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Supply Chain Resilience: Disruptions in Global Maritime Transportation

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Abstract

Supply chain resilience has become an important topic within supply chain management, as increasingly complex supply chains set out for increased risk in these networks. Supply chain resilience is a risk management approach that includes the ability to mitigate disruptions through specific capabilities. The previous disruptive events of the COVID-19 pandemic and the Suez Canal blockage-21 have highlighted the vulnerabilities of global trade and the need for more resilient supply chains. The purpose of this thesis was to analyse supply chain resilience and the need for dynamic and operational capabilities in the global maritime transport sector to mitigate impacts from slow-onset and sudden-onset disruptions. In specific, the vulnerabilities highlighted through the impacts of the COVID-19 pandemic and the Suez Canal blockage-21 over time. This study was conducted as a multiple case study investigating the maritime transport sector's resilience during COVID-19 and the Suez Canal blockage-21. The data was triangulated through semi-structured interviews, industry podcasts, and business reports and further analysed using a grounded analysis approach. The study showed that the continuous disruptions on supply chains caused by the COVID-19 pandemic and the Suez Canal blockage-21 generated economic consequences, congestions, and capacity constraints that the maritime transport sector could not fully mitigate. The study also provides evidence that severe impacts on supply chains were not necessarily caused by a lack of resilience, but rather the persistency of disruptions did not diminish over time. Even though the maritime transportation sector is considered flexible and agile in adapting to the new market situation, increased collaboration, integration, innovation, and digitalization were found necessary to improve the resilience of the maritime transport sector to become even better prepared for future disruptions.

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IV. List of Abbreviations

Abbreviation	Meaning
BCP	Business Continency Plan
CFS	Container freight station
COVID-19	Coronavirus disease 2019
DCV	Dynamic Capability View
IMF	International Monetary Fund
MSC	Maritime supply chain
MTS	Maritime transport sector
NVOCC	Non-vessel operating common carrier
OECD	Organisation for Economic Co-operation and Development
RBV	Resource-Based View
SCRES	Supply chain resilience
SCRM	Supply chain risk management
TEU	Twenty-foot equivalent unit
UNCTAD	United Nations Conference on Trade and Development
UNDRR	United Nations Office for Disaster Risk Reduction
WHO	World Health Organization

1 Introduction

This chapter provides the contextual background on supply chain disruptions and the resilience of the maritime supply chain, including current research problems and practical and theoretical gaps within this area. Continuously, this led to the research purpose and research questions of this study.

1.1 Background

Supply chains have developed as important building blocks of global trade and increased globalization has led to more complex supply chains (Shishodia et al., 2021). The maritime transport sector (MTS) is a highly important link in supply chain management as about 90 percent of world trade is transported by sea (OECD, n.d.). Therefore, disruptions from external factors, such as changes in consumer supply and demand, have a major impact on this sector (Berle et al., 2011a; Hossain et al., 2020). Disruptions in the maritime supply chain (MSC) can in return generate major ripple effects for actors in the broader supply chain network (Ponomarov & Holcomb, 2009; Tukamuhabwa et al., 2015). The number of actors and nodes involved in these increasingly complex and global supply chains set out for increased areas for risk of disruptions (Ali et al., 2017; Liu et al., 2018; Manuj & Mentzer, 2008; Ponomarov & Holcomb, 2009).

Resilience has become an important strategy in supply chain management due to increased and more complex disruptions (Ponomarov & Holcomb, 2009). As such, supply chain resilience (SCRES) describes a supply chain's ability to prepare and perform throughout all phases of a disruption. This involves preparing for and responding to disruptions, recovering quickly, and potentially even becoming better than before the disruption (Ponomarov & Holcomb, 2009; Tukamuhabwa et al., 2015). Supply chain capabilities that enhance resilience can be either operational or dynamic. Operational capabilities are defined as the basic activities in an organization that enhance present operations, while dynamic capabilities provide the ability to improve long-term performance and play a strategic role in providing competitive advantages in rapidly changing environments (Kähkönen et al., 2021; Teece, 2007). To be able to manage and develop a resilient supply chain in rapidly changing environments, such as during

COVID-19, the operational capabilities of an organization might not be sufficient, thus, dynamic capabilities are also required (Mohammed et al., 2021). In addition, these capabilities need to stay in balance with supply chain vulnerabilities to increase overall resilience while remain cost efficient (Pettit et al., 2013; Pettit et al., 2010).

Research on disruptions and resilience regarding maritime transportation has revealed three major research gaps. Firstly, risks and resilience in the transportation sector is a less explored area in previous literature (Ho et al., 2015; Wan et al., 2018) and compared to other transport networks, resilience in MTS has received even less consideration (Lam & Bai, 2016; Liu et al., 2018; Wendler-Bosco & Nicholson, 2019). Instead, most prevailing risk assessment studies on transit networks are from a security point of view (Jiang et al., 2021; Kaluza et al., 2010; Young & Gordon, 2020). Second, the term "resilience" used in the maritime industry varies considerably across research contexts, necessitating the redevelopment of a solidified framework for consistent research (Liu et al., 2018). Lastly, the literature on SCRES rarely distinguishes between operational and dynamic levels of capabilities that enhance resilience. To help bridge these gaps, this thesis will provide a deeper understanding of SCRES within the MTS by analysing mitigation strategies with applicable capabilities during all phases of resilience, including preparedness, response, and recovery, as well as the change when necessary.

1.2 Disruptive Cases

Supply chain disruptions can come from both external causes, such as natural disasters, and internal causes, such as failures to integrate certain supply chain functions (Ponomarov & Holcomb, 2009). Disruptions can also have a slow-onset or a sudden-onset appearance (Van Wassenhove, 2006). A slow-onset disaster gradually emerges over time, wherein epidemics classify as a slow-onset disaster. A sudden-onset disaster emerges from a quick and unexpected event, such as critical infrastructure failures or transport accidents (UNDRR, n.d.). Thus, the investigation of two different disruptions, such as the COVID-19 and the Suez Canal blockage-21, could provide insights on supply chain complexity and where resilience is demanded to cope with different types of disruptions.

COVID-19: The coronavirus disease (COVID-19) is caused by the SARS-CoV-2 virus (WHO, n.d.) and had its initial outbreak in Wuhan, China, in December of 2019 from which it spread all over the globe (WHO, 2020a). On March 11 in 2020, the World Health Organization (WHO) declared the COVID-19 as a global pandemic (WHO, 2020b). COVID-19 is a unique type of slow-onset disruption that affected supply chains on a global scale. Disruptions due to epidemics are characterised by long-term existence, ripple effects, high uncertainty, as well as simultaneous disruptions in supply, demand, and logistic infrastructure (Ivanov, 2020). COVID-19 has created both short-term and long-term impacts on maritime transportation due to governmental regulations, resource unavailability, and rapid changes in supply and demand (Ivanov, 2020; Kumar & Sharma, 2021; Notteboom et al., 2021). The initial decline in demand began as lockdowns and closure of production facilities in China, followed by Europe and Northern America, reduced the import demands from China and created serious disruptions in global supply chains (Cullinane & Haralambides, 2021). Epidemic impacts have been extensively researched in humanitarian logistics. However, the subject is less investigated in commercial supply chains (Queiroz et al., 2020).

Suez Canal blockage-21: The Suez Canal blockage-21 was instead categorized as a sudden disruption with direct and short-term impacts on global trade (Lee & Wong, 2021). The Suez Canal blockage-21, where a 400-metre container ship blocked this busy route for six days, created spill-over effects and delays throughout the globe (Lee & Wong, 2021). Even though the obstruction of the Suez Canal was lifted a few days after the occurrence, it continued to have an impact on global supply chains for several weeks. Over 300 ships waited to transit the canal during the blockage, preventing 12 percent of the world's trade from passing through the Suez Canal (Dürr, 2021). The backlog of ships penalized several commodities, holding up nearly $15 billion to $17 billion in that area (LeBlanc, 2021). As ships repeatedly entered the canal, they were forced to wait in line. When traffic restarted, the backlog also caused availability issues for containers, ships, and the cargo they were carrying. The vulnerability of the canal linking Europe and Asia has become apparent since the latest Suez Canal disruption, and international initiatives have been undertaken to find alternative maritime routes (Lee & Wong, 2021).

1.3 Problem

The impacts that COVID-19 and the Suez Canal blockage-21 have had on supply chains have been highly visible as lockdowns and uneven supply and demand have created problems for global trade, for example, the drastic reduction of demand (Kumar & Sharma, 2021) followed by a rapid increase of commercial goods (Alamoush et al., 2021). Actors in global MSCs have been heavily affected by recent disruptions, including stuck resources, unreliable lead times, and price fluctuations (Notteboom et al., 2021). SCRES is a somewhat new area in supply chain management literature and several frameworks have been proposed to conceptualize SCRES (Christopher & Peck, 2004; Ponomarov & Holcomb, 2009; Sheffi & Rice, 2005). However, even though a large majority of global trade is moved by the MTS, resilience in the MSC is still a relatively unexplored area (Alamoush et al., 2021; Ho et al., 2015). With the new events of the COVID-19 pandemic and the Suez Canal-21 blockage, the importance of managing risks and disruptions in the MSC is visible on a global scale. Congested ports and record high freight rates (Cullinane & Haralambides, 2021) indicate that a key problem of the current MTS lies in its inability to support the most vulnerable links in its supply chain in response to major disruptions, to reduce ripple-effects throughout its global networks.

1.4 Purpose

The purpose of this thesis is to analyse supply chain resilience and the need for dynamic and operational capabilities in the global maritime transport sector to mitigate impacts from slow-onset and sudden-onset disruptions. In specific, the vulnerabilities highlighted through the impacts of the COVID-19 pandemic and the Suez Canal blockage-21 over time.

Research questions (RQs):

RQ1. What are the impacts of COVID-19 and the Suez Canal blockage-21 on the global maritime transport sector and what has been done to counteract these disruptions?

RQ2. What dynamic and operational capabilities are required to establish a resilient maritime supply chain?

1.5 Delimitations

This study is limited to SCRES in event of disruptions. More specifically, the study will focus on resilience in the MTS with a particular emphasis on the port-to-port operations. However, hinterland operations, referring to inland transport lines connected to ports (Van Der Horst & De Langen, 2008), are also included as a touchpoint toward the port. Within the MTS, only the impacts and developments in the containerized cargo transport segment will be considered, disregarding all other seaborne cargoes such as bulk carriers and cruise ships.

In the absence of SCRES literature regarding the MTS, we rely on SCRES literature from multiple industries to provide a theoretical framework that we will apply to the MTS through triangulation of empirical data collected through semi-structured interviews and secondary data from global maritime industry stakeholders to provide a conceptual framework for maritime SCRES. The two cases of COVID-19 and Suez Canal blockage-21 will be used to uncover supply chain vulnerabilities in both slow-onset and sudden-onset disruptions. The study is not investigating specific capabilities for each phase of disruption, rather all phases of disruption are investigated to gain an encompassing understanding of capabilities required in the MTS to provide SCRES.

2 Literature Review

This chapter provides the theoretical background to the topic of supply chain resilience and the maritime transport sector. More specifically, to the conceptualization of supply chain resilience and on the resilience in the maritime supply chain to shed lights on the focus areas of this study.

2.1 Supply Chain Resilience: A Risk Management Approach

While supply chains are becoming increasingly complex in a more globalized economy, more resilient supply chains are needed to mitigate risks and reduce impacts of disruptions and ripple effects throughout supply chains (Ponomarov & Holcomb, 2009). To mitigate these risks, supply chain resilience (SCRES) functions as a supply chain risk management approach. Previous literature has attempted to conceptualise SCRES through systematic literature reviews (Ali et al., 2017; Hohenstein et al., 2015; Singh et al., 2019) or bibliometric analysis (Shishodia et al., 2021). Definitions of SCRES usually include different phases of resilience, resilient strategies, and resilient capabilities (Ali et al., 2017). Ponomarov and Holcomb (2009) define SCRES as "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them [to the same or better state] by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (Ponomarov & Holcomb, 2009, p. 131). This definition highlights resilience as an important ability of the supply chain to prepare, respond, recover, learn, and grow in the event of disruptions.

Supply chain risk management (SCRM) is an important part of risk mitigation to create efficient operations even during disruptions. This includes identifying supply chain risks, assessing the consequences of them, deciding on which actions to take and acknowledge which outcomes a certain disruption might have on supply chain performance (Ho et al., 2015). By identifying and evaluating potential risks considering the entire supply chain, organizations can have strategies implemented to mitigate a variety of risks (Manuj & Mentzer, 2008). Jüttner et al. (2003) classify risks into environmental, network, or organisational risks, where environmental risks relate to accidents or natural disasters, network-related risks relate to lack of responsiveness between supply chain actors or

changing market conditions, and organisational risks relate to work, production, or IT structures (Jüttner et al., 2003), such as failures to integrate certain supply chain functions (Christopher & Peck, 2004; Ponomarov & Holcomb, 2009).

2.1.1 Supply Chain Vulnerability and Disruptions

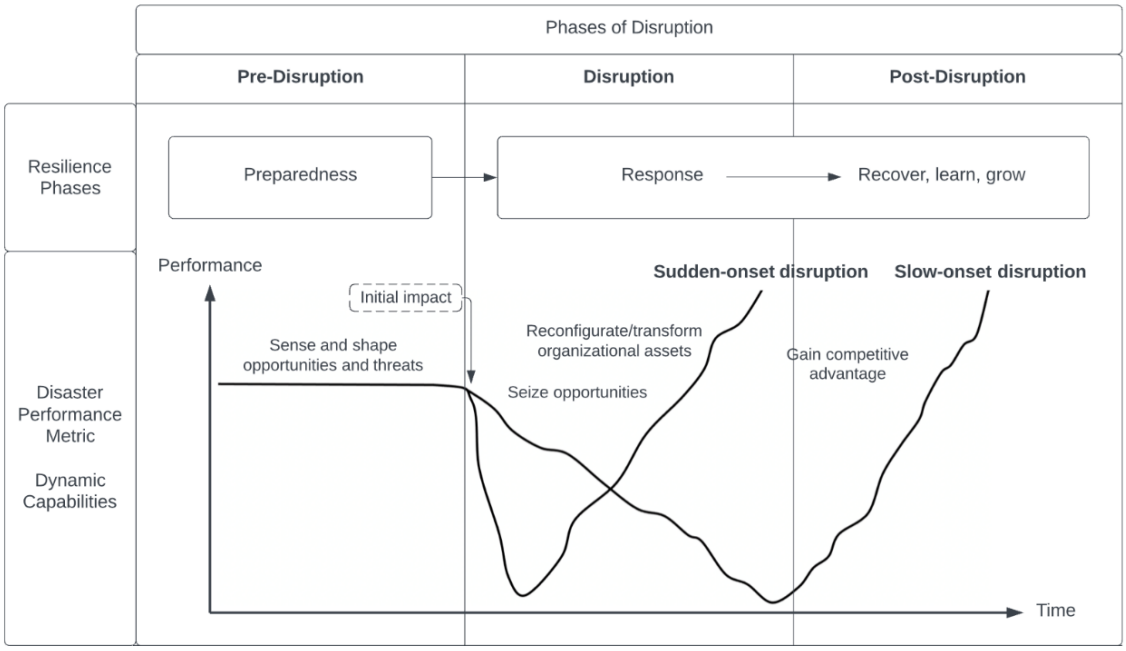
More vulnerable supply chains are more likely to be affected by disruption and the consequences of the disruption are known to be more severe (Pettit et al., 2010). Hence, one main objective of SCRES is to reduce supply chain vulnerabilities and therefore reduce the impact of disruption (Jüttner & Maklan, 2011). An excessive risk is created if vulnerabilities are greater than capabilities, or reduced profitability if capabilities are greater than vulnerabilities, as resilient investments can be costly. Thus, should capabilities to mitigate disruptions be balanced against vulnerabilities (Pettit et al., 2013; Pettit et al., 2010). However, the level of vulnerability is not always directly linked to the resilience of the supply chain and a measure taken to reduce risk may not necessarily both reduce the vulnerability and increase the resilience of the supply chain. For example, avoiding certain geographical areas may reduce the risk of disruptions without improving the supply chain's ability to respond and recover from disruptions (Jüttner & Maklan, 2011). Companies should identify to which disruptions they are most vulnerable. This could be achieved using historical or industrial data to estimate the probability of a disaster occurring (Manuj & Mentzer, 2008; Sheffi & Rice, 2005). Scenario planning is another way to forecast the impact of dynamic risks, which may be essential for management planning, decision-making, and building resilience. This implies preparation measures such as simulation to find weak links (Sheffi & Rice, 2005).

Supply chain disruptions can be classified in different ways. In the humanitarian field, van Wassenhove (2006) divides disruptions into man-made and natural disasters with either a sudden- or slow-onset. A sudden disruption has a sudden effect on the supply chain and the initial and full impact of the disruption are usually close in time to the disruption, for example in natural disasters or man-made disruptions, such as terrorist attacks. In contrast, disruptions with a slow onset have a gradual effect on the supply chain and the full impact may occur a long time after the initial impact, for example in the case of famine or political crises (Van Wassenhove, 2006).

Disruptions can be divided into three phases: pre-disruption, disruption, and post-disruption. The pre-disruption is before a disaster strikes, where a resilient strategy can include the ability to anticipate (Shishodia et al., 2021), prepare, resist, and avoid disruptions (Ali et al., 2017). The disruption phase is when disaster strikes, where common strategies include resisting (Shishodia et al., 2021), responding, coping, and adapting to the new situation (Ali et al., 2017). Lastly, the post-disruption takes place after the disruption, including strategies to respond, recover, survive (Ali et al., 2017; Shishodia et al., 2021), learn, and grow (Tukamuhabwa et al., 2015). The abilities to learn and grow are important to reconstruct the supply chain to improve the preparedness for future disruptions. In humanitarian logistics, this has been referred to as the disaster cycle (Kovács & Spens, 2009; Pettit & Beresford, 2005).

SCRES can be divided into five phases: readiness, response, recovery (Ponomarov & Holcomb, 2009), learning (Tukamuhabwa et al., 2015), and growth (Hohenstein et al., 2015). These phases of resilience are connected to the three phases of disruption (Hollnagel, 2011) (See Figure 1).

Figure 1: *Supply chain resilience through the phases of disruption*



Note. Own construction.

Previous literature on SCRES has an inconsistency in which capabilities provide a resilient supply chain, even though it is commonly agreed that SCRES includes different capabilities to cope with different phases of disruption (Hohenstein et al., 2015). Instead, the conceptualisation of the capabilities that provide SCRES has been rather unconstructed (Ali et al., 2017; Hohenstein et al., 2015) using different terms such as indicators (Hollnagel, 2011; Singh et al., 2019), principles (Christopher & Peck, 2004; Ponomarov & Holcomb, 2009), enhancers (Blackhurst et al., 2011), enablers (Soni et al., 2014), elements (Ali et al., 2017; Hohenstein et al., 2015; Ponomarov & Holcomb, 2009; Zavala-Alcívar et al., 2020) or capabilities (Brusset & Teller, 2017; Jüttner & Maklan, 2011; Pettit et al., 2010). Throughout this thesis, the influential factors of SCRES will be referred to as capabilities, which could be either on an operational or dynamic level.

2.1.2 Dynamic and Operational Capabilities

Dynamic capabilities are linked to the supply chain's ability to perform during all phases of resilience (Kähkönen et al., 2021; Singh et al., 2019). The dynamic capability view (DCV) involves higher-level activities and routines essential for an organization to provide long-term performance and competitive advantages in rapidly changing environments (Hassan et al., 2017; Kähkönen et al., 2021; Teece, 2007), to provide a higher level of performance (Winter, 2003). The DCV is an extension of the resource-based view (RBV), which focusses mainly on existing resources (Chari et al., 2022). Dynamic capabilities should provide the ability to understand the environment to sense and shape opportunities and threats, seize these opportunities, and if necessary, reconfigure and transform organizational assets (Kähkönen et al., 2021; Teece, 2007), while operational capabilities imply the basic activities in an organization that enhance present operations and improve business processes such as cost reduction, speed, and quality (Hassan et al., 2017). Resilience is therefore important to maintain the connection between dynamic capabilities and a long-term competitive advantage (Ponomarov & Holcomb, 2009). Resilience requires organizations to have the ability to prepare, respond, adapt, recover, learn, and grow from a disturbance (Ali et al., 2017; Hohenstein et al., 2015; Hollnagel, 2011; Jüttner & Maklan, 2011; Tukamuhabwa et al., 2015), in which the ability to grow implies providing long-term competitive advantages (Tukamuhabwa et al., 2015). However, the SCRES literature rarely distinguishes between the operational level and the dynamic level of capabilities, and as dynamic capabilities are focused on

providing a competitive advantage in rapid environmental change, they are important when improving resilience.

Successful capabilities that have been discussed in previous literature are flexibility, agility, velocity, visibility, design and reengineering, collaboration, coordination, digital transformation, knowledge and experience, as well as robustness (see Table 1). Agility includes the ability to respond fast to unexpected demands to reduce the vulnerabilities and risks created by long response times (Christopher & Peck, 2004). This requires flexibility, velocity, and visibility. As a key element of a resilient supply chain (Christopher & Peck, 2004; Hohenstein et al., 2015; Ivanov et al., 2019; Jüttner & Maklan, 2011; Pettit et al., 2010; Zavala-Alcívar et al., 2020), flexibility is important for the supply chain to quickly adjust and recover from disruptive circumstances (Singh et al., 2019). Velocity includes the speed to adapt to new changes and visibility requires close communications and integration between multiple actors in the network (Christopher & Peck, 2004; Scholten & Schilder, 2015) and a network perspective is needed to reduce ripple effect across the supply chain (Christopher & Peck, 2004). Hence, digitalization has an important role in mitigating risk and providing a more resilient supply chain. For example can big data improve visibility. However, digitalization can also create difficulties in cross-channel coordination (Ivanov et al., 2019). To enhance SCRES it is therefore important to understand the network and where capacity limitations and bottlenecks exist (Christopher & Peck, 2004). Consequently, the design of the supply chain impacts its level of resilience. The design also comes with certain trade-offs, such as efficiency versus redundancy and cost versus excess capacity (Christopher & Peck, 2004).

Table 1: *Key Operational and Dynamic Capabilities*

Capability	Definition	Operational level	Dynamic level
Flexibility	Flexibility enables a quick and efficient response to changes, most often associated with an operational level (Ponomarov & Holcomb, 2009).	On an operational level, this can include flexibility in processes, such as flexible transportation, flexible sourcing, and flexible order fulfilment (Pettit et al., 2010; Singh et al., 2019)	On a dynamic level, flexibility enhances agility and competitive advantages through rapid adaptation to market changes that provide reduced costs, a stronger market position, and increased revenues (Sheffi & Rice, 2005) to shape the supply chain, seize opportunities, and transform the supply chain so that it can deliver long-term results.
Agility	Agility is defined as "The ability to respond to unpredictable changes in demand or supply" (Christopher & Peck, 2004, p.18), with focus on a strategic level. Hence, this requires flexibility in operations.	On an operational level, agility can include quickly adapting operational processes, such as shipping quantities, schedules, and inventory levels (Christopher & Peck, 2004).	On a dynamic level, agility allows supply chains to respond to disruptions and quickly create new innovative competitive advantages to reshape and transform an organisation and supply chain (Ponomarov & Holcomb, 2009).
Velocity	Velocity is the time it takes to move products and materials through the supply chain (Singh et al., 2019).	On an operational level, this can include simplifying processes and reducing lead times and non-value-added operational times (Christopher & Peck, 2004).	On a dynamic level is the acceleration of speed to respond to changes in demand important to quickly reshape and transform the supply chain (Christopher & Peck, 2004).
Visibility	Visibility includes transparency in the upstream and downstream flows of the supply chain, including clear lines of communication to respond to supply chain disruptions (Jüttner & Maklan, 2011; Pettit et al., 2010).	On an operational level, this includes visibility in inventories, demand and supply conditions, and production and purchasing schedules (Christopher & Peck, 2004).	On a dynamic level, the free flow of information between actors can reduce the effect of ripple-effect effect and enhance collaborative planning (Christopher & Peck, 2004) to enhance the competitiveness of the entire supply chain.
Designing/ Reengineering	Designing supply chains not only to optimise costs or customer service, but also to understand the characteristics of the supply chain and its network, including where bottlenecks, weak links, and risks may exist (Christopher & Peck, 2004).	On an operational level, this includes planning for reserve resources, such as multiple suppliers or safety stocks (Ivanov et al., 2019; Sheffi & Rice, 2005), contingency plans, and redundancy to resist change in operations and help the supply chain to maintain its reliability (Brandon-Jones et al., 2014).	On a dynamic level, the ability to re-engineer the supply chain design enhances the ability to reconfigure and transform the supply chain in the event of disruptions to provide long-term performance (Christopher & Peck, 2004; Kähkönen et al., 2021).

***Table 2** (continued): Key Operational and Dynamic Capabilities*

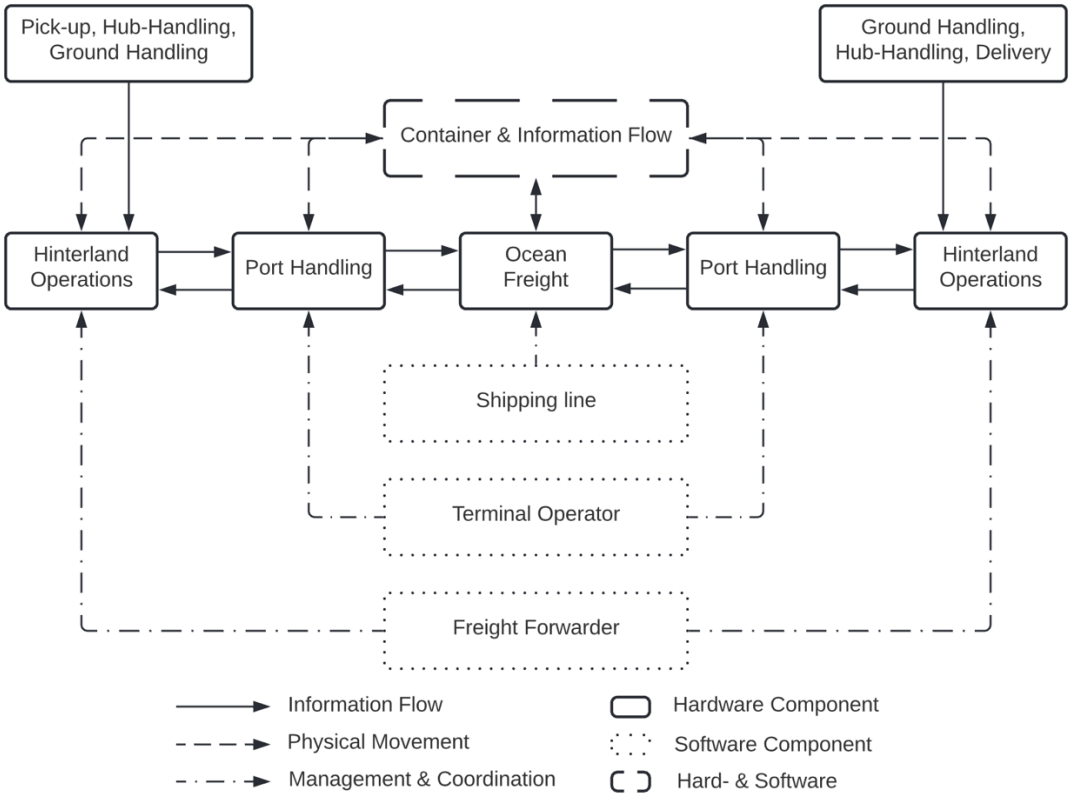
Capability	Definition	Operational level	Dynamic level
Collaboration/ Coordination	"Collaboration in a supply chain relates to the capability of two or more autonomous firms to work effectively together, planning and executing supply chain operations toward common goals" (Scholten & Schilder, 2015, p. 471).	On an operational level, collaborative conditions reduce uncertainties and increase flexibility, agility, visibility, and intelligence of the supply chain by sharing knowledge and resources between supply chain partners (Brandon-Jones et al., 2014; Christopher & Peck, 2004; Scholten & Schilder, 2015; Singh et al., 2019).	On a dynamic level, actors' ability to collaborate and coordinate effectively and efficiently before, during, and after disruptions increases the connectedness among actors and reduces ripple-effects, providing long-term competitive advantages (Ponomarov & Holcomb, 2009; Singh et al., 2019; Teece, 2007).
Digital transformation	Digital transformation can be defined as "a change in how a firm employs digital technologies, to develop a new digital model that helps to create and appropriate more value for a firm" (Verhoef et al., 2021, p. 889).	On an operational level can advanced tracking and tracing systems contribute to real-time information sharing, to better allocate resources, shorten lead times, and ensure process continuity and visibility (Ivanov et al., 2019).	On a dynamic level can information technology, integrated systems and processes increase the connectedness among actors to reduce ripple-effects (Ponomarov & Holcomb, 2009; Singh et al., 2019; Teece, 2007) and digital transformation enhances gaining competitive advantages through value creation (Ellström et al., 2021).
Knowledge/ Experience	Knowledge-based capabilities "includes various kinds of knowledge, such as explicit and tacit knowledge, information and know-how, technological, management and marketing knowledge" (Zheng et al., 2011, p. 1038).	On an operational level can acquiring and using mapping tools, scenario planning, and historical data enhance the knowledge of which risk and vulnerabilities that exists in a supply chain (Christopher & Peck, 2004; Sheffi & Rice, 2005).	On a dynamic level can an understanding of risks from the board of the organization enhance understanding of the organizational culture (Singh et al., 2019; Teece, 2007). Knowledge also enhances the ability to develop and improve processes (Zheng et al., 2011).
Robustness	Robustness implies a supply chain's ability to remain its function during disruptions (Brandon-Jones et al., 2014).	On an operational level, robustness implies using available resources and operations to remain stable and resist the impacts of disruptions (Brandon-Jones et al., 2014).	Robustness might be seen as the contrast to resilience and understood as an organisation being static (Brandon-Jones et al., 2014). However, on a dynamic level, previous literature argues that robustness often requires changes in resources or operations to remain stable during disruptions (Brandon-Jones et al., 2014; Kitano, 2004).

2.2 The Global Maritime Supply Chain

A global maritime supply chain (MSC) refers to an interrelated array of activities related to shipping operations that engage in the planning, coordination, and control of container cargoes from origin to destination (Lam, 2011), and accounts for about 90 percent of global trade (OECD, n.d.). In contrast to a maritime transport chain, carriers, shippers, and ports in a MSC are vertically linked through customer-supplier relationships. MSCs are chosen by stakeholders, namely carriers, ports, freight forwarders, suppliers, and customers, who collaborate to achieve mutually satisfactory results (Tongzon et al., 2009).

Multiple forces have contributed to shaping the latest global shipping containerization, among them the increase in trade, the appearance of new markets, the growth of new transport companies, and the increasing complexity of supply chain logistics. Trade growth and the emergence of markets created a demand for container shipments, leading to the development of new carriers and the expansion of third-party logistics providers (Brooks & Cullinane, 2006). Continued mastery of the supply chain requires huge capital investment and multi-modal infrastructure integration, resulting in a transformation of the maritime sector (Brooks & Cullinane, 2006). Given economies of scale in vessel size and ever easier access to progressive technology, shipping companies are adapting their development strategies to their vision of the market's future. Today, the use of very large vessels has become a standard operating practice for major shipping companies (Liu, 2011). Currently, the largest container vessel size has developed from approximately 5500 TEU in 1995 up to over 23,000 TEU in 2019 onwards. Commercial reasons for continued increases in vessel size depend widely on prevailing and future container shipping market forces. This includes the adaptability of ports and terminal capacity, in terms of economics as well as technology, along with environmental constraints and deliberations that have emerged more recently (Ge et al., 2021). A further impact of technological and economic evolution in the maritime transport sector (MTS) has been the advance of intermodal logistics, where ports have been progressively incorporated into a global system of multimodal supply chains (see Figure 2) (Liu, 2011).

Figure 2: *Generalized International Maritime Supply Chain*



Note. Adapted from Liu, 2011, p. 400.

2.2.1 Port Operator

As an essential component of international transport networks, ports are recognized for being not only a self-sufficient and integral space for transferring physical cargo but a systematic link in a multimodal logistics supply chain. Within this system, their role in coordinating the flow of materials and information makes the ports' role extremely crucial (Liu, 2011).

Keeping costs to a minimum and ensuring reliable freight handling are emerging as important components of global transportation logistics and supply chain management. Evermore discerning customers are putting pressure on service providers to offer fast, just-in-time services at competitive rates (Liu, 2011). As a result, shipping companies may need to move their cargoes on a far more flexible timeline and require additional ports to accommodate them. Thus, the performance of logistics operators relies heavily on the efficiency of ports, which act as integration and coordination nodes across the various components (Bichou & Gray, 2004). Integration refers to the degree to which

stakeholders work together cooperatively and collaboratively to obtain win-win solutions, collectively referred to as the 'optimal solution' (Carbone & Martino, 2003). Companies have for several years focused primarily on cost when choosing suppliers, setting up factories, and determining inventory levels. Just-in-time production originated in Japan in the late 1940s to reduce inventory, shorten setup times, and lower costs in various other areas of the supply chain. Just-in-time cost reduction and efficiency improvement gained worldwide recognition and was subsequently incorporated by many companies. It has been argued that the primary risk and vulnerability of this strategy is over-dependence on supplier resilience and flexibility (Jiang et al., 2022). In contrast to the just-in-time strategy that has prevailed in recent decades, Jiang et al. (2022) argue for the just-in-case supply chain strategy to increase resilience for multinational organisations. The just-in-case strategy suggests keeping larger inventories on hand to enhance greater robustness of the supply chain to major shocks and accounts for uncertainties where the worst case of a series of outcomes is optimized (Jiang et al., 2022).

In theory, larger vessels allow ship carriers to perform better on unit costs due to economies of scale, while in reality, larger capacity vessels face ancillary constraints. Larger vessels are often more difficult to operate because they have greater demands on financial assets, time, and physical constraints, such as navigation channels in rivers and canals, berthing depths in ports, and transhipment terminals. The optimal vessel size should therefore be determined not only by the operational cost of the vessel but also by the negative external effects that the physical scale of the ship might exert on other logistics supply chain elements (Jansson & Shneerson, 1982). Often, ships that are larger typically have a greater water draft and are constrained by the physical limitations of port conditions. To a large extent, this accounts for why operators of high seas vessels frequently exert considerable pressure on port operators to enhance their infrastructures to reap economic advantages from the use of larger vessels (Heaver, 2002; Notteboom & Winkelmans, 2001). Liu (2011) argues that the seamless flow of cargo throughout supply chains is largely contingent on the ability of ports to function as effective hubs among vessels and other modes of transport, with their effectiveness and capacity being critical to the degree of the maritime logistics system optimization. In turn, this requires modern ports capabilities to be competitive and customer-focused in management and operations (Liu, 2011).

2.2.2 Shipping Companies

Incorporating shipping companies into the transportation supply chain can be seen as an important strategy in attempts to meet demand and preserve the companies' viability in today's competitive landscape. Seaborne trade growth in recent decades mirrors the convergence of markets around the world. A geographical divide in supply and demand has increased freight service expectations. Matching the increase in global demand for maritime cargo has been seen as one of the greatest ongoing challenges. Beyond fulfilling demand, shippers and recipients have not only become more demanding, but they are also placing higher requirements on the quality of transportation services. Users of cargo transportation offered by shipping companies demand rapid and dependable services at cost-competitive rates and across a broad geographic network. The consistent expansion of shipping companies, whether achieved organically or through mergers and acquisitions, is designed to satisfy these demands and expectations (Panayides et al., 2012).

The objective of a MSC is to generate added value for the commodities transported. Through the provision of spatial and temporal value, a MSC moves goods from a location (origin) that values the cargo on an inferior level to a location (destination) that values the cargo on a superior level. Within the supply chain scale, shipping companies must coordinate freight, information, and financial movements throughout the chain, collaborating with multiple stakeholders including carriers and ports (Lam, 2015).

2.2.3 Freight Forwarder

Skiba and Karas (2022) describe that a freight forwarder, assisted by carriers, arranges for the safe transportation of goods that have been assigned into their care. The appearance of freight forwarding is connected to the growth of goods manufacturing and the evolution of trade and transport. The demand for this service occurs when the purchaser no longer takes charge of the transportation of their commodities themselves but entrusts this responsibility to specialized transport companies. Nowadays, freight forwarders are active stakeholders in the transportation chain, primarily engaged in moving cargo. Freight forwarding comprises a range of encompassing operations. Moreover, a freight forwarder is an intermediary who operates by order of importers, exporters or other entities that appoint them to arrange transportation in secure, efficient,

and cost-effective conditions. A maritime freight forwarder is a professional who is capable of organizing transport services accurately and solving problems arising frequently as early as in the planning phase of the transportation chain. The forwarder acts as the overall coordinator and architect of the transportation chain, with one of the key issues being how to properly collaborate with the supply chain stakeholders. Accordingly, the forwarder ought to be capable of influencing and negotiating with the various actors in the MSC to achieve the potential best value for the end customer. In organizing the shipment, the freight forwarder subcontracts downstream activities to its partners, subcontractors, or potentially other carriers that serve a complementary function relative to the primary freight forwarder (Skiba & Karas, 2022).

2.2.4 Hinterland Transportation

Hinterland operations include inland transport lines connected to ports (Van Der Horst & De Langen, 2008). There is a wide range of private companies involved in hinterland transport, such as shipping companies, terminal operators, freight forwarders, hinterland transport providers and inland terminal operators. Additionally, various public stakeholders such as the port authority, customs, and infrastructure providers are engaged. Container transport has become the main cargo flow in numerous seaports and part of the transport flows from these ports are intended for the hinterland, which is located near these ports (Van Der Horst & De Langen, 2008). According to Van Der Horst and De Langen (2008), hinterland access is a major concern for ports. Ports and their hinterland transportation networks can draw and handle incremental container volumes only if the hinterland transportation system is managed efficiently and effectively. Dry ports can act as an inland hub for intermodal exchange and are usually connected to the seaport by rail. They can be used as an alternative to storage of goods at terminals to reduce congestion both within the terminal and from trucks coming to the port to pick up goods (Khaslavskaya & Roso, 2019; Russell et al., 2020).

2.3 Resilience in the Maritime Supply Chain

SCRES is a relatively new concept where existing literature focuses mostly on the broader global supply chain, while resilience in the MTS has remained a relatively unexplored area (Lam, 2012; Russell et al., 2020). Increased uncertainties in global trade and interdependencies between different nodes and actors within transportation systems have

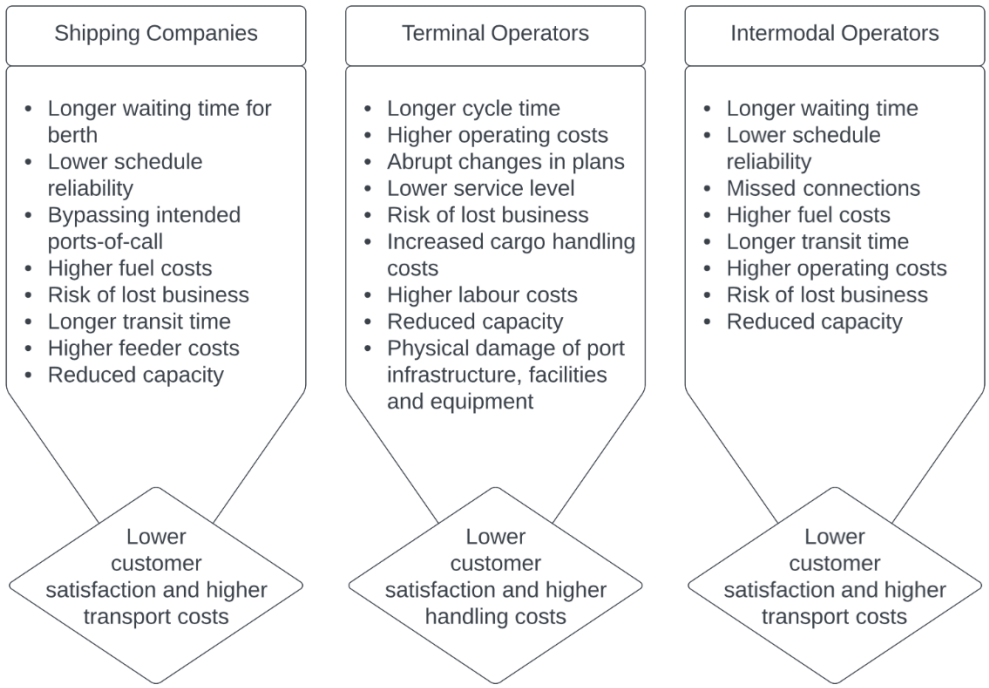
acknowledged the importance of resilient transportation systems to provide reliable and efficient supply chains (Berle et al., 2011a; Wan et al., 2018). Transportation resilience can be defined as “the ability of a transportation system to absorb disturbances, maintain its basic structure and function, and recover to a required level of service within an acceptable time and costs after being affected by disruption” (Wan et al., 2018, p. 489). In comparison to overall transportation, the MTS includes more interfaces that provide potentially vulnerable nodes, which is a result of industry consolidation and increased regulations (Berle, et al., 2011b; Lam, 2012). Therefore, the interrelation between the different actors in the MTS requires a more holistic perspective (Lam, 2012). However, previous literature on SCRES in the MTS mainly focuses on one specific actor, such as ports (Jiang et al., 2021; Thekdi & Santos, 2016) or its connection to the hinterland and intermodal transport (Chen et al., 2018; Hossain et al., 2020; Khaslavskaya & Roso, 2019), as well as specific aspects of risk management, such as security and the safety perspective (Jiang et al., 2021; Young & Gordon, 2020) and ship-ship collisions (Chen et al., 2019; Goerlandt & Montewka, 2015; Montewka et al., 2014), or specific geographical locations (Islam et al., 2021; Narasimha et al., 2021).

The MTS is an important provider of supply and as a part of a larger supply chain, disruptions in the MTS can create ripple effects across the broader network (Berle et al., 2011b; Lam, 2012). Adapted from Wilson (2007) and Craighead (2007), Lam (2012) define disruptions in the context of maritime supply chains (MSCs) as "an event that causes a sudden interruption on material flow in a supply chain, leading to a halt in the movement of cargoes, and jeopardizes the firms with operational and financial risks. Besides the direct impact on a particular supply chain node, it has an indirect impact on the rest of the supply chain network” (Lam, 2021, p. 120). Disruptions and transport system fails can therefore arise from different actors in the maritime supply chain. For example, can a disruption in one port create delays for vessels arriving at another port, increasing both direct and indirect ripple effects (Asadabadi & Miller-Hooks, 2020). Disruption can also arise if there are vulnerabilities in the capacity to supply, financial flows, transportation, communication, internal operations, or human resources (Berle et al., 2011b). MSC flexibility can be enhanced by providing transparent coordination and real-time information, using tracking and tracing tools, big data, or other digitalization tools (Russell et al., 2020).

2.3.1 Port Handling

Previous literature places ports as one of the most important actors in the MSC (Liu, 2011; Russell et al., 2020). Due to increased containerized trade, operationalized challenges such as new supply chain strategies and market dynamics have arisen for ports in the physical handling of containers and the quality of services. As uncertainties in container ports are increasing, the flexibility of the port becomes increasingly important (Russell et al., 2020). Resilience in ports is therefore important as a disruption in a port will have impacts on other parts of a MSC (see Figure 3). Port resilience is defined as "the ability [in terms of speed and recovery period] of a port to return to a stable state after a major disturbance" (Jiang et al., 2021, p. 3). Potential practices to adopt operational flexibility in ports are flexible equipment handling, alternative transportation modes, increased flexibility of vessels regarding the quantity of handled cargo, and the ability to expand the storage area to create buffer capacity at ports (Russell et al., 2020). A port also needs to be agile and robust to respond rapidly to external disruptions and to ease declines in cargo flowing through ports and reductions in revenues (Lam, 2012; Russell et al., 2020).

Figure 3: *Potential Impacts of Port Disruption on MSC*



Note. Adapted from Lam, 2012, p. 123.

The COVID-19 pandemics impact on container volume were highly visible in ports (Alamoush et al., 2021; Notteboom et al., 2021). Previous literature shows that due to limited demand at the beginning of the pandemic and high inventory costs, importers did not take responsibility for their cargo which resulted in a large amount of inventory left at terminal yards (Notteboom et al., 2021). However, as demand started to increase again due to large-scale restocking, this immediately translated into higher demand for port services, growth in cargo, and a shortage of equipment. Simultaneously, a shortage of dock workers due to quarantines, infected personnel, and medical checks at port arrival resulted in delays and congestion (Alamoush et al., 2021; Cullinane & Haralambides, 2021). In response to increased demand, the longer handling time of larger vessels put continuous pressure on ports (Cullinane & Haralambides, 2021).

Sufficient capabilities are needed to deal with the increased flow of cargo and to prevent congestion resulting in ripple effects throughout supply chains. Preparation and risk mitigation are therefore important factors for terminal operators to increase their competitiveness (Lam, 2012). While Notteboom et al. (2021) argue that cooperation and coordination among stakeholders and compensatory economic measures in ports provided rapid responses and mitigation of the adverse effects of COVID-19, including increased use of technology and application of existing contingency plans, Alamoush et al. (2021) calls for more multi-sector, regional, and global coordination, collaboration, and cooperation to facilitate global trade more efficiently throughout the entire supply chain.

2.3.2 Hinterland Operations

A flexible port is not only necessary for port operators, but also for carriers and logistic service providers operating in the maritime transportation system as limited terminal capacity might create congestions even outside the port (Russell et al., 2020). Growing containerized transport has created an increased lack of space capacity escalating the importance of efficiently moving cargo out from ports (Hossain et al., 2020). A shortage of truck drivers during COVID-19 created capacity issues in hinterland transportation moving cargo out from the port (Alamoush et al., 2021; Cullinane & Haralambides, 2021). One strategy to reduce this risk is by using dry ports to eliminate congestion in the port terminals by providing an alternative to truck transportation (Russell et al., 2020).

Hence, dry ports function as an effective resilient alternative to move cargo out of the port and provide increased flexibility and competitive advantages in the event of increased cargo flows (Khaslavskaya & Roso, 2019).

2.3.3 Ocean Freight

In the MSC, disruption may affect both shipping and port operations, requiring new business strategies and changes in market structures (Notteboom et al., 2021). Delays from the arrival, loading, and unloading of a vessel can contribute to disruptions in ports. A sufficient level of empty containers in a port highly depends on carriers and their customers to return them to the ports, which can create unbalanced container availability in different areas. Carriers can increase flexibility by expanding container fleet sizes or leasing containers to increase container utilization. This requires good planning and coordination among actors (Russell et al., 2020).

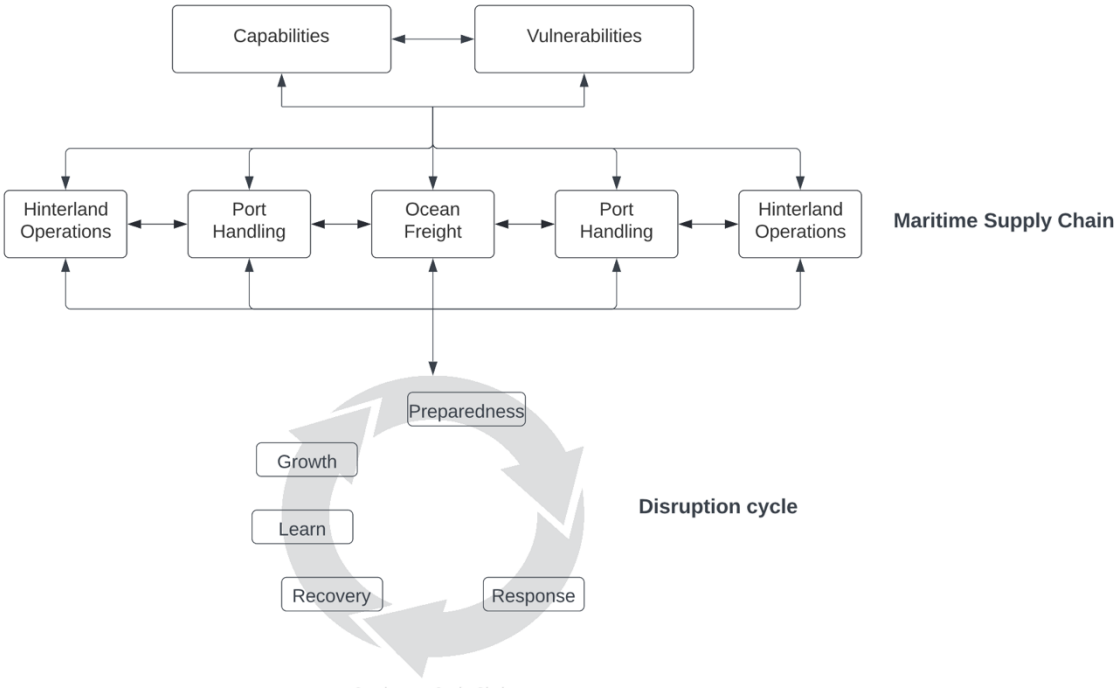
Shipping companies have noted record profits as a result of quick adaptation to supply and demand changes combined with increased freight rates (Cullinane & Haralambides, 2021). Compared to the financial crisis in 2008-2009, where the shipping industry struggled to adapt to the changing environment, literature argues for improved capacity management during COVID-19. Sharing containers on vessels, keeping a stagnant order book (Notteboom et al., 2021), and using blank sailings, meaning cancelling a part of the route to reduce the number of cancelled departures, are some strategies used to maintain capacity (Alamouch et al., 2021; Cullinane & Haralambides, 2021; Notteboom et al., 2021). However, this reduced service quality and vessel capacity while increasing delivery delays (Alamoush et al., 2021). As demand started to increase blank sailings were reduced and freight rates increased. Literature argues that the main impact of Covid-19 on freight forwarders and shipping agencies was the impact of governmental regulations, quarantines and safety measures, and strained capacity in hinterland transportation. This resulted in delays in cargo delivery, declines in demand volume, and financial issues for customers (Alamoush et al., 2021). To reduce the number of cancellations, innovations in the form of new services and storage solutions were created, which allowed customers to adjust delivery dates without cancelling the order (Notteboom et al., 2021).

Lam (2012) argues that a proactive approach to risk management will make the maritime supply chain more prepared and less vulnerable to disruption, which should provide the supply chain with more competitive advantages. However, as literature on SCRES shows, being prepared is not enough to provide competitive advantages. The MSC should also hold the capabilities to respond and grow (Mohammed et al., 2021). Due to the interconnectedness of the different actors of the MSC, it is therefore not enough to investigate only one actor of the MTS. Instead, resilient strategies need to incorporate the entire maritime system, making cooperation increasingly important (Asadabadi & Miller-Hooks, 2020).

2.4 Literature Synthesis

Figure 4 is a visualisation of the literature synthesis that incorporates operational and dynamic capabilities in balance with the supply chain vulnerabilities to mitigate the impacts of disruptions in all three phases of resilience (preparedness, response, recovery, learn, and growth). The capabilities represent the all-encompassing key elements that strengthen all supply chain channels.

Figure 4: *Literature Synthesis Model*



Note. Own construction.

The analysis level includes all MSC stakeholders from hinterland operations to transshipment at the port of departure, ocean freight, transshipment at the port of destination, and further hinterland operations. To mitigate the impact of disruptions on the MTS dynamic capabilities can provide the resilience across all stakeholders to prepare for, withstand, and learn from disruptions. An analysis of how key operational and dynamic capabilities enhance supply chain resilience in the maritime transport sector will identify the actions needed to mitigate the effects of major disruptions.

3 Research Method

This chapter presents the methodological assessments and the selected cases of this thesis. In addition, the processes of collecting and analysing the primary and secondary data are outlined.

3.1 Methodology

To address the thesis purpose and research questions, the objective of this thesis is to develop a comprehensive framework to enable the identification and understanding of relevant capabilities for maritime supply chains (MSCs) to possess in the event of disruptions. This study was conducted qualitatively by collecting data from semi-structured interviews and secondary data sources. The collected data were analysed using a grounded analysis.

3.1.1 Research Philosophy

To provide a qualitative research, Easterby-Smith et al. (2018) highlight the importance to be aware of one's philosophical assumptions. Therefore, we will start this chapter by providing our ontological and epistemological standpoints. The ontology includes the assumptions about what reality is and how we perceive it. From a realism perspective there is only one single reality regardless of how it is observed. This ontological perspective is common in natural science when investigating inanimate objects. In social science, the remaining three ontologies internal realism, relativism, and nominalism are more common as the scope is more often investigating people and their respective behaviour (Easterby-Smith et al., 2018). In this study we propose a relativistic ontology, as we believe that reality is dependent on the perspective of the viewer and each perspective is perceived as the truth. In relation to the internal realism ontology, which argues that only one truth exists even though we perceive it differently in our minds, relativism argues that more than one truth exists (Collins, 1983; Easterby-Smith et al., 2018). Therefore, we will investigate the phenomenon of supply chain resilience (SCRES) from the perspective of different maritime transport actors and multiple employees within the same organizations or organized actors to provide a more holistic picture.

As we understand that different social processes are involved in creating different truths, our epistemology is based on a social constructionist view. Hence, we believe that people's different perceptions and experiences contribute to the general understanding of the SCRES phenomenon. A constructionist epistemology is usually built on a relativism ontology (Easterby-Smith et al., 2018) and an investigation of different perspectives from purposefully chosen maritime actors and organizations, using multiple methods to collect data, contributed to a rich data covering multiple viewpoints. This also provided a result which can be generalized beyond the investigated cases. Previous literature has also emphasised the need for future research in SCRES using constructionist methods (Tukamuhabwa et al., 2015).

3.1.2 Research Approach

In line with our relativist ontology and our social constructionist epistemology, a qualitative study was conducted. In contrast to a quantitative study, where the main objective is to test theory and provide a result generalized to the entire population, this study was conducted to gain a deeper understanding of the phenomenon of SCRES in the maritime transport sector (MTS) and extend existing theory within SCRES. Following the standpoint of Charmaz (2006), a qualitative approach is beneficial as it enables us to investigate this phenomenon from different viewpoints to gain new insights and to be more flexible in creating new paths during the research process as new data emerges. In this inductive and exploratory study, previous theories on SCRES have been used to sensitize our pre-knowledge of the phenomenon, rather than determining it. Hence, we did not have any pre-assumptions tested as in a deductive study. We rather explored this relatively unresearched area to come up with new insights to build on an already existing theory, according to Saunders (2016).

A multiple-case study approach has been applied to investigate the resilience of the MTS during the two disruptive cases of the COVID-19 pandemic and the Suez Canal blockage-21. Both disruptions have affected the MTS on a global scale and were purposively chosen due to their different nature, as both sudden-onset and slow-onset disruptions cover characteristics of both man-made and natural disruptions (Van Wassenhove, 2006). Hence, a multiple holistic case study approach was used as these cases provided a rich picture of SCRES in the MTS to extend already existing theory. To provide relationships

and a variety of viewpoints from the investigated industry, the unit of analysis consists of different actors within the MTS. This type of case study is adapted from Yin (2014), which emphasises a constructionist epistemology. Since the main objective of this study is not to provide a deep understanding of these two cases, they have rather been purposively chosen to provide insight into the more general understanding of resilience in the MTS. Hence, we have conducted an instrumental case study, according to Stake (1995). The two cases were first analysed separately and continuously similarities, differences, and relationships between the two different cases were analysed, hence both a within-case analysis and a cross-case analysis were conducted, following Eisenhardt (1989) and a constructionist philosophy.

3.1.3 Research Design

To provide a holistic understanding of the SCRES in the global MTS and to answer the underlying RQs, a triangulation of different qualitative methods was conducted. This is considered a beneficial approach in case studies (Eisenhardt, 1989). Data is collected through interviews with various actors in the MTS and podcasts and business reports published by actors in the MSC. Using multiple research methods is beneficial to gather a variety of perspectives and experiences, and thus provides a more holistic understanding of a phenomenon (Easterby-Smith et al., 2018). The interviews provided us with individual perspectives from different industry actors at different organizational levels and secondary data from industry podcasts included perspectives from individuals in the industry with insight relevant to the scope of this study. Compared to individual perspectives in interviews or podcasts, business reports gave us an overall organizational view. This provided us with information that we used to contrast with individual perspectives and thus provide a more accurate understanding.

3.2 Chosen Cases

The chosen disruption cases allow a complete and practical overview of the current challenging situation in which the MTS finds itself. By looking at the slow-onset COVID-19 disruption, the analysis of the underlying impact factors of SCRES provides a valuable insight into the shortcomings in the MSC that have been exposed by this unforeseen global pandemic, which are now receiving the recognition they require. The more sudden-onset Suez Canal blockage-21 disruption provides insight into quick actions that had to

be taken to minimize its impact, but also what long-term consequences can be caused by such a disruption and the lessons drawn from it. The confrontation of the two disruptions, of which the Suez Canal blockage-21 case occurred amid the already severe COVID-19 disruption, allows insights into the unprecedented tribulations of the MTS. Both cases are ideal illustrations of the events and developments in the MTS in recent years. These cases are the basis for the analysis of the general possibilities and solutions to optimize port-to-port operations and make them more resilient to better withstand future disruptions.

3.3 Data Collection

Data collection techniques enable researchers to obtain credible data pertaining specifically to the topic under study. A primary data collection method involves acquiring data from respondents who are actively engaged in the subject under investigation, while secondary data collection involves accumulating data through various media such as journals, articles, newspapers, etc. (Lethbridge et al., 2005; Saunders et al., 2007). To investigate the effects of global disruptions on SCRES within the MTS, the data collection is based on qualitative, semi-structured interviews as primary data as well as industry-specific expert podcasts and respective business reports as secondary data. To capture multiple perspectives using assorted qualitative methods and to gather the opinions and perspectives of multiple individuals, primary interview transcripts, secondary podcast statements, and corporate data, as well as academic research findings from the literature were combined and compared. This approach increases the accuracy of all observations collected (Easterby-Smith et al., 2018) and further strengthens the validity of this study.

3.4 Primary Data

Primary data refers to original new information directly obtained by the researchers (Easterby-Smith et al., 2018). In this study, in total 14 interviewees participated of which four offered the view of a shipping company, six the port operations, three the freight forwarders, and one the view of a non-vessel operating common carrier (NVOCC). Thereby all port-to-port maritime supply chain actors are represented in the interviews and can provide different perspectives on the current situation and developments in the industry. The participants are located across the globe on three different continents and in eight different countries altogether: three participants in Asia in three different

countries, three in North America in two different countries, and eight in Europe in five different countries, enabling a holistic data collection. All interview participants have extensive knowledge in the MTS, which distinguishes them as experts through their years of experience displayed in Table 2.

For confidentiality reasons, the participants' companies cannot be disclosed; all are employed by large maritime transport organizations that are knowingly affected by the two disruptions discussed in this paper. Data for the first round of interviews were collected during calendar weeks 10 to 13 in 2022. A second round of interviews was conducted in calendar weeks 15 to 18 with participants referred by previous interviewees and further contacted individuals. The time in between the first and second interview rounds enabled a thorough review of the first primary data collected from 7 interviews and revealed already at that stage consistent answers from several participants, meaning that saturation had been reached. The interviews in the second round provided no new data, but rather additional perspectives on the industry's situation and individual knowledge.

During the entire data collection procedure, 14 interviews were scheduled and recorded. Each interview was conducted in English, and both authors of this study were present at each meeting and discussed the different areas of the guideline in turn with the interviewee. This allowed all parties to fully engage, as no notes were required to be taken due to the recording, allowing both researchers to devote their full attention to the interviewee. In total, throughout 14 interviews, 13 hours and 51 minutes of empirical data were accumulated. The average duration of each interview was 59 minutes. Table 2 summarizes all interview meetings.

Table 3: *Overview Interview Participants*

Partici-pant	MSC Actor	Business Department	Position	Industry Experience (y)	Interview Date (d-m-y)	Duration (h)
I01	Shipping company	Cargo and Hub Optimization - Asia	Manager	15	07.03.2022	00:57:00
I02	Port	Intermodal Logistics - North America	Head	15	08.03.2022	01:07:00
I03	Port	Marketing - North America	Manager	20	17.03.2022	00:56:00
I04	Port	IT - Europe	Head	7	21.03.2022	00:53:00
I05	Shipping company	Supply Chain Management - Asia	Head	10	24.03.2022	00:55:00
I06	Freight forwarder	Sea Logistics - Europe	Head	44	28.03.2022	00:58:00
I07	Shipping company	Terminal Operations - Asia	Manager	12	31.03.2022	01:02:00
I08	Freight forwarder	Product Development - Europe	Manager	13	11.04.2022	00:58:00
I09	Port	Market Intelligence - Europe	Head	21	25.04.2022	01:03:00
I10	Freight forwarder	Sea Freight - Europe	Director	18	27.04.2022	01:10:00
I11	NVOCC	Business Development - Europe	Director	26	27.04.2022	01:06:00
I12	Port	Port Authority - Europe	Director	41	29.04.2022	00:48:00
I13	Shipping company	CEO - Europe	Director	33	02.05.2022	01:00:00
I14	Port	Terminal Operations - North America	Manager	11	02.05.2022	00:58:00
					Total:	13:51:00

3.4.1 Selection of Participants

Sampling methods usually involve selecting a representative subset of a targeted or broader population based on which results obtained from the samples can be used to make pertinent generalizations about the population as a whole (Kumar, 2018). Interview participants are selected using either a probability sampling strategy or a non-probability sampling strategy (Easterby-Smith et al., 2018). In general, researchers prefer various probability sampling methods for qualitative research. In a probability sampling design,

each unit of the population that is sampled would be known. In contrast, in a non-probability sampling strategy, the probability of participation is unknown (Easterby-Smith et al., 2018).

This thesis employs the purposive sampling strategy, which belongs to the non-probability sampling design. In this approach, respondents are selected according to predetermined criteria (Easterby-Smith et al., 2018) and are commonly applied to case studies with relatively small size samples (Saunders et al., 2016). Thereby assuring the purposive selection of respondents to maximize relevance and prevent randomness in comparison to alternative sampling methods (Easterby-Smith et al., 2018; Yin, 2015). Valuable data was collected based on the sampling criteria by using the purposive sampling design.

For this study, it was essential to reach participants from all parts of the MSC, including shipping, port operator, and freight forwarder companies, to enable holistic research. To obtain a complete overview of the topic, the researchers included both managerial and operational perspectives from different individuals within the same or similar companies in different locations and departments. Initial contact was predominantly through LinkedIn direct messages to promising potential candidates. First, a search was performed on LinkedIn for dominating large corporations in the MTS and then potential candidates were selected and contacted based on their respective professional role descriptions and experience in the maritime industry. Other potential candidates were contacted directly through corporate email addresses, as in some cases there was previous contact outside of this study. Out of a total of 73 people contacted, of which 30 via LinkedIn, 35 via corporate email, and another 8 via contact forms on company websites, there were only 14 positive and 9 negative responses. Due to the still ongoing pandemic situation, it is understandable that these companies, which are still heavily affected by the COVID-19 disruption, do not have the time to respond to interview requests. In addition, in February 2022, the Russia-Ukraine war was also a factor, which limited the resources of the companies in the MTS even more significantly. Consequently, the snowballing method was used, as the researchers could not reach the respondents by themselves (Easterby-Smith et al., 2018). Using this sampling technique, the participants provided us with a

pathway to additional participants, as they already knew about the criteria that need to be met and could provide targeted recommendations.

3.4.2 Interview Structure

Interviews may be strongly formalized and structured, semi-structured based on guiding questions that are asked more flexibly, or completely unstructured and more spontaneous. In this study, semi-structured interviews were conducted using a predefined guideline (Appendix 1), which contains a loose structure of areas and questions to be covered during the interview (Easterby-Smith et al., 2018). The interview guideline (Appendix 1) includes questions that can be addressed and omitted in any order.

The foreseen logical order, which was almost always followed, began with a short introduction to the topic of the thesis and its implications. This was followed by a short introduction of all participants. The main interview started with the general risk management provisions in the respective company and its overall resilience. This was followed by questions about the two disruption incidents COVID-19 and Suez Canal blockage-21, and then further questions about the maritime supply chain situation at large were asked. The interviews ended with the interviewee's assessment of the importance of supply chain management and its current perception in the media. Depending on which maritime supply chain actor the interview was conducted with, the guideline was adapted and supplemented with company-specific questions.

The semi-structured qualitative interviews for this study were conducted to obtain information in the specific context of the MTS facing disruption. The main objective was to attain an in-depth understanding of the interviewees' perspectives, involving conceptualizing not only what point of view they hold, but also why this particular point of view is held (King, 2004). This was achieved by formulating open-ended questions, which also provided the possibility that the interviewee could be asked additional questions for a deeper insight into the response. This technique is called ‘laddering’ and can be applied sensibly to prolong an answer, ask for further explanations of the answer, or to gain illustrations and practical experiences from the respondent (Easterby-Smith et al., 2018).

All interviews for this study have been conducted remotely via Zoom or Microsoft Teams. This approach was chosen due to the global scope of this study on the one hand and the locations of the respondents spread over several continents on the other hand. In addition, the world is still in a global pandemic, so unnecessary travel is to be kept to a minimum. Compared to traditional face-to-face interviews, digital video conferences are much more flexible to schedule, less time-consuming for respondents, and can easily take place between different time zones (Easterby-Smith et al., 2018). Moreover, today's technology enables real-time video conversations that are very similar to face-to-face interviews, allowing direct reactions and responses to be captured without long reflection time.

3.5 Secondary Data

The empirical data collected through interviews was also supplemented with secondary data collected through podcast episodes, business reports and a comprehensive literature review.

3.5.1 Business Reports

The majority of business reports used for this study were sent or recommended by contacted possible interview participants who could not attend the actual interview. Due to their investigative and forecasting nature, these researched business reports were only utilized in the actual analysis of this study to further substantiate the results from the literature review, interviews, and podcasts. A detailed overview of all business reports used as secondary data can be seen in Appendix 2.

3.5.2 Podcasts

The podcasts collected as secondary data contained discussion questions on topics addressed in this thesis. However, compared to semi-structured interviews, the use of podcasts as a data source prevents us from asking follow-up questions specifically related to our RQs. Nevertheless, secondary sources are still relevant and admissible sources for collecting data and gathering multiple perspectives as it saves time in the sourcing process (Easterby-Smith et al., 2018), and as the podcast includes insight from relevant actors of the MTS, these sources can be considered as credible. Table 3 summarizes all podcasts used as secondary data; a more detailed table can be viewed in Appendix 3.

Table 4: *Overview Podcasts*

Podcast	Host from	Interviewee from	Actors	Topic	Duration (h)
P01	North America	Europe	Freight Forwarder	Freight forwarding in troubled waters	00:41:00
P02	North America	Europe	Freight Forwarder	Managing today's supply chain challenges	00:32:00
P03	North America	Europe	Freight Forwarder	Visualisation trends in ocean shipping	00:27:00
P04	North America	Europe	Freight Forwarder	Enhance sea freight visibility in an unsteady market	00:28:00
P05	North America	Europe	Consultant	How to create a resilient supply chain strategy	00:27:00
P06	North America	North America	Shipping Company	The Suez Canal and a hard year at sea	00:14:00
P07	Europe	Europe	Shipping Authority	Sustainability and Resilience	00:49:00
P08	Europe	Europe and Asia	Shipping authority/ -company	How is shipping coping with COVID-19	00:26:00
				Total:	04:04:00

3.6 Literature Review

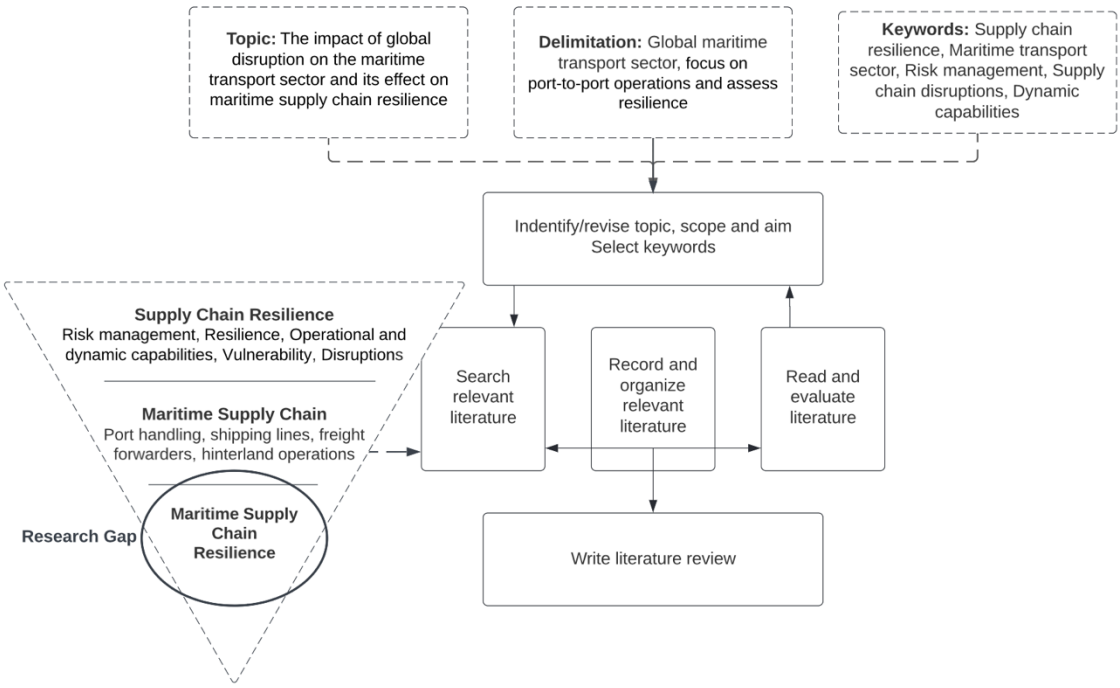
For this study we have conducted a traditional literature review, which is a common way to analytically summarize existing literature in a particular business area (Easterby-Smith et al., 2018). This type of literature review allowed us to consider the literature most relevant and interesting for the scope of our study. Another approach is to conduct a systematic literature review, which involves analysing all relevant literature in a specific research area. However, this approach is both increasingly time-consuming and involves a particular focus on the abstracts of articles. Instead, a traditional literature review provided the opportunity to use multiple search strategies (Easterby-Smith et al., 2018). For the literature review, we used databases, snowball strategy, reports, and an online library (Primus). To search for relevant literature, the main databases used were Web of Science and Google Scholar. The theoretical framework of the study includes three areas: supply chain resilience, dynamic and operational capabilities, and the maritime transport sector. However, investigating literature on SCRES in the MTS provided narrow search

results, for example, did the search query in Web of Science for *("maritime transport sector" OR "maritime supply chain") AND resilien** only resulted in 9 articles. This highlights the theoretical gap that this thesis is trying to fill. To find more literature we added additional relevant terms and combinations to the query such as *risk**, *disruption**, *transport**, *"sea freight"*, *port*, *COVID-19*, and *"Suez Canal"*. To cover information on the maritime transport sector we also used organizational reports to provide the importance of the industry on global trade.

Due to the lack of literature on SCRES from a maritime perspective, we investigated literature on supply chain resilience from all industries. Supply chain resilience is a highly extensive research area. Using the search query *"supply chain resilience"* resulted in 12,200 results in Google Scholar and 442 articles on Web of Science after filtering on topic. However, by sorting articles by mostly cited and highest relevance we could find the most important articles within SCRES. SCRES is a relatively new research area, and more than half of the articles in Web of Science were published from 2020 and forward (264 out of 442). Hence, we did an additional search where we refined the search result to articles published in 2020, 2021, and 2022, to access more up to date articles which could be relevant for our study. While reviewing this literature other relevant search words connected to SCRES were found, such as *"supply chain risk management", "supply chain vulnerability"* and *"supply chain disruption".* These keywords were additionally used to search through Web of Science, Google Scholar, and Primus to find additional literature to contribute to the area of SCRM. Snowballing is another way to find additional relevant articles (Easterby-Smith et al., 2018), which was used for this literature review. Lastly, as a gap in the connection between SCRES and dynamic capabilities was found while exploring previous literature, we did an additional search to find articles connected to both dynamic capabilities and operational capabilities, using both Web of Science, Google Scholar, and Primus.

The collected articles were organized and classified in a table depending on their connection to supply chain resilience, operational and dynamic capabilities, or the maritime transportation sector. The table included a summary of the article's content, keywords, own comments, and future research suggestions.

Figure 5: *Literature Review Process*



Note. Adapted from Easterby-Smith et al., 2018, p. 24.

3.7 Data Analysis

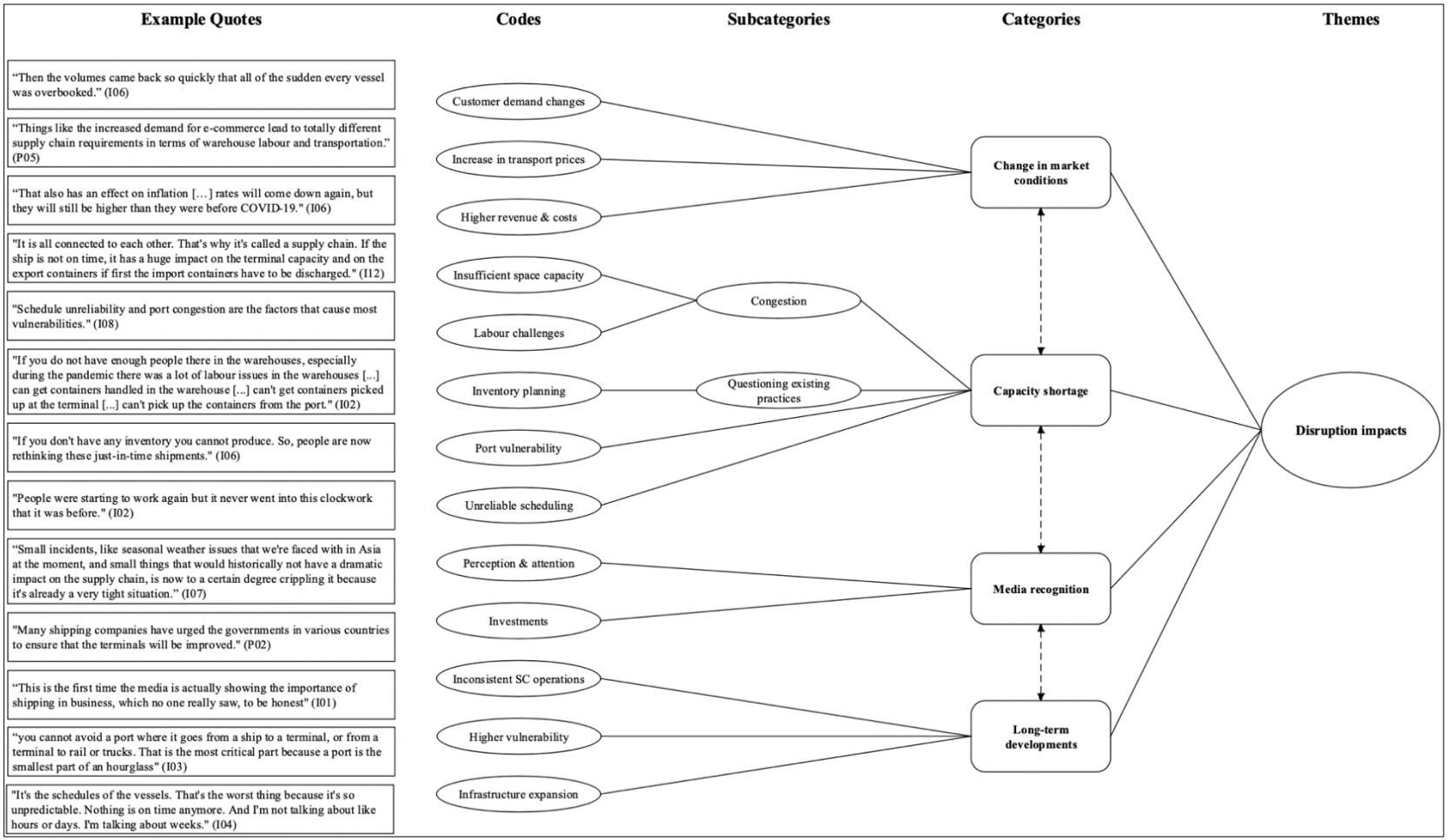
Collected data from the semi-structured interviews were saved and continuously updated in a password-protected file that only the authors of this study had access to in order to obtain data protection, according to Easterby-Smith et al. (2018). The recorded interview and collected podcasts were transcribed into written text using the AI transcribe tools Otter.ai or Microsoft Teams transcript. Following a relativist ontology and constructionist epistemology, the analysis of the data started already in the creation of the data, as we gained knowledge while interacting with the respondents during the semi-structured interviews.

The data analysis followed a grounded analysis approach since different fragments of the collected data have been compared to provide theoretical structures. Data has therefore not been collected to test a framework, rather the process of analysing and comparing different perspectives of maritime SCRES from different contexts has led to the building of a framework. Hence, the analysis of empirical data allows for an openness of new insights beyond the secondary data collected from the literature review. The data analysis

followed the seven steps to grounded analysis provided by Easterby-Smith et al. (2018): familiarization, reflection, open coding, conceptualization, focused re-coding, linking, and re-evaluation.

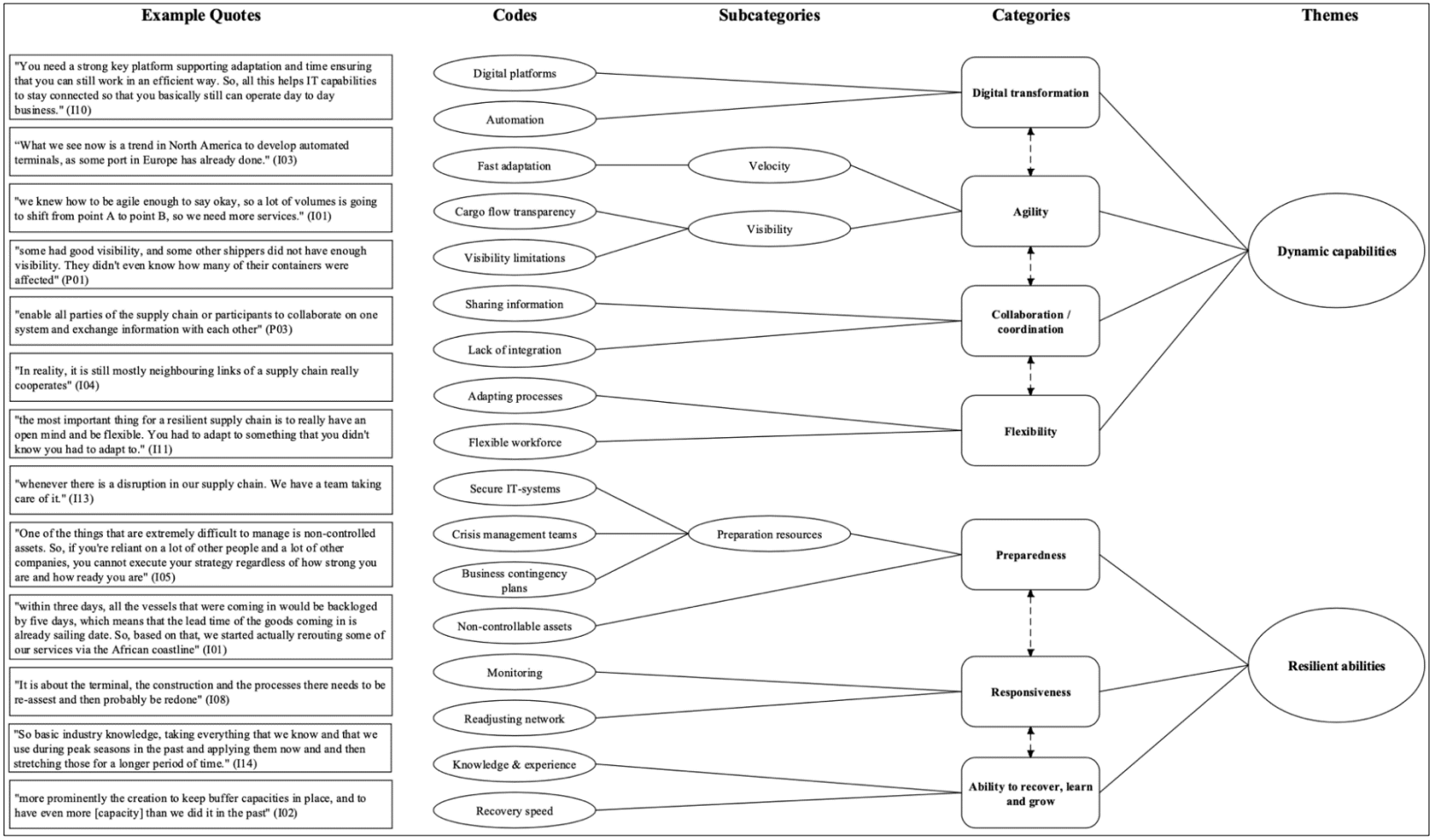
Firstly, we familiarized ourselves with the data by listening to the recorded material and reading through the transcribed interviews and podcasts. In this step, we could also correct any mistakes made in the transcription from the software tools. Secondly, we reflected on the data in context to the previous literature presented in the literature to find similarities or conflicts. In this step we could also see if any additional questions should be asked to the respondents or added to the interview guideline for future interviews, hence, these two steps were conducted directly after each interview. Third, we proceeded with open coding of data to summarize quotes into descriptive codes. From these pieces of data, codes were organized into different categories and subcategories to identify the overarching categories (See Figure 6). After conceptualization of collected data, we went back to the original data to compare perspectives from different actors, both within the same organisation and between different actors. This contributed to a more in-depth understanding of the links between the different codes and categories. In the second round of the interview data collection, the new information was compared to the already collected data to see if any new codes or categories would be identified. Lastly, the final themes were evaluated by others to evaluate if some aspects have been evaluated less or too much. Hence, any gaps in the framework were re-evaluated.

***Figure** 6: Codes-to-Theory Model*



Note. Adapted from Easterby-Smith et al., 2018, p. 245.

***Figure 7** (continued): Codes-to-Theory Model*



Note. Adapted from Easterby-Smith et al., 2018, p. 245.

3.8 Research Quality

In a positivist study, the concept of validity is often used to demonstrate the quality of the research. However, in a constructivist study the concept of validity is not used as often. Instead, to provide validity a study should include authenticity, plausibility, and criticality (Easterby-Smith et al., 2018; Golden-Biddle & Locke, 1993). To provide an authentic study, we considered each participant's perspective and compared different perspectives and values with each other. Furthermore, we used triangulation to evaluate secondary data and compare it with the data collected from the semi-structured interviews. The study field can be considered credible as SCRES is currently a growing field of research and COVID-19 and the Suez Canal blockage-21 have provided insights into the importance of SCRES in the maritime industry. To ensure plausible results, empirical data is collected from key stakeholders in MTS and individuals with extensive experience in the maritime industry. By taking a critical approach to the analysis of both previous literature and empirical data, different viewpoints were obtained from which we could create our conclusions. This demonstrates transparency in how we arrived at our findings, without dismissing other perspectives from previous literature.

Continuity, transferability, reliability and confirmability were also emphasized, according to Lincoln and Guba (1985). To provide contextually relevant results, transferability is important. This is provided by purposive sampling to provide relevant and descriptive data. The primary and secondary data sources in the empirical data provided a broad insight into the resilience of the maritime supply chain in the context of the COVID-19 and the Suez Canal blockage-21, contributing to a relevant result for the SCRES research area. The result is also transferable to the overall theory of SCRES in the MTS. Reliability was improved by continuous feedback from our master thesis supervisor and course peers throughout the research process. Before finalising the results, our interpretations and analyses were also sent back to some of the respondents for confirmation. Finally, to add to the confirmation, we were able to use the triangulation method to compare both literature, expert insights, and company information to arrive at our findings and conclusions. By using different perspectives to explore the resilience of the maritime transport sector, we reduced the risk of relying on a single source of information to draw our conclusions, thus reducing the level of bias in this study.

3.9 Research Ethics

To provide a consistent research ethic, we followed the key principles of research ethics by Bell and Bryman (2007) to assure the protection of both research participants (1-6) and the integrity of the research community (7-10). The 10 key principles were followed accordingly. (1) To ensure that participants were **not harmed**, we created a participatory and respectful environment during the interviews. The interviews were conducted online, using either Zoom or Microsoft Teams, depending on which tool the respondent felt most comfortable with. Conducting the interviews online was beneficial from a geographical perspective as participants are spread out all over the world, but it also reduced virological risk as COVID-19 was still ongoing during the interview period. (2) The **dignity** of the respondents was respected by listening carefully and showing an active interest in what was said during the interview and by not questioning their reasoning in an undignified way. (3) Participants were **informed** well in advance about the purpose of the study and how the interviews would be conducted. They were also given a GDPR **consent** form and an information sheet outlining their rights to withdraw from the study (see Appendix 4 and 5) on which they signed their consent of participation. In addition, they were asked for consent for the interviews to be recorded, as well as a reminder of their rights under the GDPR, before the interview began. (4) To make sure that the **privacy** of the respondent was preserved, information that was irrelevant to the scope of this thesis or information that could not ensure the privacy of the respondents were not asked for during the interviews, for example, their name, age, and gender. (5) To continuously assure **confidentiality**, data was secured in a password-protected file that only the authors of this study had access to, to obtain data protection according to Easterby-Smith et al. (2018). Furthermore, we ensured that secured data was only used for the scope of this thesis and thereafter would be deleted. (6) To secure the **anonymity** of the individual respondents, they have been provided pseudonyms and their job titles have been modified to the extent that they cannot be traced back to the respondent. Continuously, all organizations in this study are anonymous. Respondents were informed about the intentions of the study both at the initial contact, in more detail in the information sheet provided before the interviews (Appendix 5) and finally repeatedly before the interview began. (7) This was to ensure that there was **no deception** as to the scope of this study and the motives behind it. (8) We were transparent that the purpose of this study is within the scope of the scientific research of our master thesis, and that it is not in **conflict** with

any external organization or funding sources. (9) To communicate our research **honestly** and **transparently**, we clearly outlined for each respondent the scope of the thesis and what following steps would be taken. Continuously, we illustrate the methods and research approaches taken in this chapter. (10) Lastly, to avoid any **misleading** or **false reporting** of research findings, both researchers did participate in all steps of data collection. The data analysis was first familiarized and coded independently before different viewpoints were incorporated. This reduced the misleading of the analysed result. Continuously, the result was, as requested, also sent back to one of the respondents for validation.

4 Empirical Findings

The following chapter summarizes the main empirical findings based on the interviews and podcasts. The findings are structured according to the COVID-19 and the Suez Canal blockage-21 disruption cases, including the impacts of the disruption and the abilities to mitigate them are presented. Lastly, discovered capabilities that support resilience in general are presented.

4.1 Impacts on the Global MTS resulting from COVID-19

To contain the COVID-19 outbreak, numerous countries worldwide implemented lockdowns and enforced containment policies on an unprecedented scale. Those restrictions gradually led to alterations in global social behaviour and patterns of mobility, which resulted in apparent disruption of both societal and economic operations (Millefiori et al., 2021). This section provides an account of the impact of the COVID-19 pandemic on the maritime transportation sector (MTS) from the practical experience of the interviewees and podcast guests.

4.1.1 Changing Market Conditions

When COVID-19 had a worldwide impact at the beginning of 2020, the economy started to decline as restrictions impacted consumers' ability to go to stores and insecurities in maintaining their jobs and therefore started to consume less (I03, Port operations). Industries did not anticipate the future increases in developments of demand and supply, hence importers also started to import less: *"Every importer, every company, would say the consumer will buy less because they all sit at home. So, everybody started to import less"* (I06, Freight forwarder), and accordingly shipping companies started to reduce their capacity. Then demand drastically started to increase as people started consuming online: *"because of government money that came in people didn't get fired. They started to work from home, and they didn't use their money for services. So, they bought on the internet"* (I03, Port), importers quickly increased their import. However, there were not enough vessels to face this drastically increase in demand: *"Then the volumes came back so quickly that all of the sudden every vessel was overbooked."* (I06, Freight forwarder). Due to the reduced vessel capacity, there were biddings for the container slots on the ship and those who offered more ended up sending other containers off the ship. *"[…] That's*

what drove up the prices [...] everyone was yelling: I can pay more." (I06, Freight forwarder). This is just a question of supply and demand functioning as a regulator: "*If you have too much cargo and not enough space, then the prices are increasing automatically."* (I13, Shipping company).

Even before the COVID-19 pandemic, the demand for e-commerce was gradually increasing, but according to P05: *"it has been massively exacerbated through the pandemic".* This has been especially apparent in the MTS:

> *Things like the increased demand for e-commerce lead to totally different supply chain requirements in terms of warehouse labour and transportation. I would think of this as more of a trend and a trajectory that we were on, that just got put on a massive accelerate, and we weren't necessarily ready with the infrastructure or solutions, and the companies that where further along on that dimension before the pandemic has weathered the storm much more effectively.* – P05, Shipping company

The rapid shipping price increase created a difficult environment for a lot of supply chain executives: *"You've got inbound material costs going up exponentially, which has major implications on the cost structure. Then you have real challenges finding labour and we are also seeing major challenges from a transportation perspective."* (P05, Shipping company). Even though freight rates have been going up and down before, these sharp surges in rates have not been experienced: *"I've worked in the industry for nearly 44 years, and I have never seen these prices in shipping."* (I06, Freight forwarder). These costs fall back mainly on the customers needing to have their goods transported: *"In the end, it's the end consumer paying it and one of the key triggers for European inflation is the increase of freight rates."* (I10, Freight forwarder).

> *I think that most customers will be dealing with a situation where the cost of shipping has at least doubled. There are some that would face situations, depending of course on their size, where we'll see their cost of shipping probably times 10.* – P02, Freight forwarder

I11 also confirmed this, observing a similar increase in rates, with a tenfold rise in just a few months. Still, essential goods had to be transported somehow: *"Whatever the price is, just move it. Price was secondary, which had never ever happened before, ever in our industry."* (I11, NVOCC). The high shipping prices are on the one hand beneficial in terms of increased overall revenue for many maritime organizations, but on the other hand, they also have substantial extra costs they did not have before:

> *We as an organization have been purchasing 800,000 containers in addition just to supply them. This was an investment of close to four billion U.S. dollars. Which means it is nice to have good freight rates on one side, but you have an exposure on the other side, which is enormous.* – I13, Shipping company

Yet the change in shipping prices is not the only alteration to the economy: *"The whole supply chain is kind of out of rhythm. Not only the transport industry, the logistics chains, and the production business are also affected."* (I04, Port).

4.1.2 Capacity Shortage

The main challenge during the pandemic appeared to be the capacity in ports, on ships, and of labour for cargo handling, as these capacity constraints were continuously mentioned most often throughout all interviews.

Space: As a result of demand changes and irregular schedules, numerous ports around the world are in a state of congestion since November 2020 (I01, Shipping company; I03, Port; I04, Port; I08, Freight forwarder; I11, NVOCC; I14, Port). The strongest effects thereof were then evident on the West Coast of North America: *"[…] on the height of the port congestion in November 2021 about 105 ships was waiting in front of the LA and Long Beach ports."* (I03, Port). This in turn has vast effects on the entire maritime supply chain: *"Vessels stuck outside of the Port of Los Angeles waiting for up to two weeks will have a ripple-effect on your supply chain."* (P02, Freight forwarder). But the problems were not only visible in the US, but China also caused a lot of issues for global supply chains when they closed off their whole country, including their ports (I11, NVOCC).

Evidently, the terminal capacity at the ports is a major issue, especially when it comes to the discharge of containers at the destination ports: *"There are enough vessels and volume to export cargo. But the challenges that happened in COVID-19 happened under import, so it's more about terminal capacity. [...] as the yard fills up the terminals cannot operate, which creates a chain reaction."* (I01, Shipping company). I04 expressed that there is a need to increase the capacity to store containers in ports, but ports are also limited inland capacity to expand: *"[the port is] very limited in space because we have a city around and you can't just expand as you wish"* (I04, Port). It is particularly difficult for ports to cope with the highly fluctuating volumes of containers which was a result of the lockdowns of ports due to COVID-19:

> *China was closing down ports or the region around the port when there was a COVID-19 outbreak and then for three, four days no ships were loaded. So, you had a little bit of an open space at the destination ports, but then a bunch of cargo came to your port. This irregular flow of cargo didn't help, it can be handled, but it is always an interruption.* – I03, Port

Another issue is that some shipping lines try to accommodate their customers' requests to keep the containers longer at the port instead of the usual few days in which a container should leave the terminal (I03, Port).

All cargo that moves through the MTS needs to move through the ports and its terminals. The interviewees mention that companies have learned, due to COVID-19, that a lot of vulnerabilities lie within getting cargo to move through the ports and the restricted capacity of ports has become more visible:

> *You cannot avoid a port where it goes from a ship to a terminal, or from a terminal to rail or trucks. That is the most critical part because a port is the smallest part of an hourglass. A lot of ships are coming from all over the world, but all have to move through that little hole.* – I03, Port

Vessel schedule unreliability also contributed to the port congestion, causing longer lead times and dwell times (I10, Freight forwarder; I14, Port). Interview participants indicated

that ports are highly dependent on the reliability of the scheduling of vessels and the capacity of hinterland transportation (I03, Port; I04, Port; I12, Port), and as neither the hinterland operations had high enough capacity, nor could the shipping companies provide a reliable schedule, this created even more issues for ports to respond efficiently (I08, Freight forwarder). P01 explains that "*maritime shipping can never be at 100 percent reliability,* [...] *but in general shipping, reliability is at 70 to 90 percent. Now we are down to 30 percent".* If the ship is not on time, it has a huge impact on the terminal capacity and on the export containers if the import containers first must be discharged (I12, Port):

> *Just imagine a ship should be here on Saturday to discharge and load, but it doesn't come on Saturday, it comes one week or two weeks later. In the meantime, all the export cargo is coming into the terminals, so the terminals are flooded with cargo. They cannot accept any additional cargo and then the big ships are coming in and bringing additional import cargo.* – I13, Shipping company

> *Schedule unreliability and port congestion are the factors that cause most vulnerabilities. On top of course we also have the truck driver shortages and chassis shortages, but from my perspective, that would be manageable if the vessel schedules were more reliable, and we could plan.* – I08, Freight Forwarder

I03 indicates, that the port congestion does not only arise from irregular volumes but the hinterland operations adjacent to the port also generate various issues:

> *The biggest challenge now is caused by hinterland operations. The distribution centres are full, they still have to work under the COVID-19 protocol and instead of 3 to 4 persons handling the containers, only one person has to do it at the moment. There are some work protocols in those distribution centres that prevent efficient offloading of those containers and the circulation of those containers and the chassis back to the port. Also, driver shortages clog up movements. So, downstream from the ports are the most difficulties that affect the whole supply chain operations at the moment.* – I03, Port

When operating normally without major disruptions, most terminals *"run at 70 to 80 percent utilization of the terminal area"* (I14, Port). This means that there is always a buffer of what a terminal can still add based on regular operation to high-density operation. But due to COVID-19, the amount of dwell time and the whole supply chain situation surpassed what normal terminals can handle (I14, Port).

I02 (Port) indicates that the port-to-port perspective of maritime transportation is not enough, instead, the intermodal network is very important to move containers out of the port as fast as possible. The container also needs to get back from the hinterland transportation to be able to be shipped back to where it is needed. However, if there is congestion in the hinterland somewhere, this will create a ripple-effect on the rest of the supply chain:

> *"Beyond the terminals. There are also supply chains called rail and truck. These organizations have also been majorly impacted because at a certain moment you have to stop the trades because they couldn't deliver any more containers to the terminal, but the containers were needed to evacuate from the terminal. So, all the supply chain from the producer side after the receiver side was completely disrupted and it still is.* – I13, Shipping company

However, despite the hinterland challenges, I14 is of the opinion that *"everything revolves around the terminal. If the terminal is not working, everybody is stopped. If the terminal is working good, everybody can be good."* (I14, Port).

Labour: The severe capacity problems also concern the workforce throughout the MSC. Starting with the employees in offices, who had to work change to working from home overnight, several difficulties were encountered. Among other things, the isolation of workers has led to a decrease in productivity in many areas, communication has suffered greatly, and more mistakes have been made (I06, Freight forwarder). In addition, this situation made it much more difficult to train new staff:

> *The biggest challenge for a logistic provider is if you were working in a department where you have 20 people and all of a sudden you need to send them*

> *home and they are no longer working in a team. How do you train them? […] Getting new people on board, that was, of course, a big learning […] when you bring new people and you don't sit together and you need to learn the new software, it is far more difficult than if you would sit together in one room in the office.* – I06, Freight forwarder

Furthermore, increased workload and the home-office situation created a lack of motivation for employees, resulting in people even leaving the industry (I06, Freight forwarder; I08, Freight forwarder; I13, Freight forwarder). However, workers who did not have the option of working from home but would have to continue to work directly on a ship or at the port faced obstacles such as staff or staffs' family members being infected with COVID-19, so they could not go to work, which created labour shortages. The lack of labour capacity *"also slowed down the offloading of containers from the vessels onto land transportation, which lead to those longer dwell times on the terminals"* (I06, Freight forwarder). The same issues were seen in parts of the supply chain where electronic solutions don't work:

> *If you do not have enough people in the warehouses, especially during the pandemic there were a lot of labour issues in the warehouses, there is no way you can get your containers handled in the warehouse, there's no way you can get your containers picked up at the terminal, and there's no way you can pick up the containers from the port. So, then you see these 100 vessels in front of the US West Coast.* – I02, Port

> *Staff is key. [...] we need people to receive the trucks, who need to load the containers, who need to issue the bill of lading, who need to talk to the carriers, who need to book the containers. All these things we cannot do electronically. We cannot bridge many things with IT. You cannot do it without people.* – I11, NVOCC

As established earlier, the biggest congestion is at the US American ports, which is largely due to their labour market situation: *"Labour challenges are most acute in the US right now, although we see it in other forms across the globe."* (P05, Shipping company).

Inventory: The unexpected magnitude of the COVID-19 pandemic has made some companies rethink the way they operate in terms of inventory (I02, Port; I04, Port; I06, Freight forwarder; I09, Port; P01, Freight forwarder). The congested terminals are also the result of customers not picking up their goods because these simply do not fit into their current just-in-time production schedule (I02, Port). The participants indicate that we will see a change in that regard, that people will start to build up stocks as inventories have been too low and too lean to cope with any kind of disruption (P1, Shipping company). The whole just-in-time production and supply strategy is now being questioned: *"If you don't have any inventory you cannot produce. So, people are now rethinking these just-in-time shipments."* (I06, Freight forwarder). This has been mentioned by several participants, including I13: *"Just-in-time is over. People have to realize that it has to change. [...] Now the new slogan should be: Happy to have it."* (I13, Shipping company).

Relocating facilities and multiple sourcing is also a topic of discussion for many businesses around the world to ensure that if anything went awry, they would have the flexibility to have more of their production in the same region as their customer base: *"I would say spreading risk supports supply chain resilience the most. Don't just buy everything from China or have production in more places than one. Spread the risk so that you're not dependent on just one."* (I09, Port).

Another inventory problem uncovered by COVID-19 was that many ports had insufficient equipment on site:

> *What the ports also need to do is to better understand their spare capacities, not only in terms of space, but also in terms of equipment, and also in terms of how to work with the equipment and how to do maintenance of the equipment [...] in order to prevent breakdown.* – I02, Port

4.1.3 Media Recognition

The impacts of Covid-19 have received a lot of attention in the media, which has recognized the importance of the MTS for global trade: *"This is the first time the media is actually showing the importance of shipping in business, which no one really saw, to*

be honest" (I01, Shipping company). This media attention has highlighted the vulnerabilities of the MTS and the need for investments in infrastructure and resilience has now caught the attention of both governments and organizational CEOs (I02, Port I03, Port; P5, Consultant), however, the understanding received from parties outside of the MTS is not necessarily enough: *"When President Biden said we need to have the ports in Long Beach and LA now working 24/7. This is showing there is an understanding, but maybe not to the extent that it's really required"* (I02, Port). Media is something good and bad. It can be both used and abused: *"So, the informative media is a good thing. It gives people answers and explains things. The backside of the media, for COVID specifically, is the fear that the media has put into the world, which can be very dangerous."* (I11, NVOCC).

4.1.4 Long-term Developments

Given that the COVID-19 situation has been an ongoing process for the MTS for about two years now, experts have already ventured a few predictions for the way ahead with this disruption that keeps occurring in waves. Despite this long period in which the sector has had time to adapt to the new realities brought on by the pandemic, the MTS has never returned to the original seamlessly synchronized supply chain:

> *People were starting to work again but it never went into this clockwork that it was before, because [...] the vessels are coming, but now there are too many vessels coming at the same time, and we still have these hinterland or inland restrictions that don't disappear by that.* – I02, Port

Furthermore, a higher vulnerability is still found among SC actors:

> *Small incidents, like seasonal weather issues that we're faced with in Asia at the moment, and small things that would historically not have a dramatic impact on the supply chain, are now to a certain degree crippling it because it's already a very tight situation.* – P02, Freight forwarder

However, the MTS actors are also hopeful about a development in the expansion of terminals, which have had their vulnerabilities exposed by the difficult situation during

COVID-19. Many shipping companies have urged the governments in various countries to ensure that the terminals will be improved (I02, Port). The necessity of terminal infrastructure improvement has been mentioned by several participants, as the global pandemic has confirmed that fully automated terminals were less affected than conventional terminals.

4.2 Developed Abilities to act through COVID-19

The conducted data showed certain abilities to act through COVID-19 connected to each specific phase of resilience. This will be presented in this section.

4.2.1 Preparedness

All interview respondents stated that they were not prepared for a disruption in the extent of the COVID-19 pandemic to occur. Instead, mitigation measures for risks such as cyber-attacks and terrorist attacks had been more heavily invested in. Hence, industry actors have developed their ability to be prepared for disruption mostly by creating secure IT systems (I01, Shipping company; I03, Port; I04, Port; I06, Freight forwarder; I12, Port). However, certain risk management strategies were in place to increase the preparedness for these disruptions, such as centralized and decentralized crisis management teams (I01, Shipping company; I02, Port; I05, Shipping company; I13, Shipping company) business contingency plans (BCPs), (I01, Shipping company; I02, Port; I03, Port; I05, Shipping company; I13, Shipping company) and preparations to create task forces (I04, Port; I05, Shipping company).

> *We have a crisis management team [...] that takes into account all the risk preparations and starts cascading instructions on what to do next, that's a central team. Then we have our regional teams, which are headed by our head of operations.* – I01, Shipping company

I14 responded that the port had certain preparations in place for a pandemic, but the COVID-19 pandemic had impacts beyond what they were prepared for, *"the terminals did have some protocols and preparedness for a pandemic, but it never reached the levels that we saw now"* (I14, Port). However, even though measures were not taken specifically to prepare for COVID-19, certain measures in place could be adapted towards the new situation. BCPs could be modified by looking at the broader characteristics and they had

also been used to build up more capabilities and increase the overall preparedness both internally and with business partners (I01, Shipping company; I05, Shipping company).

Overall, Ports have a certain amount of spare capacity to be prepared for increased demand (I02, Port; I03, Port; I04, Port; I09, Port; I14, Port), *"Optimally, we try to run at 70 to 80 percent utilization of the terminal area […] so we have some room to grow"* (I14, Port). Respondents from ports also highlight the maintenance of a strong internal network to keep containers flowing out from the port to hinterland storage (I02, Port; I09, Port). One respondent stated that they did not have problems in adapting to the increased demand, as they already had enough spare capacity and good intermodal infrastructure: *"We have a lot of inland terminals with rail connections. I think 60 percent of the containers to and from the port comes or leave on rail"* (I09, Port).

Both shipping companies and freight forwarders mentioned that they already had invested in a more digital landscape which made them more prepared to quickly move employees to home office (I01, Shipping company; I06, Freight forwarder).

4.2.2 Responsiveness

The results show one initial reaction to the COVID-19 pandemic was to make sure that *"ports remain open, ships keep transporting goods, borders remain open and also already quite early highlighting the challenge of the crew change the seafarers"* (P07, Shipping Authority). Shipping companies began to monitor the situation to decide what action needed to be taken by making daily assessments and looking at trends and situations in different countries (P08, Shipping company). To adapt to the new changes in the market, respondent I01 mentioned that they started re-adjusting their network to fit with the new needs of their customers to keep the supply chain active. Later, as demand went down in the initial phase of COVID-19, shipping companies reacted by cancelling ships (P06, Shipping company) and as demand increased again and lead times increased, accordingly the new lead times were communicated to customers:

> *We started planning with those delays in our network. So, we knew that if we were going to go into Australia, there was going to be a quarantine period of 14 days*

> *if that vessel had called China before, so we started planning with a 14-day delay on arrival.* – I01, Shipping company

Workforces were also adapted to the impacts on the market and capacity. Freight forwarders, who are not physically handling cargo, adapted by moving all their employees to home-office and extended the workhours: *"Teams that are on-site that are working basically day and night with our customers to ensure that product is moved."* (P02, Freight forwarder), and crew members of shipping companies were kept longer on the ships to reduce the risk of infected staff: *"I had to ask all the crew members who were on board [...] if they would make the next trip with me as it wouldn't be safe to take on new people"* (P06, Shipping company). Similarly, for terminals where people can't work remotely, *"working from home was kind of not an option for us on the terminal"* (I14, Port), and schedules and roles were adapted to maintain efficiency: *"It was only possible to work the operations of the terminal with people working a lot more than they were supposed to"* (I02, Port).

As ports started to become congested and run out of space to store containers, ports creatively tried to free up additional space (I03, Port; I14, Port), *"using basically odd corners of the terminal to stack containers, moving equipment into a non-usable area for containers and converting that into a container stacking area"* (I14, Port) and increasing the speed of moving goods out of terminals, even threatening importers with charges if they did not pick up their cargo from the terminals:

> *They use our terminals as storage for their goods because they could not put them in their warehouse. So, we threatened them with a fee if they don't pick it up. We threatened with it, but we didn't implement that fee yet.* – I03, Port

4.2.3 Recover, Learn, and Grow

The results show that maritime transportation actors have learned from the impacts of COVID-19 which has resulted in more improved capabilities and *"For every wave that happened, the supply chain just became stronger and also its agility and flexibility to cater to this whole scenario."* (I01, Shipping company). Companies started to invest in

equipment to be able to have a more flexible workforce (I06, Freight forwarder; I11, NVOCC; I13, Shipping company).

> *When we had to send our people home overnight there were stations that didn't have laptops, but they had fixed PCs. That we switched so everybody today has a laptop. [...] so that everyone can quickly take their laptop and leave the office. That makes you more flexible.* – I06, Freight forwarder

During COVID-19 companies have had a difficult time to recover, which was under normal circumstances possible, with normal seasonal fluctuations of drops and increases in demand. This allows terminals to have some time to recover from the peaks in demand, but during COVID-19, the recovery period never came. (I14, Port). Continuously, the result shows the need for increased capacity in the different facilities of the port, *"[...] more prominently the creation to keep buffer capacities in place and to have even more [capacity] than we did it in the past."* (I02, Port) and to extend the space capacity even beyond the port terminal:

> *To go more into the idea and implementation of creating facilities or areas somewhere in the hinterland that allows us to have that space. Not that it would be always used the same amount, but to have the ability to really cater for that.* – I02, Port

Even though the industry was not specifically prepared for the effects of the COVID-19 pandemic, the findings show that actors agree that their level of resilience has increased due to disruptions: *"Is [the resilience of the organization] 100 percent perfect? No, but it is far more resilient as compared to two years ago because of all the learning we had. We adapted fantastically in that aspect."* (I06, Freight forwarder).

4.3 Impacts on the Global MTS resulting from the Suez Canal blockage-21

The impacts of the Suez Canal blockage-21 *"were there more or less immediately"* (I04, Port). In fact, the impact of this was not as severe as everyone expected: *"We saw containers piling up out there, and we also saw containers destined for export, and also*

a shortage of empty containers, but that's it." (I02, Port). Furthermore, there were sufficient measures in place for the vessels that were not already completely stuck in the Suez Canal: *"If the Suez Canal is closed, you go around. It takes a bit longer, it might cost a little bit more money, but it's still something which is possible and plannable."* (I02, Port). Apart from this, there were *"not many options. You simply had to wait."* (I13, Shipping company).

4.3.1 Alternative Route

The participants also explained that there were indeed some long-term problems related to the dispute between the Suez Canal, the shipping company of the stuck vessel Evergreen, and all other parties involved (I05, Shipping company). Moreover, as this was one of the major incidents in the history of the Suez Canal, it highlighted and showcased the vulnerability of the canal. With all MSC stakeholders looking to move their cargo quickly, the alternative route around Africa is too slow (I11, NVOCC): *"To my knowledge, we don't have a sustainable alternative to the Suez Canal."* (I05, Shipping company). But that route is not only slower but also more expensive and inefficient:

> *To get back into an operation via South Africa, you need to have at least two more ships in the fleet per service. The supply chain will be even more disruptive, so you can only hope that the Suez Canal will not have any situation like that ever again in order to be relatively fast from Asia to Europe or from Europe to Asia. [...] Because going around will not bring you back into the normal schedule reliability.* – I13, Shipping company

Despite the vulnerabilities of the Suez Canal highlighted by the incident, I13 pointed out that a very large number of ships have passed through the canal over the years without anything ever happening (I13, Shipping company).

4.3.2 Media Attention

Disruptions have happened before in the MTS, but the media attention the industry has received during the Suez Canal blockage-21 is unique: *"everybody, the broader public, newspapers, TV channels [...] So it's getting a much broader coverage."* (P01, Freight forwarder). The Suez Canal incident was an eye-opener for many people: *"There were so many interviews with different experts and films and photos around the world. I think that*

was an eye opener for many, many people on how transportation actually works." (I09, Port).

All this media attention has highlighted the weaknesses of the MTS, which include the Suez Canal infrastructure. Many participants agree that this sensational incident has stimulated discussions on the necessity of investing in its infrastructure to continue to allow the passage of increasingly large mega-ships.

4.4 Developed Abilities to act through the Suez Canal blockage-21

The conducted data showed certain abilities to act through the Suez Canal blockage-21 connected to each specific phase of resilience. This will be presented in this section.

4.4.1 Preparedness

Most of the respondents' state that compared to COVID-19 they were more prepared to handle this type of disruption. This was explained due to the fact that there have already been several blockages of the Suez Canal and thus there is already experience in minimizing the impact and taking measures to restore normalcy:

> *Because it has happened previously, we already have contingency plans for us know what we are going to do. And to be honest, we made the same decisions as before. [...] I mean, every time you learn from it, and it happened before, and it will happen again.* – I01, Shipping company

However, the Suez Canal blockage-21 created increased pressure on ports that were already struggling to adapt to the increased demands and schedule unreliability due to the impacts of the COVID-19 pandemic (I04, Port; I12, Port).

The results also show that it is possible to reach a certain internal level of preparedness, however, supply chain actors are dependent on each other and as they cannot control other actors, this makes it more difficult for them to be fully prepared for disruptions.

> *One of the things that are extremely difficult to manage is non-controlled assets. So, if you're reliant on a lot of other people and a lot of other companies, you*

cannot execute your strategy regardless of how strong you are and how ready you are. – I05, Shipping company

4.4.2 Responsiveness

In the initial stage of the Suez Canal blockage-21, actors impacted by the Suez-Canal disruption responded quickly by building up taskforces: *"In the first few hours of the company being notified, we had a few different workstreams set up. […] Then a vessel operation taskforce was built that was separated in ships in the canal, ships waiting and ships enroute."* (I05, Shipping Company), and to continuously share information with their customers to provide new solutions and services for them, and within days they started rerouting ships to try to avoid even longer lead times (I01, Shipping company; I05, Shipping company; I08, Shipping company).

> *We were informed the moment it happened, we track all our vessels worldwide and when all of this happened, we knew about it right away […] and we started to inform people right away so within hours everybody was informed, internally and also externally.* – I06, Freight forwarder

For vessels already stuck in the canal, *"[…] you do not have much options, you simply have to wait."* (I13, Shipping Company). One respondent mentioned that they also started re-routing some of their customers' cargo through other transportation modes, *"we even trucked cargo from China, through Russia, to Europe."* (I06, Freight forwarder). The impacts of these stuck vessels in the Suez Canal had ripple-effects on ports and this created an even worse situation for ports that were already struggling with the effects of COVID-19, leading to ports even rejecting exporters to bring more cargo to the port*:*

> *Before we could see a little increase in the dwell times […] but once the Suez Canal blockage hit us, everything got out of range, and then in a pretty short time, we implemented mitigation measures. […]we started giving out information to the truckers, not to bring containers and the second one was to reject them here at the gates, which could be implemented within a couple of days.* – I04, Port

4.4.3 Recover, Learn, and Grow

While COVID-19 is an ongoing disruption that actors are still trying to recover from, the Suez Canal blockage-21 was a more short-term disruption and the respondents indicated that the individual impact of this disruption has a faster recovery phase: *"it probably took four months to go back to normal again"* (I06, Freight forwarder), and respondent I01, said that it took around one month to reroute ships and to get the cargo flow back to its original speed. As the Suez Canal has been blocked before, learnings from previous disruptions made them more prepared to respond and hence recover from this disruption: *"To be honest, we took the same decisions that we did previously. [...] I mean, each time you learn from it, and it happened before and it will happen again."* (I01, Shipping company).

However, for actors that already had a problem with the impacts of COVID-19, the answers showed that these disruptions put additional stress on actors (I02, Port; P04, Port; I11, NVOCC; I12, Port), and they are still struggling to recover from the combination of the COVID-19 impact and the Suez Canal blockage-21, *"would [the Suez Canal blockage-21] have been an isolated case I believe that still, it would have been a big thing in the press, but we would have recovered from it rather quickly."* (I10, Freight Forwarder).

> *When the Suez Canal was blocked it got really bad and it hasn't recovered since. I'm not sure if it's still because of the Evergiven or maybe now because the production in China is also going up and down. I would say that's rather the problem.* – I04, Port

Even though the Suez Canal blockage-21 created difficulties for maritime transportation, the participants emphasize that the Suez Canal route will not be reconsidered, due to the lack of other beneficial routes around it (I01, Shipping company; I05, Shipping company; I06, Freight forwarder; I10, Freight forwarder; I11, NVOCC; I13, Shipping company). Instead, the importance of the Suez Canal and its compelling necessity to function has gained increasing visibility.

> *[…] to get back into an operation via South Africa, you need to have at least two more ships in the fleet per service. The supply chain will be even more disruptive, so you can only hope that Suez Canal will not have any situation like that ever again in order to be relatively fast from Asia to Europe or from Europe to Asia. […] Because going around will not bring you back into the normal schedule reliability.* – I13, Shipping company

4.5 Resilience Capabilities

The respondents explained that MTS had some abilities to prepare, respond, recover, learn, and grow after the two disruptions. However, some capabilities are not specific to one distinct case or disruption phase. This section presents capabilities found in the empirical data connected to both the COVID-19 pandemic and the Suez Canal blockage-21.

4.5.1 Flexibility

The impacts of COVID-19 and the Suez Canal blockage-21 have required organizations to be more flexible to quickly change their operations and processes, *"the most important thing for a resilient supply chain is to really have an open mind and be flexible. You had to adapt to something that you didn't know you had to adapt to."* (I11, NVOCC). It was observed that some actors had it easier to be more flexible and adapt their workforce to the new situation:

> *If you would have asked us one week before it happened, can you imagine that if we would send home 45 thousand people overnight that the company still works? Forget it, it will not work. But it worked. So, this was amazing.* – I06, Freight forwarder

This was also supported by other respondents (I02, Port; I08, Freight forwarder; I13, Shipping company). For actors such as ports and shipping companies, where people are required to work in the terminal or on vessels, the results show that it was more difficult to adapt (I10, Freight forwarder; I11, NVOCC; I14, Port): *"We need people on the floor to receive the trucks, to load the containers, to issue the bill of loading, to talk to the carriers, to book the containers. All these things we cannot do electronically."* (I11, NVOCC). Ports that had automated terminals were more flexible in handling the

challenges caused by COVID-19 as they are handled remotely (I01, Shipping company; I02, Port; I04, Port; I12, Port).

> *When you look at fully automated terminals, they probably had less impact than any conventional terminal did and were able to continue to move through the pandemic at a better rate than the conventional terminals. So yes, I think automation is probably the infrastructure improvement that needs to be done, but it's very costly and takes time.* – I14, Port

4.5.2 Agility

The result shows that agility is one capability that is important to respond and recover from a disruption*, "if you have the agility and you can see what is going to happen, you're able to start making decisions to bring the network back on track"* (I01, Shipping company). The speed at which these changes need to be made does impact the level of agility, *"it's going to really be about how quickly can everyone continue to innovate and adapt to be able to provide a better visibility down to these customers that are out there"* (P1, Freight forwarder), *"it's all about reaction speed"* (I05, Shipping company). In shipping, services were quickly adapted to face the new market:

> *During COVID-19, customers actually started moving out of China […] and we knew how to be agile enough to say okay, so a lot of volumes is going to shift from point A to point B, so we need more services.* – I01, Shipping company

However, as the situation needed to be monitored during the Suez Canal blockage-21, and in combination with high uncertainties, the decision-making process did take time which affected the execution: *"When the planning is tight, the execution is slow."* (I01, Shipping company). Reliability and quick adaptation have been key aspects during the last two years to keep cargo flowing through the supply chain, and one podcast guest stated that *"Availability is this years' innovation."* (P5, Freight forwarder). Findings showed that as the pandemic evolved, actors learned and their agility and flexibility increased (I01, Shipping company; I06, Freight forwarder).

4.5.3 Visibility

Multiple participants indicated that MTS actors consider visibility in maritime transportation highly important when facing disruptions (I02, Port; I03, Port; I06; Freight forwarder; I07, Shipping company; I08, Freight forwarder; I09, Port; P01, Freight forwarder; P03, Freight forwarder; P04, Freight forwarder; P07, Port Authority). Actors who did not have good enough visibility started to develop this capability, as they saw the need for it (I06, Freight forwarder). Overall, the level of visibility varied between MTS actors.

> *There were at one point roughly 90 to 100 vessels affected by the vessel stuck in the Suez Canal [...] and some people had good visibility, and some other shippers did not have enough visibility. They didn't even know how many of their containers were affected.* – P01, Freight forwarder

The lack of visibility impacted ports which were not fully informed on which containers were going to be delivered and how they would be transported out of the port (I03, Port, I04, Port; I12, Port; I14, Port). For freight forwarders, the main objective is to be a logistic service actor and deliver customers' goods from point A to B transparently and reliably (I06, Freight forwarder; P03, Freight forwarder; P04, Freight forwarder). Providing visibility is one of their main business services and they, therefore, work hard on providing visibility for their customers: *"The most important thing for a logistic provider is to provide really good visibility."* (I06, Freight forwarder). However, the results also demonstrate that visibility cannot improve the supply chain if the capacity and execution are not given*: "Of course, visibility can enhance your safety, in regards to managing your supply chain, but it will not airlift a container of a container vessel that is stuck outside Los Angeles."* (P02, Freight forwarder).

> *At the end of the day, it's good to know where [the cargo] is. But how about the capability to execute on this information? What are we doing with its visibility? What are we doing with these predictive arrival dates?* – P03, Freight forwarder

4.5.4 Collaboration and Coordination

One of the main issues identified in the empirical data has been the lack of integration and cooperation between the actors in the maritime supply chain. Although some actors work closely with their stakeholders, the findings show a need for cooperation and integration between all actors in the supply chain (I02, Port; I03, Port; I09, Port; P02, Freight forwarder; P03, Freight forwarder). One problem is that many maritime actors are first and foremost trying to optimise their operations and as cooperation often requires some trade-offs between actors, this becomes a challenge (I04, Port; I09, Port; I14, Port).

Information sharing has been important in mitigating risks and responding to disruptions and when the vessel got stuck in the Suez Canal, respondents state that they were informed immediately thanks to a well-developed internal information flow (I01, Shipping company; I06, Freight forwarder; I04, Port). However, regarding the exchange of information between actors who do not work closely together, but who nevertheless work in the same network, the results show a need for a common system that improves the exchange of information and the transparency of where capacity is available (I02, Port; I09, Port; P03, Freight forwarder).

> *It is about sharing information between all the different stakeholders in the port. So not having the shipping lines with their system, the terminal with its system, the railroad, the forwarders, etc, with their own system, but really trying to combine one central platform where people can exchange information.* – I02, Port

However, there is a lack of willingness to share information, *"it's not that easy because people or businesses are not so keen on sharing data [...]."* (I09, Port) and *"it is difficult to spend money on something that may not benefit you only but gives everybody else a benefit.*" (I14, Port). This was also seen from the freight forwarding perspective: *"Why would I put my advantage which I have on [information] in the hands of my competition? […] Rather than using that platform, I want to be the one offering that."* (I10, Freight forwarder).

4.5.5 Digital Transformation

To provide visibility and integration between different actors of the MTS during disruptive events, digital tools have been used to visualize and ease the situation. This includes digital tracking platforms that provide real-time information on equipment and vessel locations (I06, Freight forwarder). Visualization tools could be used to analyse the situation to enhance decision-making (I06, Freight forwarder; I10, Shipping company; P3, Freight forwarder). The result also shows that digital tools are important to provide resilience and maintain daily operations:

> *[…] strong operational capabilities to ensure your teams are not collapsing on a global scale. You need a strong key platform supporting adaptation and time ensuring that you can still work in an efficient way. So, all this helps IT capabilities to stay connected so that you basically still can operate your day-to-day business.* – I10, Freight forwarder

Digitalization is also being used in ports in the form of digital platforms, such as coordination centres, to enhance the efficient moving of vessels and cargo within the ports to meet the demand and prepare to handle changes in traffic and cargo flow (I02, Port; I14, Port). The results also show that digitalization will become even more important in the future, especially with the usage of automation, blockchains, robotics, and AI (I01, Shipping company; I02, Port; P07, Shipping Authority), *"we could really see that individuals sometimes really made the difference. So, in a partially automated world where we try to be as efficient as possible and less dependent on individual manual tasks."* (I10, Freight forwarder). Suggestions for innovation in ports mentioned by the respondents are also box-bays, explained as an automated warehouse where cargo can be stored vertically to improve container density (I04, Port), or *"WOW, warehouse on wheels, maybe that's a solution? Cargo may stay somewhere, and then final distribution could also vary."* (I13, Shipping company).

5 Analysis

The following chapter includes an analysis of the triangulated data collected from interviews and podcast and the secondary data from the literature review and business reports. The analysis provides an overview of supply chain vulnerabilities in the maritime transport sector and which capabilities need to be further developed to increase their resilience.

To create a resilient supply chain, previous literature has emphasised the importance of identifying supply chain vulnerabilities and building capabilities that reduce the risk of these vulnerabilities being disrupted and to mitigate the consequences when disruptions do occur. These vulnerabilities and capabilities should be balanced against each other to ensure that the supply chain is neither overly vulnerable nor has costly investments in creating capabilities that are not needed (Jüttner & Maklan, 2011; Pettit et al., 2013; Pettit et al., 2010). To structure this analysis, vulnerabilities and capabilities connected to the COVID-19 pandemic and the Suez Canal blockage-21 will be linked and contrasted against previous literature.

5.1 Vulnerabilities and Performance in the MTS

This section will mainly focus on the impacts observed during the COVID-19 pandemic and the Suez Canal blockage-21, which have revealed the current vulnerabilities of the maritime transport sector (MTS). The likelihood of being affected by a disruption is greater, and the impacts more significant, the more vulnerable supply chains are (Pettit et al., 2010). Numerous actors have influenced the recent global containerization of maritime transportation, including the surge in trade, the emergence of new markets, and new carrier growth (Brooks & Cullinane, 2006). This creates complexity and the need for closer interconnectedness of all MSC when disruptions are more hazardous, as a single disrupted link in the chain can cause the entire operation of all other actors to cease functioning.

5.1.1 Economic Consequences: Demand-supply Gap and increased Shipping Prices

Commencing in early 2020, the MTS experienced a year of exceptional demand volatility due to COVID-19, moving from a severe excess supply of capacity in the first quarter to a scarcity of ships and equipment during the second half as demand recovered, resulting in a substantial spike in shipping rates in the short term. Both the empirical findings and secondary data demonstrate the unusual situation with a surge in demand that also led to bottlenecks in the supply chain and shortages of resources (A. P. Moller - Maersk, 2021). Coping with the rising global demand for ocean freight has been considered one of the biggest challenges even before COVID-19 and the Suez Canal blockage-21 (Panayides et al., 2012), and the findings resonates that this is still an ongoing and accelerating challenge, especially for the MTS.

The volatility of demand presented in the finding is also supported by secondary data. Mearsk (2021) reported that as an immediate consequence of the COVID-19 outbreak, private household incomes decreased in 2020. While a significant part of the income losses was absorbed by comprehensive monetary support programs and policy in several countries, overall consumer demand deteriorated. Country lockdowns and the ensuing social distancing policies, as well as travel constraints, caused a plunge in the consumption of services. Simultaneously, due to protected disposable earnings and pent-up needs, consumers invested a larger share of their income on tangible goods like electronics and household appliances. This development converged with a sharp rise in e-commerce (A. P. Moller - Maersk, 2021), which supports the empirical findings of this study. The findings also indicate that actors in the MTS drew the wrong conclusions from the outset of the pandemic and anticipated less demand for transport. This misconception then ensured that the demand, which in turn soared above the norm, overwhelmed ports, and shipping companies in particular, and their capacities were rapidly exhausted.

Both empirical findings and secondary data demonstrate that the surge in demand put the flexibility of the logistics industry's supply side to the test and created onshore bottlenecks. Storage capacity was not adequate for customers' shifting buying patterns and rising demand in e-commerce. Truck driver shortages, such as in the United States, caused a large portion of container volumes to remain unutilized at congested facilities,

which negatively affected industrial and retail supply chains. Supplier lead times increased substantially, and while port productivity levels were notably higher than prior to COVID-19, considerable delays continue to be a problem as vessels are anchored off Los Angeles for at least double the time than prior to COVID-19 (A. P. Moller - Maersk, 2022).

High demand in conjunction with supply shortages prompted a significant increase in the cost of logistics services. For many shipping companies, the financial performance in ocean transportation, logistics services and terminals were unprecedented. Both the empirical data and secondary business reports illustrate how revenues increased by over 50 percent for several companies (A. P. Moller - Maersk, 2022). Cullinane and Haralambides (2021) also found that shipping companies have experienced record profits since the COVID-19 pandemic. The findings indicate that this resulted primarily from higher ocean freight rates, volume increases and acquisitions, as well as greater global demand and increased terminal storage earnings. In contrast, overall operating costs rose due to increased fuel prices, additionally acquired equipment, and the cost of container handling as a result of congestion and bottlenecks (A. P. Moller - Maersk, 2022). In this regard, the empirical findings indicate that the media has focused on the sharp increase in revenue for some MTS companies and portrayed them as beneficiaries of the pandemic. However, it has been disregarded that these companies have also incurred enormous additional costs and significantly more labour, as well as making large investments with no guarantee that they will pay off in the future.

Continuously, previous literature has shown that disruptions in the MTS can have significant implications for global trade and the overall economic situation in certain locations, implying that vulnerabilities in the MTS not only impact its own operations but also have consequences beyond (Heaver, 2002; Notteboom & Winkelmans, 2001). The empirical findings support this assumption in the context that the surge in transport prices has had an effect on the European rise in inflation and is potentially a trigger thereof. The International Monetary Fund (IMF) confirms this through observations in its long-term study of the impact of shipping prices on inflation since 1992. The IMF determined that shipping costs are a key factor driving inflation worldwide. In fact, whenever freight rates are doubling, the inflation increases by approximately 0.7 percent. Also, the impact is

rather prolonged, reaching its peak after one year and persisting for as long as 18 months (Carrière-Swallow et al., 2022).

5.1.2 Ports as Supply Chain Bottlenecks

It is acknowledged that ports represent not only an autonomous and integrated area for handling physical goods but also a systematic element in a multimodal supply chain. In the maritime supply chain (MSC), ports play an extremely important role due to their coordination function in the transfer of cargo and information, implying that the performance of maritime stakeholders is highly dependent on the efficiency of ports (Liu, 2011). The findings suggest that ports are seen by many as the most critical part of the supply chain, like the middle section of an hourglass, as cargo is collected from all corners of the world and then must pass through a particular port to be delivered further in many directions. Therefore, vulnerabilities in port operation have considerable impacts on the MSC. Empirical findings and previous literature confirm that especially since COVID-19, the increase in containerized cargo volume has greatly affected the ports (Alamoush et al., 2021; Notteboom et al., 2021).

Lam (2012) mentioned that port disruptions can lower the schedule reliability of shipping companies. This was also seen both in the empirical finding and in secondary data. Sea-Intelligence research has found that the reliability of schedules for global shipping container services has sunk to a record low level: “Schedule reliability dropped from 78.0% in 2019 to 63.9% in 2020, and then to 35.8% in 2021 […]” (Murphy et al., 2022). Consequently, numerous ports around the world have been congested since November 2020 because of the altered demand and unpredictable schedules. The findings indicate that the unreliability of vessel schedules was a factor in port congestion and resulted in extended lead times and dwell times. This demonstrates that maritime ports are extremely sensitive to the dependability of vessel scheduling and hinterland transport capacity, which was very visible during the COVID-19 pandemic when ports were confronted with unreliability from both the hinterland and the ocean side. In addition, vessels arrived several days to weeks late, making capacity planning at the port impossible. Therefore, increased unreliability in the schedules and congestion at the ports are the factors that expressed the most vulnerabilities influencing the performance of all other stakeholders.

In accordance with previous literature (Notteboom et al., 2021), findings indicated that import cargoes were staying in the terminals much longer than usual, creating increased difficulties with capacity utilization in ports. This was mainly due to a shortage of truck drivers, but also because some shipping companies attempted to accommodate the demands of their customers and leave containers in the port much longer than the standard period in which containers are expected to depart from the terminal. Notteboom et al. (2021) also confirm this large quantity of stock in terminals caused by importers not assuming responsibility for their cargo. The longer storage times in the port cause congestion whereby the shipping lines damage themselves, as this only further slows down and aggravates operations. However, the result indicated that this was not the main concern of the shipping companies, as they can compensate for the longer storage times in the port due to the increased transport prices.

In addition to the space capacity challenges, there were also personnel shortages due to illnesses and regulations. Especially in the ports, home office was not an option, as cargo is handled manually in most places, especially in warehouses and terminals, which have operations that cannot be managed electronically. Literature also reports shortages of port workers as a result of quarantines, infections, and health screening upon arrival at the port, resulting in delayed and congested conditions (Alamoush et al., 2021; Cullinane & Haralambides, 2021).

Interviewees confirmed that seaports are designed to cope with seasonal fluctuations in capacity utilization and therefore normally have some spare capacity. When COVID-19 spread in early 2020, all ports were initially empty, but this quickly changed due to strong growth in demand. The heavy flow of goods was perceived by ports as a continuous, ever-increasing spike that did not flatten out. Ports that were not automated and had limited possibilities to flexibly expand further to create more space for containers in the terminals were particularly quickly congested and are still in the same difficult situation today. The results show that it is only possible to overcome this strong backlog if the demand for maritime transport reduces or stabilizes in equilibrium. For this to happen, however, the operations of all players must improve, as the ports rely heavily on all others. Nevertheless, the MTS also expresses optimism about the development of the terminals.

Many shipping companies have requested governments of several countries to arrange for the terminals to be enhanced.

The findings continuously show that the scarcity of capacity in ports, on ships, in personnel, and in terms of resources have also caused companies around the world to experience problems in their supply chains throughout COVID-19, which compelled a major corporate strategy redesign in many areas. Multiple interview participants have already been able to observe that the unanticipated severity of the COVID-19 pandemic has resulted in several businesses reconsidering their operations regarding inventory. The findings indicate that both freight forwarders, seaports and shipping companies agree that just-in-time is a thing of the past. Therefore, especially in the MTS, the possibility of using the other standard strategy just-in-case is now being discussed. This is in line with Jiang et al. (2022) who argue that a just-in-case approach could better prepare businesses for specific risks (Jiang et al., 2022). The results also included the distribution of risk factors such as relocating production facilities in different countries and sourcing materials where possible locally or from multiple suppliers. For future operation strategies, organizations are possibly not completely relinquishing their established supply chain strategies but are rather revising them to increase their resilience.

5.2 Capabilities enhancing Resilience

The previous section describes where the main vulnerabilities lie within the MSC. The findings have also indicated certain areas where capabilities are present on both an operational and dynamic level. Providing capabilities on a dynamic level is important to maintain competitive advantages during the entire disruption phase (Hassan et al., 2017; Kähkönen et al., 2021; Teece, 2007), hence areas of improvement will also be analysed.

5.2.1 Network and Organizational Transformation

To be resilient, both individual organizations and supply chains should be able to transform to cope with a new dynamic environment as quickly as possible, both at an operational level by using already existing resources to quickly adapt to changes (Chari et al., 2022), but more importantly to enable a transformation of existing resources and operations (Ponomarov & Holcomb, 2009; Sheffi & Rice, 2005). Even though the Suez

Canal blockage-21 created additional challenges on top of the COVID-19 impacts, the findings indicate that MTS was flexible in its response to this sudden disruption due to the increased level of preparedness. Contingency plans, task forces, and alternatives for additional transport routes were already in place as actors had learned from previous blockages in the Suez Canal or similar disruptions. This implies that resources were already in place on an operational level and current operations were also adopted according to already existing plans, hence, capabilities such as knowledge and experience did increase the preparedness and the ability to quickly provide a new structure and adapt operations. Freight forwarders can be seen as even more flexible in this aspect as they are not fixed to many physical resources and can use multiple sources of transport. Therefore, they can redirect goods to other modes of transport, such as road or air. However, this implies a trade-off, as they become highly dependent on other actors providing physical resources, such as carriers, shipping lines and terminal operators.

The results repeatedly indicate that there is no sufficient alternative to the Suez Canal when transporting seaborne cargo between Europe and Asia. Still, from a short-term perspective, impacts were reduced due to flexibility in changing transportation routes and catching up with the cargo flow of delays specifically from this individual disruption. However, as incorporating new routes both increases lead times and costs of the operation, the result indicates that re-routing cargo would reduce the competitiveness from a long-term perspective. Hence, the robustness of the Suez Canal becomes increasingly important during disruptions. This was especially visible as the Suez Canal blockage-21 impacts were increased due to an already disrupted supply chain from COVID-19.

In the case of the COVID-19 pandemic, it was the first time that a disruption of this magnitude affected the MTS, as visualized by the extreme impacts presented in the findings. Previous literature highlights that an important aspect of preparedness is that it comes from previous experience (Kovács & Spens, 2009). In the case of COVID-19, the results show that one of the main reasons for the reduced level of preparedness is the lack of experience with a disruption of this kind and that the impacts were not anticipated. Hence, the response was not as quick and precise as in the case of the Suez Canal blockage-21. Nevertheless, the results still indicate that companies quickly implemented

remote offices, created even more spare capacities, and changed existing operations. This indicates a dynamic level of agility as actors quickly manage to reconstruct their operations to the new dynamic environment while maintaining their operations efficiently. Furthermore, the empirical findings indicate a certain level of agility in shipping companies and ports. However, as these actors are more tied to physical resources and operations, individuals had to cover for each other or increase their workload to maintain their working capacity. Even organizations that were able to move their workforce online and uphold the basic function still faced issues such as lack of proximity to other employees and an increased workload, which impacted the employee's motivation. The impact on employees shows that it is necessary to ensure continuous operations and highlight the creation of long-term benefits and restructure the network to become even better than before the disruption occurred. This is where freight forwarders appear to struggle, as two years after the pandemic outbreak they are still trying to retain their employees within the company. Shipping companies and ports have also struggled with adapting their workforce COVID-19 impacts, without creating a rougher situation for employees. This is an area where the industry continuously needs to improve. However, for future disruptions, the data indicated that organizations now have more resources in place to handle operations more remotely and therefore have become increasingly flexible both on an operational and dynamic level.

Further on, the empirical result and secondary data demonstrate that shipping companies started investing in more vessels and containers to face the increased demand due to COVID-19 (Hapag-Lloyd, 2022), which is a more long-term adaptation measure. Russell et al. (2020) and Notteboom et al. (2021) suggest that expanding the container fleet size is one way for shipping companies to increase their flexibility. Increased capacity is a long-term investment that not only increases the operational flexibility of shipping companies but also provides long-term benefits as shipping companies gain more agility in confronting increased demand in the future. Nonetheless, Christopher and Peck (2004) argue that increased capacity always comes as a trade-off to cost. Thus, even if the capacity of vessels increases, it will not be beneficial if ports continue to be bottlenecks and the increased amount of cargo cannot be handled by hinterland transportation. Instead, the cargo will continue to be stuck somewhere, which does not improve the efficiency or resilience of the entire MSC.

The findings indicate that in the event of a sudden disruption, operational capabilities are essential to respond quickly. Dynamic capabilities and the ability of actors to change are rather important for organisations to become better prepared and have operational capabilities and resources in place for future disruptions. Instead, for a slow-onset disruption, the result indicates that organizations needed to transform the network and their operational capabilities and resources to face the changing demand of the environment. This highlights a need for more dynamic capabilities during slow-onset disruptions.

5.2.2 Integration and Collaboration

Asadabadi and Miller-Hooks (2020) underline that the entire maritime system is important to provide resilience, due to its interconnectedness. This is especially visible in ports, which function as coordination nodes for various actors (Bichou & Gray, 2004). The empirical results demonstrate that the MTS is constantly learning from the COVID-19 pandemic, and individual organizations are continuously improving their capabilities. However, looking at the perspective of the overall MTS, ripple effects are still visible throughout the network which indicates that the industry was not coordinated enough to transform the entire network and maintain efficiency throughout the supply chain. Instead, the findings reveal a lack of interconnectedness between different maritime transport actors which specifically created congestions in ports.

On the one hand, the congested ports are a result of insufficient capacity. On the other hand, there is also a lack of cooperation and visibility within the MTS, which harms ports as an integrated node. Some shippers and freight forwarders provide well-developed cargo tracking tools, but a problem remains within the communication between actors that do not cooperate. To create more transparency across the MSC, visibility is also needed between more organisations, perhaps even competitors. As ports do not receive enough reliable information about cargo or vessel schedules, this has created ripple effects across networks. To reduce these ripple effects, previous literature mentions that sharing of information and more integrated coordination and collaboration may enhance the competitiveness of not only the individual actors but also the entire supply chain, thus, creating more efficient global trade (Alamoush et al., 2021; Christopher & Peck, 2004).

The findings of this study also reveal a lack of cross-sector partnerships coordination and collaboration. Even though the result signals the need for a more transparent supply chain and that an integrated communication platform across various actors would be useful, an issue exists in stakeholders being sceptical to share their data due to the risks that come with it. The MTS is highly competitive, and visibility contributes as a competitive advantage for individual organizations. Therefore, the high competitiveness among maritime transport actors is hindering the integration of competing actors. Several stakeholders are calling for a higher degree of visibility, and both the COVID-19 pandemic and the Suez Canal blockage-21 have highlighted the importance of visibility to track stuck cargo in the supply chain and to anticipate where future congestion may occur to plan more accurate. However, as the results showed, visibility does not help to create an efficient flow if there is not sufficient capacity to cope with the ever-changing environment.

5.2.3 Digital Transformation and Innovation

The impacts of the Suez Canal blockage-21 and the COVID-19 pandemic have highlighted the importance of a digital landscape and the ability to use digital capabilities to adapt and respond to disruptions. A well-developed digital landscape provides a higher value and competitive advantage for an organization (Verhoef et al., 2021) and integrated systems can enhance the connectedness among actors (Ponomarov & Holcomb, 2009; Singh et al., 2019; Teece, 2007). The result indicates that certain actors in the MTS already had a developed digital landscape, including advanced tracking and tracing systems that provide visibility, digital platforms for information sharing with stakeholders, already established digital infrastructures for remote work, and automated equipment. The findings continuously emphasize that ports with automated terminals were more flexible in dealing with the increased cargo flow due to the COVID-19 pandemic, as they operate remotely and do not require physical labour, thus increasing the robustness of port operations. The importance of investing in innovative and digitalized infrastructure is also supported by secondary data. The Port of Rotterdam, which is the largest seaport in Europe, is striving to enhance its operational efficiency and increase its competitive advantage by building a smart port, using sensors, and data models, as well as providing smarter infrastructures, sites, and buildings (Port of

Rotterdam, 2022). Still, one of the main capacity problems in ports is the lack of storage capacity combined with the inability to move containers out of the terminals.

Although the findings illustrate a certain level of flexibility in terms of storage capacity, they also indicate that some ports were not flexible enough to quickly transform their operations to continuously move cargo through the ports during the extreme increase of volumes due to COVID-19. This reduced the robustness of the ports which many other actors are highly relying on for a functioning supply chain. Port's high reliability on the hinterland transportation was also one main reason that put these constraints on ports. If containers cannot be picked up and returned to ports on time, the terminals will eventually be overwhelmed. Hence, the lack of flexibility and robustness of the hinterland transportation created ripple effects throughout the entire supply chain. Ports also have limited options to expand their space. Three innovative ways to increase port capacity withdrawn from the empirical findings are the use of dry ports, box bays, or warehouses-on-wheels. In line with previous literature, dry ports can be used to provide a more flexible storage capacity (Russell et al., 2020) and the results showed that dry ports can increase supply chains flexibility even on a dynamic level, as terminal capacity can be extended to the inland if demand increases. The Port of Rotterdam has also included an accessibility strategy in which they are collaborating with national governments, authorities, and industry actors, in improving the infrastructure, such as connecting inland terminals and reducing bottlenecks through capacity management or joint investments (Port of Rotterdam, 2022).

5.3 Balance between Capabilities and Supply Chain Vulnerabilities

To summarise the analysis, a framework for the resilience of the global MTS has been visualised in Figure 7 below. The framework shows how operational and dynamic capabilities must be balanced with supply chain vulnerability to efficiently mitigate the impacts of disruptions in the MTS. The flow of containers and information is the overall key factor passing through all supply chain channels and the primary objective is to mitigate the impact of disruptions on the flow of cargo while maintaining the efficiency of operations. Achieving this requires a resilient MSC. This study has identified several capabilities that should be implemented and developed to mitigate impacts and reduce vulnerabilities in the MTS. According to Jüttner and Maklan (2011), Pettit et al. (2013)

and Pettit et al. (2010), vulnerabilities in the supply chain and capabilities of actors need to be balanced to create an equilibrium of resilience in the supply chain. Therefore, this framework provides a visualisation of the resilient state of the MSC.

Figure 7: *Maritime Supply Chain Resilience Framework*

Note. Own construction.

The findings of this study have shown that there is an unbalance between capabilities and vulnerabilities in the MTS at the moment, as impacts of the COVID-19 pandemic and the Suez Canal blockage-21 have reduced the efficiency and performance of the MTS to transport cargo in the extend that the market is requiring. Hence, more capabilities, specifically on a dynamic level, should be developed to reduce the vulnerable parts of the MSC to prevent impacts of future disruptions. However, the findings have also shown that the MTS's dependency on actors outside of this sector, such as hinterland transportation and consumer behaviour, also creates additional vulnerabilities for this sector. Therefore, increased resilience in the MSC might not be enough to mitigate future disruptions in this extent. Instead, there is also a need for more resilience beyond the port-to-port supply chain.

6 Conclusion

This chapter concludes the research by outlining the research questions and their outcome. Additionally, the potential limitations and future research opportunities of this thesis are elaborated upon.

The purpose of this thesis is to analyse supply chain resilience and the need for dynamic and operational capabilities in the global maritime transport sector (MTS) to mitigate impacts from slow-onset and sudden-onset disruptions. In specific, the vulnerabilities highlighted through the impacts of the COVID-19 pandemic and the Suez Canal blockage-21 over time. One main conclusion of this study is that continuous disruptions in supply chains, caused by the COVID-19 pandemic and the Suez Canal blockage-21 generated economic consequences, congestions, and capacity constraints that the MTS could not fully mitigate. Operational capabilities are important to quickly respond to sudden disruption. However, during a slow-onset disruption, dynamic capabilities become increasingly important as organizations need to change and adapt over time to face the ongoing impacts of disruption.

To fulfil this study's purpose, in the following sections the two research questions are answered:

RQ1. ***What are the impacts of COVID-19 and the Suez Canal blockage-21 on the maritime transport sector and what has been done to counteract these disruptions?***

The study showed that the COVID-19 pandemic stands as a unique case to reflect on a complex disruption, as it has highlighted the weak points of the supply chains. Freight forwarders and shipping companies had abilities to respond quite quickly to the disruption and improve their operations during the different waves of the pandemic. Instead, the main damage has been seen in ports being heavily affected by the increased volume of cargo. While the congestion in ports may indicate a lack of resilience, the findings suggest that this may not be the main cause. Being used to seasonal fluctuations, ports had spare capacities in place and responded quickly by even extending their capacity. Even though the cargo turnover was record high and ports had a certain flexibility in spare capacity,

ports still became overloaded and congested and the actors have still not fully recovered from this. Therefore, the findings indicate that although the supply chain was not fully prepared for a disruption of the magnitude of COVID-19, the impacts were not necessarily caused by a lack of preparedness or lack of resilience in the MTS, but rather by the continuous disruptions which did not diminish over time and exceeded the industry's abilities to mitigate all impacts. Continuously, the Suez Canal blockage-21 was an incident that actors were more prepared to deal with. However, this disruption created even more pressure on actors already challenged by the impacts of COVID-19. The disruptions revealed supply chain vulnerabilities regarding inventory and capacity and led to a potential paradigm shift in multinational companies' supply chain strategies. Over the past two years, it has been widely argued that a more resilient supply chain is warranted. The just-in-time strategy is now being re-examined due to current supply constraints and transportation unreliability. The findings advocate for the just-in-case strategy to be more prepared for uncertainties.

RQ2. ***What dynamic and operational capabilities are required to establish a resilient maritime supply chain?***

The study finds that at an overall level the MTS managed to be flexible and agile enough to use its resources to adapt to the new market situation and maintain a continuous flow of cargo, even though it was not at the extreme level required to meet the increased market demand. Previous knowledge and experience enabled actors to be more prepared to quickly react and face both COVID-19 to a certain extent, but especially the Suez Canal blockage-21. However, the results show a need for more coordination and cooperation between all actors in case of disruptions. This is particularly linked to sharing information and providing visibility and transparency throughout the supply chain, which was primarily requested by ports that act as an integrated node linked to other various actors. Nevertheless, the competitive situation in the MTS hampers the necessary information sharing during a disruption, as transparency and information give companies a competitive advantage that they are not easily willing to share. There is also a need for more innovation and digitalization in the MTS to become increasingly resilient, which has been more visible during these two disruptions. Automation, digital communication- and visualization tools, and innovative capacity solutions can all enhance the resilience of the maritime transportation sector.

7 Discussion

This chapter is dedicated to gaining deeper insights into the empirical findings. It establishes the connection of the research questions and the results in terms of the implications pertaining to the managerial, theoretical, and social perspective. Further, limitations of the study are presented and areas for future research are suggested.

7.1 Managerial Implications

The study highlights several implications for managers in the maritime transport sector (MTS). Firstly, the study highlights the importance of developing certain dynamic capabilities to be flexible and agile enough to mitigate disruptions. Specifically, to improve visibility, cross-sector coordination, and digitalization to enhance preparedness and the efficiency of the response, as both integration and digital tools can improve forecasting and allow for more accurate planning. Therefore, there is a need for managers to see the benefits of collaborating with more stakeholders to improve the efficiency of the MTS as a whole, and not only focus on the loss of competitive advantage it may bring to the individual player. Even though the MTS is a highly competitive and price-sensitive sector, the result of this study shows that increased collaboration during disruptions could benefit even the most prepared actor, as they are highly dependent on other actors in the supply chain. Hence, increased collaboration may reduce ripple effects impacting multiple actors. Continuously, digitalisation and investment in new innovative solutions, such as automation, can both increase the efficiency of processes and improve the capacity of ports, contributing to the resilience of operations and the ability to adapt and change quickly to mitigate disruptions, thus providing competitive advantages.

Secondly, the study also highlights the interconnectedness of the MTS and its hinterland operations. Hence, managers need to be aware of the impacts that both individual consumers and organizations have on the maritime transportation sector.

Lastly, the study further emphasises that the philosophy of just-in-time is becoming questioned and that there is a need for new structures to increase efficiency in transportation and inventory to reduce bottlenecks and congestions throughout the entire supply chain.

7.2 Theoretical Implication

This study is a contribution to connecting SCRES theory to the practical implications of the MTS, as well as visualizing the impacts of the COVID-19 pandemic and the Suez Canal blockage-21 connected to supply chain vulnerability and risk. The synthesis of already existing theories and the empirical finding of this study has contributed to a new theoretical framework linking vulnerabilities and capabilities in the MTS to each other, hence, extending the existing theory on SCRES. Secondly, this study is also connecting the impacts of the two separate cases of COVID-19 and the Suez Canal blockage-21, by illustrating how the Suez Canal blockage-21 had additional impacts on the MTS besides the challenges of the ongoing pandemic, which created impacts that might not have been as severe if the blockage had occurred separately. Lastly, the study contributes to the Dynamic Capability View, by extending the theory into the MTS and showing its relevance in the area of creating resilience in this specific sector.

7.3 Social and Ethical Implications

The study identifies certain ethical implications that have an influence on society. Firstly, having a flexible workforce that can quickly change and become remote increases the resilience of an organization. This adaptation has also benefited organizations beyond the disruption, as they now have the resources to be more flexible even in their usual daily operations, using digital landscapes and the possibility to work remotely. However, this study indicates that during disruption, a situational outcome was the lack of proximity between employees, which had impacts such as reduced efficiency and reduced motivation. The results also show that the increased workload resulting from the effects of COVID-19 has made the industry less attractive and even resulted in people leaving the industry. Hence, this study indicates that from a short-term perspective, moving people to home-office indicated a flexible organization, but created an inflexible and less attractive situation for some employees. However, from a long-term perspective, some organizations now have resources in place to provide employees with more options, hence increasing their flexibility.

Secondly, the impact of COVID-19 and the Suez Canal blockage-21 on maritime transportation has not only been considered within the MTS but these two disruptions have been recognised even outside this specific sector. The results show that the impact of the MTS on global trade is now visible in multiple sectors, even down to the final consumer. A more resilient supply chain will contribute to the availability of consumer goods and reduce delays in final product delivery to the end consumers.

7.4 Limitations

Firstly, this study only observes the port-to-port perspective of the supply chain, while the lack of capacity in the hinterland transportation and its impact on the maritime part of the supply chain has not been included in the scope of this study. The findings have shown that maritime transportation is highly dependent on containers being efficiently transferred in and out of ports. Continuously, consumer behaviour greatly influences the demand for transportation of containerized consumer goods. This limitation has therefore restricted the exploration of the full impacts that the additional parts of the entire supply chain have on maritime transportation.

Secondly, this study examines the two cases of the Suez Canal blockage-21 and the COVID-19 pandemic as two different cases, one sudden-onset disruption and one slow-onset disruption. However, the results demonstrated that the effects of the COVID-19 pandemic reduced the preparedness of organisations as the Suez Canal Blockage-21 occurred. Accordingly, a limitation is that this study did not examine a sudden-onset disruption without the additional effects of a slow-onset disruption.

Thirdly, this study only touches the surface of a very complex supply chain issue. As this specific area has been limited in previous research, this study only provides a broad and holistic picture of the complicated and unique impacts of the two case disruptions and the capabilities of industry actors. Further research should be conducted to provide a more in-depth understanding of the impacts of maritime transportation in this research field (see section 7.5).

Finally, during the writing of this thesis, the war between Ukraine and Russia began. This situation created disruptions in maritime transport beyond the cases examined in this study. According to van Wassenhove (2006), war is an additional type of disruption, in addition to slow-onset and sudden-onset disruptions. Thus, limiting this study to the two specific cases might not show all the impacts that the maritime transport sector is currently facing. It is therefore possible that important capabilities to mitigate this additional disturbance are not included in the results of this study.

7.5 Future Research

Additional research opportunities for further and more in-depth exploration have emerged based on the findings, implications, and limitations presented in this thesis. The MTS resilience investigated during the two disruptive events exhibits complexity and scope that only scratches the surface of this important research area.

As identified in the limitations above, this study largely disregards the impact and operations in the hinterland areas. It is important to further examine the extent to which the effectiveness of hinterland operations influences other stakeholders in the maritime supply chain. Further, the results of this study revealed a significant difference in the efficiency of the US American hinterland operations compared to Europe and Asia. Which then resulted in the US ports, especially in Los Angeles and Long Beach, being severely more congested than in other parts of the world. Therefore, further investigation would also be interesting as to why such additional difficulties arose there in particular. Given that this research could only gain limited insights into the transportation situation in Asia, it would also be important to further explore what impact the complete lockdowns of ports in Asia had on the rest of the maritime supply chain.

Although this research has addressed the different phases of disruption and their different capability needs, this study has focused primarily on the overall capabilities needed during all phases of disruption. For future research, a more thorough examination of the specific capabilities needed in each phase of disruption could contribute to an extension of the framework presented in this study.

As a by-product of the strenuous and labour-intensive years during the COVID-19 pandemic, according to our research results, several workers have completely abandoned the MTS and relatively few have chosen this industry anew for themselves. Therefore, it would also be relevant to understand how to motivate employees in this industry and what measures can be taken to attract additional talent to the sector.

A final possible research opportunity involves obtaining insights into the influences of governments and policies in various countries on the maritime supply chain. This is an area that this study does not address, but there were nevertheless indications from interview participants of a strong regulatory impact during disruptions.

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Appendix

Appendix 1: *Interview Guideline*

JÖNKÖPING UNIVERSITY
Jönköping International Business School

Guideline to the research discussion on the subject

'Supply Chain Resilience: Global Disruptions in Maritime Transportation"

The aim of this work is to investigate the impact of slow-onset and sudden-onset disruptions on the maritime supply chain and its resilience. Everything stated in the interview will be recorded and used for academic purposes only. The transcribed interview will be applied as empirical data in a 'International Logistics and Supply Chain Management' Master Thesis for the Jönköping University in Sweden.

General information:

- Introduction of the interviewee – Role description
- Details about the company – What does the company do?
- Which contributions does the company make to the maritime supply chain?

Risk management:

- What risk management strategies in the event of disruptions does the company have?
- Which areas of operation are most vulnerable?
- How do you assess the general preparedness against disruptions of your company?

Covid-19 disruption:

- Was the company prepared for such a major disruption? - If so, what measures were taken in advance?
- What changes did the company have to make at the onset to adapt to the new pandemic situation?
- What prevented a normal workflow the most? (Staff shortages, government regulations, home office, lack of resources, etc.)
- Which strategies were applied to maintain the workflow/operations?
- Which actions were taken during which stage of the pandemic? – Were there recovery periods and/or strategy adjustments before or during a new Covid-19 wave?
- Where do you currently see major constraints in the maritime supply chain impacting all actors from port-to-port?
- What changes made during the last two years are going to be kept in place to mitigate future disruptions?

Suez Canal blockage:

- Were the company operations affected by the Suez Canal blockage in March 2021?
- When and how was the company informed about the incident?
- Which measures have been taken while these vessels were stuck to mitigate impacts?
- How long did it take until operations were back to normal?
- Were there any long-term consequences for your company?
- Did this event lead to reconsideration of the route through the Suez Canal and the search for alternative routes?

Maritime supply chain:

- Which part of the port-to-port maritime supply chain do you consider most important and which most vulnerable? (Hinterland operations, terminal handling or sea freight)
- How would you justify the major challenges in the world's biggest ports at the moment?
- What is most important to support a resilient supply chain?
- How resilient was the company's supply chain two years ago and how is its state now?
- Does the company have digital tools available for supply chain visibility?
- Would a centralized communication system including all maritime supply chain actors be useful and attainable?

Final questions:

- What are your key insights that you've been able to gather over the last few years about the importance of supply chain management?
- Have you come across gaps in this research area that would be interesting to investigate further?

Appendix 2: *Detailed Business Report Overview*

Company	Report Name	Retrieved from
A.P. Moller - Maersk	2020 Annual Report	https://ml-eu.globenewswire.com/Resource/Download/b6733b95-7047-4870-a4cc-8acb20c41dbf
A.P. Moller - Maersk	2021 Annual Report	https://ml-eu.globenewswire.com/Resource/Download/9135269a-6909-4fac-a06f-11fc0b222a97
Port of Rotterdam	2021 Annual Report	https://reporting.portofrotterdam.com/FbContent.ashx/pub_1006/downloads/v220309173702/Highligths-Annual-Report-2021-Port-of-Rotterdam-Authority.pdf
Hapag-Lloyd	2021 Annual Report	https://www.hapag-lloyd.com/content/dam/website/downloads/ir/HLAG_Annual_Report_FY2021.pdf
International Monetary Fund (IMF)	Shipping Costs and Inflation	https://www.imf.org/en/Publications/WP/Issues/2022/03/25/Shipping-Costs-and-Inflation-515144
Sea-Intelligence	Global Liner Performance report - 2021-FY	https://www.sea-intelligence.com/images/press_docs/GLP-FY2021/Global_Liner_Performance_-_2021-FY.pdf

Appendix 3: *Detailed Podcast Overview*

Pod-cast	Host	Interviewee	Company	Recorded	Retrieved from
P01	Sara Vollmer	Otto Schacht	Kuehne+Nagel	Nov. 2021	https://home.kuehne-nagel.com/-/market-insights/sea-freight/podcast/shipping-insights
P02	Sara Vollmer	Casper Ellerbaek	Kuehne+Nagel	Nov. 2021	https://home.kuehne-nagel.com/-/market-insights/sea-freight/podcast/shipping-insights
P03	Sara Vollmer	Marcus Johannsen	Kuehne+Nagel	Feb. 2022	https://home.kuehne-nagel.com/-/market-insights/sea-freight/podcast/shipping-insights
P04	Sara Vollmer	Kathrin Wolf	Kuehne+Nagel	Mar. 2022	https://home.kuehne-nagel.com/-/market-insights/sea-freight/podcast/shipping-insights
P05	Roberta Fusaro	Knut Alicke & Dan Swan	McKinsey	Dec. 2021	https://getpodcast.com/de/podcast/the-mckinsey-podcast/how-to-create-a-resilient-supply-chain-strategy_a8518a7cde
P06	Wall Street Journal	WSJ's Costas Paris and Captain Brian Mossman	Wall Street Journal; A.P. Moller - Maersk	Mar. 2021	https://www.wsj.com/podcasts/the-journal/the-suez-canal-and-a-hard-year-at-sea/0ec555a5-ff02-4e85-93f2-1dddb410a1c7
P07	Lena Göthberg	Jan Hoffman	Shipping podcast: Voices from the maritime industry	Dec. 2020	https://shippingpodcast.com/151-jan-hoffmann-chief-trade-logistics-branch-division-on-technology-and-logistics-unctad/
P08	Richard Meade	Guy Platten	Lloyd's List	Mar. 2020	https://lloydslist.maritimeintelligence.informa.com/shipping-podcast

Appendix 4: *GDPR Thesis Study Consent Form*

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GDPR Thesis Study Consent Form

GDPR Consent for: "The impact of global disruption on the maritime transport sector and its effect on maritime supply chain resilience"

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I consent to JIBS processing my personal data in accordance with current data protection legislation and the data delivered.	☐	☐
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐

My signature below indicates that I choose to take part in the thesis study and consent to JIBS treating my personal data in accordance with current data protection legislation and the data delivered.

Name of participant [IN CAPITALS]	Signature	Date

Thesis contact details for further information

Researcher 1: Vivien Andresen, M.Sc. Student International Logistics and Supply Chain Management
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Appendix 5: *Participant Information Sheet*

JÖNKÖPING UNIVERSITY
Jönköping International Business School

Participant Information Sheet

You are being invited to take part in a thesis study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

It is entirely up to you to decide whether or not to take part. If you decide to do so, you will be given this information sheet to keep and will be asked to give your consent. All the information that we collect about you during the course of the research will be kept **strictly confidential**. You will not be able to be identified in any ensuing reports or publications and recorded interviews will be deleted after submitting the thesis.

The transcribed interview will be applied as confidential empirical data in an 'International Logistics and Supply Chain Management' Master Thesis for the Jönköping University in Sweden. The duration of the study will be during the Spring period of 2022.

Under GDPR you have the following rights over your personal data:

- ***The right to be informed**. You must be informed if your personal data is being used.*
- ***The right of access**. You can ask for a copy of your data by making a 'subject access request'.*
- ***The right to rectification.** You can ask for your data held to be corrected.*
- ***The right to erasure**. You can ask for your data to be deleted.*
- ***The right to restrict processing**. You can limit the way an organisation uses your personal data if you are concerned about the accuracy of the data or how it is being used.*
- ***The right to data portability**. You have the right to get your personal data from an organisation in a way that is accessible and machine-readable. You also have the right to ask an organisation to transfer your data to another organisation.*
- ***The right to object**. You have the right to object to the use of your personal data in some circumstances. You have an absolute right to object to an organisation using your data for direct marketing.*
- ***How your data is processed using automated decision making and profiling**. You have the right not to be subject to a decision that is based solely on automated processing if the decision affects your legal rights or other equally important matters; to understand the reasons behind decisions made about you by automated processing and the possible consequences of the decisions, and to object to profiling in certain situations, including for direct marketing purposes.*

You should also know that you may contact the data protection officer if you are unhappy about the way your data or your participation in this study are being treated at dpo@ju.se