points. We looked at what alternative products are available within our portfolio and how we utilise those raw materials. For example, we moved from the push pump liquid hand wash bottle to a shower gel bottle to fill gaps on shelves and still satisfy consumer demand. We were able to turn that around quickly because we had all the stock available.

Furthermore, the strict government measures implemented during the initial COVID-19, such as social distancing and movement restrictions, prompted numerous companies to change workplace settings and transition to remote working practices. Hence, firms needed to adapt flexible staff management and working environments to sustain their operations during this phase of the pandemic. For example, Interviewee B explained such practices below.

There was other parts of the organization that was paper based, and we'll have to go to the office. And I think we're probably all trying to work through a program now of how do we get to a point that we can be flexible and agile to build and have sort of Flexi worker management to cope with a second wave of pandemic.

Interviewee C further supported this point, describing how they had to adapt staff management practices between shifts to adhere to the restrictive rules.

Things like shift change, we put in 40 minutes blackout periods between shifts and virtual handover between managers and supervisor to maintain our operations.

However, these flexible staff management and working conditions also presented challenges to some firms depending on the degree of adaptability in their supply chain, as explained by Interviewee A.

While other staff can work remotely, warehouse and distribution staff who oversee on-site operations cannot. Also there were complexities relying on foreign suppliers. So there was varying levels of adaptation across our supply chain. So, from our standpoint, the transition was reasonably easy to manage. But, understanding and coordinating the different situations of business functions, partners, and suppliers was a challenge.

Also, the COVID-19 pandemic disruption required firms to be flexible in coping with changes by leveraging technology. The findings indicated that the firm's ability to be creative in shifting not only meetings and administrative work online but also customer care and client support using technology tools and innovative ideas were essential to adapt to changes. This is supported by Interviewee D,

So for the first, probably two or three weeks, it was radio silence. And then we started getting back in and having zoom team meetings and leveraging all of the technology available to support our clients. This included building S&OP platforms and building MRP systems for clients. So, we're able to do a lot of that remotely to cope with disruptions.

Finally, having flexible supply and alternative suppliers was highlighted as a critical practice to adapt to the pandemic disruption due to the over-reliance on single suppliers, as illustrated by Interviewee C.

Just in terms of general inventory, many of our partners struggle in terms of getting parts and raw materials, and probably have focused on using one supplier in China, and suddenly that supply chain is completely broken.

In summary, the findings are consistent with previous studies on flexibility practices to build SCRES capabilities (Pettit et al., 2013; Tang & Tomlin, 2008). Flexibility is a critical element that fosters a firm's adapting capabilities to manage and adjust its resources during disruptions (Ali et al., 2017). Moreover, as highlighted by the Interviewees, the dimensions of a firm's ability to adapt share attributes with dynamic adapting and seizing routines. For example, firms with high adapting capability often display dynamic capabilities in a volatile environment (Teece et al., 1997). This is through the strategic flexibility of resources and their positioning, the firm's structure, and the rapidly changing needs of the business environment (O'Reilly III & Tushman, 2008). Also, adapting capability encompasses various dimensions, spanning from a firm's capacity to adjust its product-market scope in response to external opportunities to market (Wang & Ahmed, 2007) while seizing opportunities and threats in a timely focused (Barreto, 2010). Hence, adaptability empowers a firm to promptly respond to changes and evolve swiftly as market conditions shift (Gibson & Birkinshaw, 2004). Thus, based on the data coding as shown in Table 2, the following research proposition is formulated:

***RP2:** A firm's ability to adapt during COVID-19 pandemic disruptions by building flexibility practices such as flexible staff management, flexible working environments, flexible manufacturing processes, flexible product design and flexible supply demonstrates its dynamic adapting and seizing routines by adapting to environmental changes and seizing opportunities to respond. Such practices, in turn, enhances a firm's responsiveness during disruptions.*

Table 2. A Hybrid Thematic Analysis for SCRES Ability to Adapt.

1st – Cycle Coding:	2nd – Cycle Coding:	
Interview Themes	SCRES Ability to Adapt Elements & Practices	Link to Dynamic Capability Theory
	Flexibility	*Dynamic Adapting and Seizing Routine*
New production points	Shifting in Production Process	Adjust New product-market Scope
Alternative routes to market		
Alternative products within the portfolio		
Rapid shift in the production configuration		
Surplus raw material stock capacity		
Organisation flexibility and agility	Flexible Workplace Setting	Rapid Changing of Firms' Structure and Operations
Flexible worker management		
Shift schedule changes		
Virtual handover	Fast Transition to Remote Working	Display dynamic capabilities in a volatile environment
Feasibility of remote working		Adaptive responses to changing conditions
Different adaptation abilities of partners and suppliers	Supply Chain Flexibility	Strategic Resources Flexibility
Creating flexible supply		
Alternative suppliers		
Innovative utilisation of technology	Effective utilisation of technology	Evolve swiftly as market conditions shift
Leverage all available technologies to operate as usual		

4.2.2. Response capabilities

The ability to respond was defined as the capability required to react to crisis efficiently to lessen the adverse impact of disruptions (Ali et al., 2017). The study identified practices associated with two SCRES elements of collaboration and agility that enabled firms to react in the immediate response to the COVID-19 pandemic. The findings suggest collaboration is needed to create an immediate response mechanism to react during a pandemic. Different types of collaboration were evident in planning, coordinating, building relationships and information sharing. Indeed, this finding is consistent with the previous study on collaboration as a critical element in building resilience, for instance, collaborative planning (Christopher & Peck, 2004), information-sharing (Jüttner & Maklan, 2011), and building relationships (Scholten et al., 2019). Some Interviewees, however, argued that Irish supply chain partners have not fully embraced collaborative initiatives, which, in turn, has impacted supply chain visibility. Nevertheless, the impact of COVID-19 has shifted most organisations' attitudes towards supply chain collaboration. Interviewee C succinctly summarised this point from an international forwarder perspective.

> *I think connectivity between suppliers and customers is lacking but has undoubtedly improved through this crisis. It is one of the good things to have come out of it. However, we see that some customers are better at collaborating. I think a greater collaboration between stakeholders would vastly improve our processes. Whether it is EDI connectivity, simplifying processes, digitalisation going paperless, all that kind of stuff.*

Similarly, Interviewee A elaborated on how internal collaborative approaches during the pandemic have increased transparency in addressing various issues, from demand risks to product rationalisation on a specific stock-keeping unit (SKU). The findings align with Scholten et al. (2014) on the role of collaboration in coordinating an immediate response and Leat & Revoredo-Giha (2013) on vertical and horizontal collaborations in increasing SCRES. Interviewee A - the customer supply chain manager - exemplified this point:

> *Now we have a weekly meeting with all stakeholders to review demand risks. We have open, transparent discussions about portfolio rationalisation, return dates on specific SKUs, and we include commercial as part of those discussions, which we had not done previously. We are now looking to retain that cross-functional collaboration and across collaboration with partners on an ongoing basis.*

Also, The data indicated that agility is vital to a firm's response mechanism during the pandemic disruption. The agility construct described a firm's ability to respond quickly to changes, which was evident through operational and management responsiveness. Interviewee C explains an example of operational agility via staff management to improve response time.

> *We are now building an agile and flexible staff management program for potential second-wave disruption.*

Furthermore, process agility is vital for effective response to the pandemic implications; interviewee H.

> *Look at your S&OP process to identify the constraints as COVID-19 caused demand spikes and changes in the consumer behaviour. Therefore, understanding the constraints and enhancing visibility enables my clients to respond and adapt to changes quickly in the new norms.*

In addition, management responsiveness through quick decision-making is a critical agile practice. Interviewee B illustrated this by explaining how critical decisions involving operations and customers were made to respond quickly.

> *Our food network spreads across three countries; it is in multiple formats. Straight away, we are into that kind of decision making. Do we cut our range to prioritise the main ones? So, get the big ones out, keep production going, keep the supply coming in. Hoping that we do not lose a factory, lose a whole shift and with staff, unfortunately, getting sick. We are trying to balance all those things.*

The findings suggest that collaboration and agility are antecedents of a firm's ability to respond during COVID-19 disruptions. Furthermore, the findings show that the ability to respond shares commonalities with dynamic coordinating activities, as discussed in DCT literature. For instance, firms that demonstrate timely responsiveness to effectively coordinate and deploy internal and external competencies within dynamic environments can establish global market competitiveness (Teece et al., 1997). During periods of uncertainty, operational capabilities necessitate the efficient coordination of tasks and resources and the synchronisation of activities to reshape a firm's resource base (Helfat & Peteraf, 2003). Moreover, the coordinating capability empowers firms to orchestrate tasks, resources, and activities (Pavlou & El Sawy, 2011) while combining diverse resources in an entrepreneurial manner (Teece, 2014). Thus, the following research proposition is suggested based on data coding in Table 3:

Table 3. A Hybrid Thematic Analysis for SCRES Ability to Respond Capabilities.

1st – Cycle Coding:	2nd – Cycle Coding:	
	SCRES Ability to Respond	Link to Dynamic Capability Theory
Interview Themes	Elements & Practices	
	Collaboration	*Dynamic Coordination Capability*
Connectivity between customers and Suppliers	Building Relationships	Orchestrating and deploying tasks, activities, and resources
Collaboration between all involved stakeholders	Supply Chain Collaboration	
Open, transparent discussions among stakeholders	Enhance Transparency	Integration and enhanced shared language
Frequent meetings		
Cross-functional collaboration	Inter/Intra organisational collaboration	Combining diverse resources in an entrepreneurial manner
Collaboration between partners	Information Sharing	
	Agility	
Agile people and staff management	Ability to respond quickly to changes	Effective deployment of the firm's internal and external competencies
	Operational and management responsiveness	
Frequent revision of supply and operations processes	Process Agility	Synchronise firm's activities for effective and agile responses to disruptions
Understanding the constraints and enhancing visibility		
Optimise the trade-offs involved in related decisions	Quick Decision Making	Timely responsiveness to coordinate and deploy internal and external competencies effectively

> *RP3: A firm's ability to respond during COVID-19 pandemic disruptions through collaborative planning, information sharing, and agile practices, demonstrate their dynamic SCRES capabilities by coordinating tasks and resources and synchronising activities. Such practices, in turn, increases a firm's responsiveness to disruptive events.*

4.2.3. Learning capabilities

Significant aspects of learning were explored in relation to sharing information and allocating resources for education and training to address skill shortages and gaps in supply chain knowledge, Table 4. The knowledge management theme was prominent in the discussions surrounding the imperative of investing in the training

Table 4. A Hybrid Thematic Analysis for Learning Capabilities.

1st – Cycle Coding:	2nd – Cycle Coding:	
Interview Themes	SCRES Ability to Learn Elements & Practices	Link to Dynamic Capability Theory
	Knowledge Management	*Dynamic Learning Capability*
Developing detailed reports on upstream and downstream risks	Sharing information for the sake of learning	The speed at accessing relevant information and data of partners & stakeholders.
Identify risks that were previously ignored	Address Skill Shortage & Gaps	Experimentation and Reflection on Failure & Success
Inject more investments to upskill people Hiring competent human resources to face disruption risks	Investment in Training & Education	Training and upskilling professionals
	Building Social Capital	
Collaboration between education institutes & industry Solution driven by societal and business needs	Public-Private Partnership	Organisational Learning
Government voice coming up with guidelines and strategies Getting business groups to talk with the government	Policy Engagement in SC Disruption Societal Impact	Inter-organisational Relationships Trust

and education of supply chain personnel to enhance their skills after the COVID-19 pandemic. Interviewee G highlighted this point during the conversations.

> *It became essential to inject more investments to upskill people already working in the industry with relevant knowledge such as customs brokerage, pandemic response, and supply chain disruptions.*

Furthermore, Interviewees A and G were concerned that the SC knowledge and skills shortage leads companies to miss the holistic view of supply chain management during disruption. During a mapping exercise for a food and drink supply chain, Interviewee H found it surprising how little companies were proactive in applying measures to inform customers of disruption risks extended upstream of their supply chains and how they learned lessons from previous disruptions.

> *We have developed new reports for customers about upstream risks that they previously did not have at the level of details. However, we had to manage that because we had a combination of issues relating to the SKUs. So, we now identified the risks by SKUs details that we previously did not, and the customers have endorsed us for it. This has given our team back time to invest in work that will deliver for the business as opposed to distractions of the day-to-day.*

Companies' involvement in preparing for Brexit has led to a scarcity of supply chain skills and knowledge in the Irish context. Businesses faced intense competition in recruiting supply chain professionals, as their companies retained many to address the challenges of Brexit on Irish supply chains. This scarcity directly affected companies' ability to cope with the disruptions caused by COVID-19. Interviewee B highlighted this concern, underscoring the imperative of implementing effective knowledge management strategies to elevate supply chain management knowledge within Irish businesses.

> *I find it hard to hire good demand planners in Ireland. And now obviously over the last two years, the good ones have been tied up because companies are holding them for Brexit, which makes sense.*

Building Social Capital was another critical aspect of learning that emerged during the interviews. It refers to the shared norms and values facilitating cooperation between the firms after a disruptive event. Thus, evaluating these shared values enhances understanding of how social capital is nurtured and emerges during pandemic disruptions. Interviewees alluded to several social capital practices, such as the co-creation process, relational competence, and fostering public-private partnerships. Interviewee G endorsed this and called for better collaboration between the education and business sectors to co-create relevant knowledge in the SCM industry.

> *It is about making sure that we give people the right knowledge, the right skills, the right competencies. That can only happen if we develop genuinely collaborative approaches between education providers, whether it be third level education or otherwise, and the industry. We need to focus and be driven by societal, and business needs rather than academic niceties.*

Furthermore, Interviewee H provided an example of how different clients within the same geographical region co-operated through resource pooling to demonstrate relational competence. The consensus from the Interviewees is that more government engagement is needed, especially in policy decisions that impact logistics

and SCM policies. For example, Interviewee C explained the need for logistics representatives in government policy and encouraged conversations with the government through representative bodies.

> *Getting more of a voice with the government in coming up with better guidelines and a clear strategy would be fantastic. We need to find a forum to do that, whether meeting with different representative bodies such as the Irish freight forwarding association or consumer organisations. It is essential to get these groups together to talk to the government.*

The findings highlight the significance of knowledge management and social capital as integral SCRES elements contributing to firms' ability to learn from the disruptions of the first-wave pandemic. Notably, resilience practices such as investing in education and training, sharing risk-related information, engaging with governments in dialogue, and harnessing co-creation processes exhibit similarities to dynamic learning routines, as discussed in the DCT literature. For example, learning is at the heart of dynamic capabilities and plays a significant role in their creation and development (Eisenhardt & Martin, 2000; Teece et al., 1997). Learning as a dynamic capability allows tasks to be performed more efficaciously, often due to experimentation and reflection on failure and success (Ambrosini et al., 2009). Organisational Learning is defined as 'a learned and stable pattern of collective activity through which the organisation systematically generates and modifies its operating routines in pursuit of improved effectiveness' (Zollo & Winter, 2002), p. 340). Therefore, organisational learning is a source of dynamic capabilities formed by the co-evolution of the learning mechanism (Eisenhardt & Martin, 2000; Zollo & Winter, 2002). Hence, a research proposition is developed;

> ***RP4:** A firm's ability to learn during COVID-19 pandemic disruptions through investments in education and training, co-creation process, relational competence, and fostering public-private partnerships demonstrate their dynamic SCRES capabilities by learning from success and failure. Such capabilities not only increase a firm's learning mechanisms but also enhance its adapting and response capabilities from disruptive events.*

Figure 3 illustrates the proposed Dynamic SCRES Capabilities conceptual framework that links high-order SCRES capabilities to a firm's DC to pandemic disruptions. The framework indicates dynamic interactions between SCRES capabilities as some elements that support these capabilities overlap in practice, as the empirical evidence suggests. Therefore, building SCRES capabilities as DC cannot be achieved in isolation without understanding the dynamic interactions of their constituent parts (Stadtfeld & Gruchmann, 2023). Hence, a firm's dynamic SCRES capabilities during the initial pandemic disruptions are conceptualised as adapting and seizing, coordinating, and learning routines.

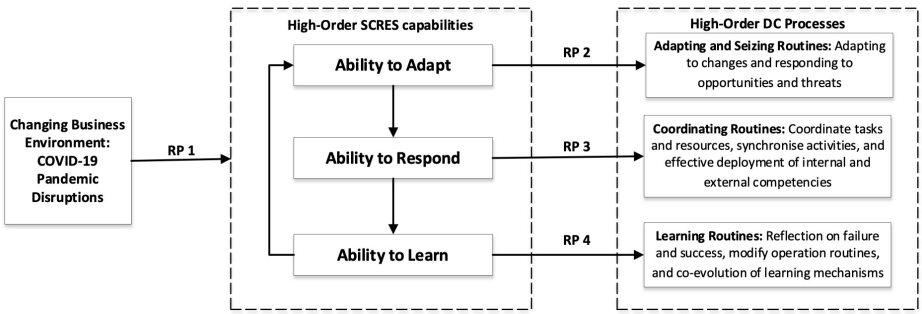

Figure 3. Proposed Dynamic Supply Chain Resilience Conceptual Framework.

5. Implications for theory, research, and practice

In times of uncertainty and rapid change, such as the COVID-19 pandemic, businesses require a prompt response to the disruptive effects of the crisis and a comprehensive understanding of their resilience capabilities to survive and thrive. The study demonstrates how a firm's ability to adapt, respond, and learn in the early stages of the pandemic can enhance its dynamic SCRES capabilities by adapting to changes, seizing opportunities, coordinating tasks, and employing learning mechanisms to modify resources and sustain operations. This study has important implications for research, theory, and practice.

One of the current limitations of SCRES studies is the lack of theoretical lenses to ground current models proposed in the literature (Ambulkar et al., 2015). This study contributes to theory by providing a theoretical fusion of the DCT and SCRES domains to identify compatible dynamic SCRES capabilities, offering avenues for further theory-building and testing of SCRES capabilities. This study synthesises knowledge in the DCT and SCRES literature to present a coherent and integrative framework that explains the synergies between high–order dynamic and SCRES capabilities with their low-order capabilities, which are the building blocks to alter a firm's resources. Consequently, this study extends the knowledge of SCRES capabilities to mitigate pandemic disruptions by showing how operational capabilities and resilience practices form a part of high-order SCRES capabilities. This study builds on (Stadtfeld & Gruchmann, 2023) to highlight the interactions and interconnectedness between these competencies at different levels and to distinguish between dynamic and operational capabilities to mitigate pandemic disruptions.

This study's research implications are rooted in exploring SCRES learning capability, grounded in the framework of DC learning routines. Learning is crucial for firms to cope with disruptions by enabling them to understand past events, respond immediately, and prepare for future disruptions. Hence, knowledge management and social capital are essential in fostering learning in the SCRES literature (Ali et al., 2017). Effective information sharing, training, and education strengthen knowledge management, whereas social partnerships with community stakeholders and government departments enhance the learning process. Furthermore, trust-building between supply chain firms and external stakeholders facilitates information sharing and incorporates expertise to train supply chain personnel for future disruptions. Public-private partnerships have emerged as a vital aspect in raising awareness about mitigation measures, future precautions, and policies necessary to brace for future waves of disruptions. Consequently, nurturing specific aspects of social capital, such as inter-organizational relationships, relational competence, trust, and co-creation processes, is necessary to cultivate resilience-oriented thinking throughout supply chains (Johnson et al., 2013; Papadopoulos et al., 2017; Seville et al., 2015).

The managerial implications of this research within the context of Irish firms yielded appealing findings, particularly considering Brexit's concurrent disruption, which directly impacted supply chains. During the COVID-19 pandemic, Ireland grappled with the additional complexities posed by Brexit, including the need to reconfigure supply chain networks, adapt to new customs administration systems, and reposition marketing strategies. While these challenges compounded the effects of COVID-19, they also provided Irish businesses with a unique opportunity to stress-test their recovery strategies in preparation for operational disruptions anticipated in the Brexit era. Consequently, Brexit preparations instilled a robust culture of risk management and operational resilience within Irish businesses, equipping them with valuable insights and strategies for implementation, which in turn played a pivotal role in mitigating specific disruptions stemming from COVID-19. Few studies have investigated the dynamics of SCRES capabilities in the context of multi-disruptions, specifically examining how the interplay between such disruptions can challenge or enhance a company's efforts to establish effective resilience capabilities.

6. Conclusion, limitations, and future research

This study explored firms' responses to initial COVID-19 disruptions by examining the SCRES capabilities demonstrated during this time. To answer this question, the research investigated these capabilities using the theoretical lens of the DCT. Based on a theoretical synthesis, a set of three high-order SCRES capabilities was presented: the ability to adapt, respond, and learn, which arguably share commonalities with the DC processes of adapting and seizing, coordination, and learning, as part of a theory-elaboration process of dynamic SCRES capabilities. In doing so, an explicit distinguishing between high-order SCRES capabilities and their supporting operational capabilities was illustrated. These distinctions are often blurred in the current literature; therefore, this study provides a better theory-building platform for using DCT in SCRES studies.

Despite the in-depth findings and implications of the research, the study has certain limitations. First, the purposive sampling of eight Interviewees representing single cases cannot be generalised broadly. However, the study aimed to provide a theoretical synthesis and empirical evidence to elaborate on the theory rather than generalise it to the population. Second, the results of this study are based on the Irish context. Although most countries have faced similar COVID-19 impacts on their supply chain operations, Ireland's specific challenges are unique due to its reliance on the UK and EU markets. Third, the focus was on the immediate and medium-term resilience strategies for COVID-19 disruptions at the time of study while recognising the ongoing pandemic challenges. Therefore, this exploratory study does not include SCRES capabilities relating to pre- and post-disruptions (e.g., anticipation and recovery) that can be aligned to DC processes of sensing threats and reconfiguring resources.

Despite these limitations, this study provides several paths for future research. First, investigating triadic relationships could shed light on emergent dynamic capabilities that have not been explored in the literature and offer interesting areas for future research. Second, a longitudinal study to track the progression of dynamic SCRES capabilities over time could provide valuable insights, particularly considering the potential for further global disruptions such as climate change, pandemics, and geopolitical events that could impact global supply chains. Third, a survey to gain a broader view of dynamic SCRES capabilities and the relationships between them and using some contingent factors as moderators or mediators is a fruitful avenue for theory testing.

Acknowledgements

This work was partially supported by the project "Societal and Economic Resilience within multi-hazards environment in Romania" funded by European Union – Next generation EU and Romanian Government, under National Recovery and Resilience Plan for Romania, contract no. 760050/23.05.2023, code PNRR-C9-I8-CF 267/29.11.2022, through the Romanian Ministry of Research, Innovation and Digitalization, within Component 9, Investment I8.

References

Adobor, H. (2020). Supply chain resilience: an adaptive cycle approach. *International Journal of Logistics Management*, *31*(3), 443-463. http://doi.org/10.1108/IJLM-01-2020-0019.

Ali, A., Mahfouz, A., & Arisha, A. (2017). Analysing supply chain resilience: integrating the constructs in a concept mapping framework via a systematic literature review. *Supply Chain Management*, *22*(1), 16-39. http://doi.org/10.1108/SCM-06-2016-0197.

Ambrosini, V., Bowman, C., & Collier, N. (2009). Dynamic capabilities: an exploration of how firms renew their resource base. *British Journal of Management*, *20*(s1), S9-S24. http://doi.org/10.1111/j.1467-8551.2008.00610.x.

Ambulkar, S., Blackhurst, J., & Grawe, S. (2015). Firm's resilience to supply chain disruptions: scale development and empirical examination. *Journal of Operations Management*, *33-34*(1), 111-122. http://doi.org/10.1016/j.jom.2014.11.002.

Barratt, M., Choi, T. Y., & Li, M. (2011). Qualitative case studies in operations management: Trends, research outcomes, and future research implications. *Journal of Operations Management*, *29*(4), 329-342. http://doi.org/10.1016/j.jom.2010.06.002.

Barreto, I. (2010). Dynamic capabilities: a review of past research and an agenda for the future. *Journal of Management*, *36*(1), 256-280. http://doi.org/10.1177/0149206309350776.

Birkie, S. E., Trucco, P., & Fernandez Campos, P. (2017). Effectiveness of resilience capabilities in mitigating disruptions: leveraging on supply chain structural complexity. *Supply Chain Management*, *22*(6), 506-521. http://doi.org/10.1108/SCM-01-2017-0009.

Choi, T.-M. (2020). Innovative "bring-service-near-your-home" operations under corona-virus (COVID-19/SARS-CoV-2) outbreak: can logistics become the Messiah? *Transportation Research Part E, Logistics and Transportation Review*, *140*, 101961. http://doi.org/10.1016/j.tre.2020.101961. PMid:32346356.

Chowdhury, M. M. H., & Quaddus, M. (2016). Supply chain readiness, response and recovery for resilience. *Supply Chain Management*, *21*(6), 709-731. http://doi.org/10.1108/SCM-12-2015-0463.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management*, *15*(2), 1-14. http://doi.org/10.1108/09574090410700275.

Collis, D. J. (1994). How valuable are organizational capabilities? *Strategic Management Journal*, *15*(S1), 143-152. http://doi.org/10.1002/smj.4250150910.

Craighead, C. W., Ketchen Junior, D. J., & Darby, J. L. (2020). Pandemics and supply chain management research: toward a theoretical toolbox. *Decision Sciences*, *51*(4), 838-866. http://doi.org/10.1111/deci.12468. PMid:34234384.

Dabhilkar, M., Birkie, S. E., & Kaulio, M. (2016). Supply-side resilience as practice bundles: a critical incident study. *International Journal of Operations & Production Management*, *36*(8), 948-970. http://doi.org/10.1108/IJOPM-12-2014-0614.

Danneels, E. (2016). Survey measures of first- and second-order competences. *Strategic Management Journal*, *37*(10), 2174-2188. http://doi.org/10.1002/smj.2428.

Di Stefano, G., Peteraf, M., & Verona, G. (2010). Dynamic capabilities deconstructed: a bibliographic investigation into the origins, development, and future directions of the research domain. *Industrial and Corporate Change*, *19*(4), 1187-1204. http://doi.org/10.1093/icc/dtq027.

Dubey, R., Bryde, D. J., Dwivedi, Y. K., Graham, G., Foropon, C., & Papadopoulos, T. (2023). Dynamic digital capabilities and supply chain resilience: the role of government effectiveness. *International Journal of Production Economics*, *258*, 108790. http://doi.org/10.1016/j.ijpe.2023.108790.

Eftekhar, M., Li, H., Van Wassenhove, L. N., & Webster, S. (2017). The role of media exposure on coordination in the humanitarian setting. *Production and Operations Management*, *26*(5), 802-816. http://doi.org/10.1111/poms.12669.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, *14*(4), 532-550. http://doi.org/10.2307/258557.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal*, *21*(10–11), 1105-1121. http://doi.org/10.1002/1097-0266(200010/11)21:10/11<1105::AID-SMJ133>3.0.CO;2-E.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods*, *5*(1), 80-92. http://doi.org/10.1177/160940690600500107.

Gibson, C. B., & Birkinshaw, J. (2004). The antecedents, consequences, and mediating role of organizational ambidexterity. *Academy of Management Journal*, *47*(2), 209-226. http://doi.org/10.2307/20159573.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: notes on the Gioia methodology. *Organizational Research Methods*, *16*(1), 15-31. http://doi.org/10.1177/1094428112452151.

Helfat, C. E., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., & Winter, S. G. (2009). *Dynamic capabilities: understanding strategic change in organizations*. Hoboken: John Wiley & Sons.

Helfat, E. C., & Peteraf, A. M. (2003). The dynamic resource-based view: capability lifecycles. *Strategic Management Journal*, *24*(10), 997-1010. http://doi.org/10.1002/smj.332.

Helfat, E. C., & Winter, G. S. (2011). Untangling dynamic and operational capabilities: strategy for the (n)ever-changing world. *Strategic Management Journal*, *32*(11), 1243-1250. http://doi.org/10.1002/smj.955.

Helfat, F. S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., Winter, G. S., & Maritan, A. C. (2007). Dynamic capabilities and organizational processes. In S. Finkelstein (Ed.), *Dynamic capabilities: understanding strategic change in organizations* (pp. 30-45). Malden: Blackwell Pub.

Hendry, L. C., Stevenson, M., MacBryde, J., Ball, P., Sayed, M., & Liu, L. (2019). Local food supply chain resilience to constitutional change: the Brexit effect. *International Journal of Operations & Production Management*, *39*(3), 429-453. http://doi.org/10.1108/IJOPM-03-2018-0184.

Hohenstein, N.-O., Feisel, E., Hartmann, E., & Giunipero, L. (2015). Research on the phenomenon of supply chain resilience: a systematic review and paths for further investigation. *International Journal of Physical Distribution & Logistics Management*, *45*(1-2), 90-117. http://doi.org/10.1108/IJPDLM-05-2013-0128.

Ivanov, D. (2020). Predicting the impacts of epidemic outbreaks on global supply chains: a simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case. *Transportation Research Part E, Logistics and Transportation Review*, *136*, 101922. http://doi.org/10.1016/j.tre.2020.101922. PMid:32288597.

Ivanov, D., & Das, A. (2020). Coronavirus (COVID-19/SARS-CoV-2) and supply chain resilience: a research note. *International Journal of Integrated Supply Management*, *13*(1), 90-102. http://doi.org/10.1504/IJISM.2020.107780.

Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, *58*(10), 2904-2915. http://doi.org/10.1080/00207543.2020.1750727.

Johnson, N., Elliott, D., & Drake, P. (2013). Exploring the role of social capital in facilitating supply chain resilience. *Supply Chain Management*, *18*(3), 324-336. http://doi.org/10.1108/SCM-06-2012-0203.

Jüttner, U., & Maklan, S. (2011). Supply chain resilience in the global financial crisis: an empirical study. *Supply Chain Management*, *16*(4), 246-259. http://doi.org/10.1108/13598541111139062.

Ketokivi, M., & Choi, T. (2014). Renaissance of case research as a scientific method. *Journal of Operations Management*, *32*(5), 232-240. http://doi.org/10.1016/j.jom.2014.03.004.

Kochan, C. G., & Nowicki, D. R. (2018). Supply chain resilience: a systematic literature review and typological framework. *International Journal of Physical Distribution & Logistics Management*, *48*(8), 842-865. http://doi.org/10.1108/IJPDLM-02-2017-0099.

Leat, P., & Revoredo-Giha, C. (2013). Risk and resilience in agri-food supply chains: the case of the ASDA PorkLink supply chain in Scotland. *Supply Chain Management*, *18*(2), 219-231. http://doi.org/10.1108/13598541311318845.

Lee, M. S., & Rha, J. S. (2016). Ambidextrous supply chain as a dynamic capability: building a resilient supply chain. *Management Decision*, *54*(1), 2-23. http://doi.org/10.1108/MD-12-2014-0674.

Miles, B. M., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis: a methods sourcebook* (3rd ed.). Thousand Oaks: SAGE Publications.

Miroudot, S. (2020). Reshaping the policy debate on the implications of COVID-19 for global supply chains. *Journal of International Business Policy*, *3*(4), 430-442. http://doi.org/10.1057/s42214-020-00074-6.

Mollenkopf, D. A., Ozanne, L. K., & Stolze, H. J. (2021). A transformative supply chain response to COVID-19. *Journal of Service Management*, *32*(2), 190-202. http://doi.org/10.1108/JOSM-05-2020-0143.

Niiniluoto, I. (1999). Defending abduction. *Philosophy of Science*, *66*(S3), S436-S451. http://doi.org/10.1086/392744.

O'Reilly III, C. A., & Tushman, M. L. (2008). Ambidexterity as a dynamic capability: resolving the innovator's dilemma. *Research in Organizational Behavior*, *28*, 185-206. http://doi.org/10.1016/j.riob.2008.06.002.

Papadopoulos, T., Gunasekaran, A., Dubey, R., Altay, N., Childe, S. J., & Fosso-wamba, S. (2017). The role of Big Data in explaining disaster resilience in supply chains for sustainability. *Journal of Cleaner Production*, *142*, 1108-1118. http://doi.org/10.1016/j.jclepro.2016.03.059.

Pavlou, A. P., & El Sawy, A. O. (2011). Understanding the elusive black box of dynamic capabilities. *Decision Sciences*, *42*(1), 239-273. http://doi.org/10.1111/j.1540-5915.2010.00287.x.

Perry, P., Wood, S., & Fernie, J. (2015). Corporate social responsibility in garment sourcing networks: Factory management perspectives on ethical trade in Sri Lanka. *Journal of Business Ethics*, *130*(3), 737-752. http://doi.org/10.1007/s10551-014-2252-2.

Pettit, T. J., Croxton, K. L., & Fiksel, J. (2013). Ensuring supply chain resilience: development and implementation of an assessment tool. *Journal of Business Logistics*, *34*(1), 46-76. http://doi.org/10.1111/jbl.12009.

Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *International Journal of Logistics Management*, *20*(1), 124-143. http://doi.org/10.1108/09574090910954873.

Queiroz, M. M., Ivanov, D., Dolgui, A., & Fosso Wamba, S. (2022). Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review. *Annals of Operations Research*, *319*(1), 1159-1196. http://doi.org/10.1007/s10479-020-03685-7. PMid:32836615.

Saldana, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Thousand Oaks: SAGE Publications.

Sawyerr, E., & Harrison, C. (2023). Resilience in healthcare supply chains: a review of the UK's response to the COVID-19 pandemic. *International Journal of Physical Distribution & Logistics Management*, *53*(3), 297-329. http://doi.org/10.1108/IJPDLM-09-2021-0403.

Schilke, O. (2014). Second-order dynamic capabilities: how do they matter? *The Academy of Management Perspectives*, *28*(4), 368-380. http://doi.org/10.5465/amp.2013.0093.

Schilke, O., Hu, S., & Helfat, C. E. (2018). Quo vadis, dynamic capabilities? A content-analytic review of the current state of knowledge and recommendations for future research. *The Academy of Management Annals*, *12*(1), 390-439. http://doi.org/10.5465/annals.2016.0014.

Scholten, K., & Schilder, S. (2015). The role of collaboration in supply chain resilience. *Supply Chain Management*, *20*(4), 471-484. http://doi.org/10.1108/SCM-11-2014-0386.

Scholten, K., Scott, S. P., & Fynes, B. (2014). Mitigation processes: antecedents for building supply chain resilience. *Supply Chain Management*, *19*(2), 211-228. http://doi.org/10.1108/SCM-06-2013-0191.

Scholten, K., Scott, S. P., & Fynes, B. (2019). Building routines for non-routine events: supply chain resilience learning mechanisms and their antecedents. *Supply Chain Management*, *24*(3), 430-442. http://doi.org/10.1108/SCM-05-2018-0186.

Schriber, S., & Löwstedt, J. (2020). Reconsidering ordinary and dynamic capabilities in strategic change. *European Management Journal*, *38*(3), 377-387. http://doi.org/10.1016/j.emj.2019.12.006.

Schulze, A., & Brusoni, S. (2022). How dynamic capabilities change ordinary capabilities: Reconnecting control and problem-solving. *Strategic Management Journal*, *43*(12), 2447-2477. http://doi.org/10.1002/smj.3413.

Seville, E., van Opstal, D., & Vargo, J. (2015). A primer in resiliency: seven principles for managing the unexpected. *Global Business and Organizational Excellence*, *34*(3), 6-18. http://doi.org/10.1002/joe.21600.

Sheffi, Y., & Rice, B. J. (2005). A supply chain view of the resilient enterprise. *MIT Sloan Management Review*, *47*(1), 41-48.

Shekarian, M., Reza Nooraie, S. V., & Parast, M. M. (2020). An examination of the impact of flexibility and agility on mitigating supply chain disruptions. *International Journal of Production Economics*, *220*, 107438. http://doi.org/10.1016/j.ijpe.2019.07.011.

Stadtfeld, G. M., & Gruchmann, T. (2023). Dynamic capabilities for supply chain resilience: a meta-review. *International Journal of Logistics Management*. http://doi.org/10.1108/IJLM-09-2022-0373.

Tang, C., & Tomlin, B. (2008). The power of flexibility for mitigating supply chain risks. *International Journal of Production Economics*, *116*(1), 12-27. http://doi.org/10.1016/j.ijpe.2008.07.008.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319-1350. http://doi.org/10.1002/smj.640.

Teece, D. J. (2014). The foundations of enterprise performance: dynamic and ordinary capabilities in an (economic) theory of firms. *The Academy of Management Perspectives*, *28*(4), 328-352. http://doi.org/10.5465/amp.2013.0116.

Teece, D. J. (2017). Towards a capability theory of (innovating) firms: implications for management and policy. *Cambridge Journal of Economics*, *41*(3), 693-720. http://doi.org/10.1093/cje/bew063.

Teece, D. J. (2019). A capability theory of the firm: an economics and (strategic) management perspective. *New Zealand Economic Papers*, *53*(1), 1-43. http://doi.org/10.1080/00779954.2017.1371208.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509-533. http://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z.

van Hoek, R. (2020). Responding to COVID-19 supply Chain risks: insights from supply chain change management, total cost of ownership and supplier segmentation theory. *Logistics*, *4*(23), 1-18. http://doi.org/10.3390/logistics4040023.

van Hoek, R., Gibson, B., & Johnson, M. (2020). Talent management for a post-COVID-19 supply chain: the critical role for managers. *Journal of Business Logistics*, *41*(4), 334-336. http://doi.org/10.1111/jbl.12266.

van Hoek, R., & Dobrzykowski, D. (2021). Towards more balanced sourcing strategies – are supply chain risks caused by the COVID-19 pandemic driving reshoring considerations? *Supply Chain Management*, *26*(6), 689-701. http://doi.org/10.1108/SCM-09-2020-0498.

Wang, L. C., & Ahmed, K. P. (2007). Dynamic capabilities: a review and research agenda. *International Journal of Management Reviews*, *9*(1), 31-51. http://doi.org/10.1111/j.1468-2370.2007.00201.x.

Wieland, A., & Durach, C. F. (2021). Two perspectives on supply chain resilience. *Journal of Business Logistics*, *42*(3), 315-322. http://doi.org/10.1111/jbl.12271.

Wieland, A., Stevenson, M., Melnyk, S. A., Davoudi, S., & Schultz, L. (2023). Thinking differently about supply chain resilience: what we can learn from social-ecological systems thinking. *International Journal of Operations & Production Management*, *43*(1), 1-21. http://doi.org/10.1108/IJOPM-10-2022-0645.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, *24*(10), 991-995. http://doi.org/10.1002/smj.318.

Yin, R. K. (2009). *Case study research: design and methods* (Vol. *5*). Thousand Oaks: SAGE Publications.

Zahra, A. S., Sapienza, J. H., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: a review, model and research agenda. *Journal of Management Studies*, *43*(4), 917-955. http://doi.org/10.1111/j.1467-6486.2006.00616.x.

Zhu, G., Chou, M. C., & Tsai, C. W. (2020). Lessons learned from the COVID-19 pandemic exposing the shortcomings of current supply chain operations: a long-term prescriptive offering. *Sustainability*, *12*(14), 1-19. http://doi.org/10.3390/su12145858.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, *13*(3), 339-351. http://doi.org/10.1287/orsc.13.3.339.2780.

Zsidisin, G. A., & Wagner, S. M. (2010). Do perceptions become reality? The moderating role of supply chain resiliency on disruption occurrence. *Journal of Business Logistics*, *31*(2), 1-20. http://doi.org/10.1002/j.2158-1592.2010.tb00140.x.

Appendix A. Interview Protocol.

- *General Information about the Company*
- The company's background, customers and targeted markets, supply base and resource products and services, and supply chain design and nature of integration.
- *Overview of Interviewee Background*
- Can you briefly tell us about your role and responsibility in the company?
- Can you share the role of your team/department in the company's supply chain dynamic?
- *Perceived Pressure of COVID-19 on Supply Chain Strategies and Operations*
- What new business behaviours and patterns did you witness within the first months of the pandemic?
- What were the leading causes of disruptions during the first months of pandemics?
- How do you see the Impact of COVID-19 on your supply chain operations in the immediate short to medium-term?
- What was the immediate disruption to the company's working methods from a remote working perspective? How ready were the supply chain organisations to work from home and operate efficiently and productively during the lockdown?
- How did the social distancing rule affect the operations of your supply chain, particularly in the manufacturing and distribution echelons?
- How have consumers' ordering patterns changed at the time of the pandemic? Have you experienced significant demand fluctuation during the pandemic?
- *Supply Chain Responding & Adapting Strategies to Initial COVID-19 Disruption*
- What were the resilient initiatives that supported supply chain operations in terms of responding to COVID-19 Impact?
- How did your company work with other supply chain partners in the upstream and downstream to absorb the disruption's shocks and respond effectively?
- What practices did the company adapt to return to a steady state?
- What measures will help mitigate the effects of the second wave of the pandemic?
- What practices did the company fail to apply within the immediate response to the first wave of the pandemic and plan to apply if another lockdown occurs?
- *Lesson Learned to Inform Business Recovery*
- What practical considerations did the company learn in responding to future pandemic waves?
- In the last decades, our supply chains were designed to satisfy lean principles, making them vulnerable during disruptions. How this could be changed based on the lessons learned from COVID-19?
- What have we learned from consumers' behaviour over this disruptive period?
- To prepare for the new disruptive business atmosphere, are there any initiatives you can look at to upskill supply chain professionals to bridge the current SCM skill gap and enhance creativity?
- During the initial COVID-19 period, supply chains have embraced many effective practices to cope with the disruptive effects of the pandemic. How can these practices be embedded permanently into your supply chain in the future?
- Do you think government support is necessary to help develop supply chains to face business risks? How do you see this support, and how can it be magnified?
- How do we expose the criticality of your supply chain to the broader economic, political or even societal perspectives to enhance preparedness and responsiveness capabilities to future disruptions?