CRANFIELD UNIVERSITY

ANIS DAGHAR

THE ROLE OF COGNITIVE CAPITAL IN SUPPLY CHAIN RESILIENCE: A FOCUS ON RESILIENT INTERORGANIZATIONAL CULTURE IN SUPPLY CHAIN NETWORKS

SCHOOL OF MANAGEMENT

Management and Leadership

PhD

Academic Year: 2017 - 2024

Supervisors:
Professor Leila Alinaghian
Professor Neil Turner

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ABSTRACT

This thesis's central thread comprises three papers (i.e., Papers 1, 2, and 3). Paper 1 is a literature review consolidating the state of research on collaborative interorganizational relationships in supply chain risks. Paper 2 is a case study that explores the role of cognitive capital in supply chain resilience. Finally, Paper 3 is a case study analyzing how resilient interorganizational culture functions in multi-tier supply networks.

Firms increasingly engage in developing collaborative interorganizational relationships (CIRs) to manage supply chain risks (SCRs) and improve supply chain resilience (SCRES). While there is a wealth of fragmented studies on CIRs and SCRs, the literature still lacks a synthetic theoretical articulation of how various aspects of CIRs affect different SCRs. Employing a systematic literature review approach, Paper 1 grounds CIRs in the social capital theory to explain the role of structural, relational, and cognitive capital residing in these relationships in various SCRs. The review reveals that the three social capital dimensions positively and negatively affect different SCRs (i.e., environmental, supply, manufacturing, demand, information, financial, transportation). The findings suggest that the perceived SCRs can influence structural and relational capital. Providing a future research agenda, the literature review calls for researching how the underexplored cognitive capital aspect influences SCRES.

Recognized as the most challenging dimension to operationally separate from other social capital dimensions, cognitive capital has remained an elusive concept. Adopting a buyer-supplier case study approach during a global disruption, Paper 2 unveils different cognitive capital elements (e.g., shared goals, assumptions, values, kinesics language, multilingualism, virtual negotiation, prior disruption experience, shared process capabilities), and explains how they enable positively and episodically the four SCRES temporal capabilities to prepare, respond, recover, and learn, under contingencies of increased and decreased demands, and suppliers' geographical proximity.

Forming the core identity of interorganizational relationships, interorganizational culture is a fundamental element of cognitive capital representing symbols and meanings shared by groups or individuals from different organizations through

intersections of cultures and boundaries. Multiple research calls have highlighted the lack of research on interorganizational culture in SCRES. Going beyond the established dyadic view, Paper 3 enriches the existing literature by exploring the role of interorganizational culture in SCRES in a multi-tier supply chain network. Using a case study of a disrupted multi-tier supply chain network, Paper 3 identifies and explains how aligned and misaligned interorganizational cultural elements (i.e., shared goals, expectations, understanding, processes, values) impact the SCRES elements of collaboration, flexibility, visibility, and velocity. Applying balance theory, the study characterizes a resilient network-level interorganizational culture by highlighting different supply chain network-level mechanisms (i.e., cultural alignment, propagation, transitivity) influencing SCRES elements differently.

Keywords:

Collaboration, buyer-supplier relationships, interorganizational relationships, interorganizational culture, supply network, supply chain risks, supply chain resilience, social capital, cognitive capital, balance theory

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Through this thesis, I teach the following lesson to the inner voice that used to make me doubt myself: I can do whatever I put my mind to.

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I dedicate this thesis to my mother who passed away on July 23rd, 2024, and my children: Gabreel and Anissa. I hope to inspire you to fulfill your dreams and always do your best, no matter the circumstances.

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LIST OF ABBREVIATIONS

CIRs	Collaborative Interorganizational Relationships
SCRES	Supply Chain Resilience
SCRs	Supply Chain Risks
SLR	Systematic Literature Review

1. Introduction

1.1 Research rationale

Supply Chain Resilience (SCRES) is the adaptive capability to prepare for, respond to, recover from, and learn from unexpected events through business operations continuity (Ponomarov and Holcomb, 2009). SCRES copes with Supply Chain Risks (SCRs) and operational difficulties (Turner et al., 2018). SCRs stem from supply chain irregularities such as interruptions of material or informational flow. SCRs go beyond the boundaries of one single firm. Thus, firms increasingly invest in developing and maintaining collaborative interorganizational relationships (CIRs) to manage their SCRs (Braunscheidel and Suresh, 2009). Extant studies have examined the role of CIRs, such as supplier development (Dahlmann and Roehrich, 2019), joint problem-solving (Scholten and Schilder, 2015), joint planning (Jain et al., 2017), information sharing (Subramanian et al., 2015), reciprocity (Jüttner and Maklan, 2011), and trust (Laeequddin et al., 2009). Existing studies have used meta-concepts (e.g., collaboration, integration, bridging), combining different dimensions of CIRs together, and preventing the distinction between unique aspects of CIRs. While there is a wealth of dispersed studies in CIRs and SCRs, the literature still lacks a synthetic theoretical articulation of how various aspects of CIRs affect different SCRs.

Helping to understand social relationships between groups (Nahapiet and Ghoshal, 1998), social capital theory has recently been effective at explaining how supply chain communities behave (Matthews and Marzec, 2012). Social capital consists of structural, relational, and cognitive dimensions. Structural capital encompasses shared routinized practices such as information sharing, joint decision-making, and joint planning (e.g., Jain et al., 2017; Scholten and Schilder 2015), but also the structure of interactions (i.e., connectivity patterns/overall configuration of relationships) (Choi and Krause, 2006). Relational capital revolves around closeness, reciprocity, and trust (e.g., Jüttner and Maklan, 2011). Cognitive capital is composed of shared context, representations, interpretations, and meaning (i.e., Johnson et al., 2013). Suffering from shortcomings, the literature is missing a comprehensive account of the multidimensionality of fragmented and unconsolidated CIRs in SCRs. Also, the role of CIRs in SCRs remains divergent as CIRs can influence positively and negatively different SCRs. As such, a systematic literature review is adopted in this

work using a social capital lens grounded in the work of Nahapiet and Ghoshal (1998) to explain the role of CIRs in SCRs in supplier-buyer dyads and when these are deep-seated in supply networks.

Scholars have clearly recognized that meaningful collaboration requires the cognitive capital element of context sharing, representations, interpretations, and meaning between parties (Johnson et al., 2013). Through shared codes and language, cognitive capital provides a behavioral framework that can promote synergies and reduce friction among parties (Rossetti and Choi, 2005). Shared codes and language between parties in terms of shared goals, key performance indicators, sector language, and past adaptive responses improve shared cognitions and identity, establishing rules of coordination and collaborative identification, and thus mitigating supply chain risks (Johnson et al., 2013). Previous studies have suggested that interest harmonization using cognitive capital develops shared understanding and reduces buyer-supplier opportunism (Gittell, 2002), and hence supports collaboration, task completion (Inkpen and Tsang, 2005), and conflict resolution (Christopher and Lee, 2004; Johnson et al., 2013). Despite the importance of cognitive capital in supply chain risk and resilience, the current literature examining collaborative relationships has largely focused on the structural and relational capitals existing in these relationships (Daghar et al., 2021). Embedded in structural and relational capitals, cognitive capital is the most intricate dimension to distinguish (Nahapiet and Ghoshal, 1998; Chowdhury et al., 2019; Krause, 2006; Villena et al., 2011) and has remained an inscrutable concept requiring examination in SCRES (Daghar et al., 2021). According to Nahapiet and Ghoshal (1998), cognitive capital consists of two categories: shared codes and language, and shared narratives. Shared codes and language organize sensory data through perceptual categorization and establish a framework enabling the examination and interpretation of the environment (Nahapiet and Ghoshal, 1998). Shared narratives embody stories, myths, and metaphors providing rich sets of meanings (Nahapiet and Ghoshal, 1998).

Corporate shared culture or interorganizational culture is a fundamental underexplored element of cognitive capital (Daghar et al, 2023; Inkpen and Tsang, 2005; Villena et al., 2011). Interorganizational culture is a relatively new concept in the supply chain literature (Cousins et al., 2006; Fawcett et al., 2008; Whitfield and Landeros, 2006) that borrows definitional ideas from the concept of organizational

culture. It is composed of shared goals and objectives, business philosophies, and management styles targeting strategic alignment between partners (Cheung et al., 2010; Sarkar et al., 2001; Sáenz, Revilla and Knoppen, 2014). Interorganizational culture represents symbols and meanings shared by groups or individuals from different organizations through intersections of cultures and boundaries (Larentis et al., 2019). Compatible or aligned organizations create interorganizational cultures that help avoid business failure, strife, and suspicion (Rajaguru and Matanda, 2019, 2013; Sarkar et al., 2001). Playing an important part in nurturing trust, aligned interorganizational culture leads to partnership commitment (Fukuyama, 1995), and better decision-making processes supporting strategic alignments or congruence (Cartwright and Cooper, 1993; Cheung et al., 2010; Sarkar et al., 2001). Shaping how companies address issues, culture affects interfirm relationships (Cao et al., 2015) and is instrumental in making supply networks resilient (Ali et al., 2017; Christopher and Peck, 2004). Although the notion of culture has mainly been studied at the dyadic level in buyer-supplier relationships (Rajaguru and Matanda, 2019; Zhang and Cao, 2018), supply chains go beyond the boundaries of buyer-supplier dyads (Kim et al., 2011). A firm's failure to mitigate supply disruptions is usually due to a lack of understanding of the supply network it is embedded in (Kim et al. 2015). Indeed, the performance of a supplier relies on the effectiveness of its extended supply network (Kim et al., 2011; Roehrich et al., 2023). As such, a network lens is necessary to develop resilience and understand how global supply chains work comprehensively. Focusing predominantly on the flow of materials and information, the current supply chain literature falls short of articulating how resilient interorganizational cultures work and what cultural mechanisms regulate them in multi-tier supply networks.

1.2 Research aim and objectives

This thesis examines the role of collaborative interorganizational relationships in SCRs. Through this examination, cognitive capital, deep-seated in collaborative interorganizational relationships, appeared to be an impactful and fascinating neglected social capital dimension to explore. Interested in how to tackle SCRs, this thesis then focuses on SCRES or the adaptative capabilities that cope with SCRs stemming from supply chain irregularities. Thus, in this thesis, the relationship between cognitive capital and SCRES is examined at the dyadic level. Shared culture is an important facet of cognitive capital and supply chains are more than dyads: they

are networks where dyadic relationships exist. Consequently, this thesis also delves into the role of the underexplored cognitive capital element of interorganizational culture in SCRES at the multi-tier supply chain network-level.

1.3 Research field mapping and theoretical background

The research field is composed of five main areas consisting of CIRs, social capital, SCRs and SCRES, interorganizational culture, and supply networks (see Figure 1.1 below). The sections below will examine these fields and their intersections.

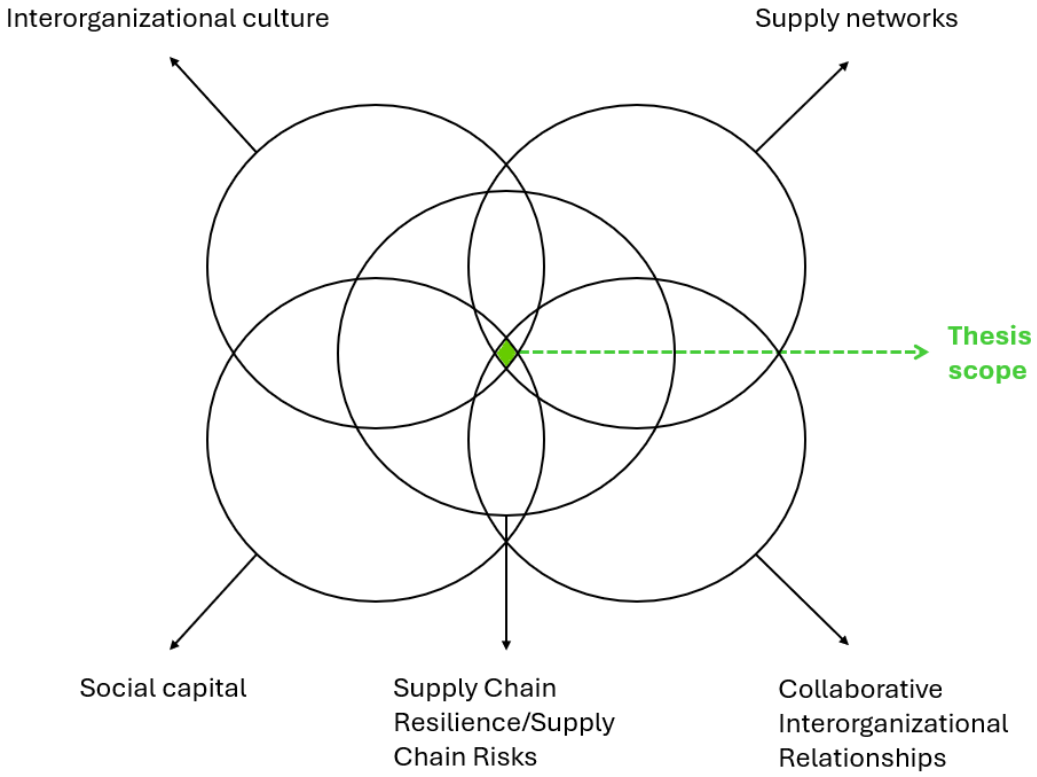

Figure 1-1 Thesis scope

1.3.1 A social capital view of CIRs in SCRs

Social capital theory highlights that the sum of all resources associated with the network of relationships or social capital is critical in the management of social affairs. Social capital consists of structural, relational, and cognitive dimensions. First, the structural capital consists of systems, routinized practices, or regular patterns of interactions structuring interorganizational communication and joint action (Lawson et al., 2007; Carey et al., 2010) by ways of formal and informal methods (Roden and Lawson, 2014). Structural capital deals with collaborative practices, but also the

network-level configuration that they shape, enabling information circulation and accessibility between organizations (Nahapiet and Ghoshal, 1998). Second, relational capital describes personal relationships that people develop through interactions (Nahapiet and Ghoshal, 1998). Roden and Lawson (2014) operationalized relational capital with interaction closeness, trust, respect, friendship, and reciprocity. Third, cognitive capital represents resources providing shared representations, interpretations, meanings, values, goals, and understanding developed via participative and continuous sense-making processes (Krause et al., 2006; Nahapiet and Ghoshal, 1998).

SCRs consist of macro and micro-risks that refer respectively to catastrophic and operational risks (Tang, 2006). Macro-risks are rare external natural and human-made events. Micro-risks are repetitive events emanating from internal activities or relationships within the supply chain, consisting of demand, manufacturing, supply, and infrastructural risks (i.e., informational, transportation, and financial risks) (Ho et al., 2015).

While studies in CIRs and SCRs are abundant, the literature still suffers from drawbacks. Indeed, a comprehensive account acknowledging the multidimensionality of CIRs and their connections to a theoretical lens (e.g., social capital) and specific SCRs is still lacking. Fragmented, the literature often uses meta-concepts (e.g., collaboration, integration, bridging), blending collaborative dimensions together, while preventing the distinction between unique aspects of CIRs. Also, the role of CIRs in SCRs remains divergent and unconnected to specific SCRs. In fact, the literature suggests that both CIRs and SCRs can positively and negatively influence each other.

As such, the first research question of this thesis is:

- How do collaborative interorganizational relationships influence supply chain risks?

1.3.2 Cognitive capital in SCRES

Cognitive capital developed between actors enables the understanding of information and the classification of categories. Through participative and continuous sense-making processes, cognitive capital develops shared understanding and ideas needed

to frame the coordination of exchanges and shared thinking processes (Carey et al., 2010; Krause et al., 2006).

SCRES is an adaptive capability that prepares the supply chain to deal with unexpected events, respond to disruptions, and recover and learn from disruptions through business operations continuity (Ponomarov and Holcomb, 2009).

The literature discusses cognitive capital in SCRES through shared codes, language, and narratives. Shared codes and language appear in the form of goals, key performance indicators, sector language, task ownership, standardization, and training. These elements improve collaboration, flexibility, and preparedness needed in SCRES, by establishing explicit and tacit understanding (Johnson et al., 2013) and improving supply chain risk identification (Fan and Stevenson, 2018) and mitigation (Chen et al., 2013; Chowdhury et al., 2019). Shared narratives are stories, myths, and metaphors sustaining meaning in communities (Nahapiet and Ghoshal, 1998). Johnson et al. (2013) suggest that shared narratives, such as past adaptive responses, help solidify collaboration, identify problems, support curiosity, and enhance visibility.

Research on cognitive capital remains limited and misunderstood, despite the dimension's embeddedness and importance in other social capital dimensions (Nahapiet and Ghoshal, 1998). Qualitative work could help thoroughly operationalize cognitive capital embedded in CIRs and understand how it influences SCRs and SCRES. Overall, the current literature recognizes the role of some cognitive capital elements in SCRES enablers (i.e., collaboration, flexibility, visibility, velocity), but remains limited as to what and how cognitive capital's elements impact the four SCRES capabilities to prepare, respond, recover, and learn.

Therefore, the second research question tackled in this thesis is as follows:

- How do cognitive capital elements, embedded in collaborative interorganizational relationships, influence the SCRES temporal capabilities to prepare, respond, recover, and learn in a disrupted buyer-supplier dyad?

1.3.3 Interorganizational culture in SCRES

Interorganizational culture is composed of cultural elements consisting of symbols and meanings shared by groups or individuals from different organizations through intersections of cultures and boundaries (Larentis et al., 2019). As a component of cognitive capital, interorganizational culture consists of company values, philosophies, approaches to business dealings, management styles, and business capabilities (Chowdhury et al., 2019) that support the process of shared understanding and cognitive effort needed in supply risk identification (Fan and Stevenson, 2018) and mitigation (Chowdhury et al., 2019). Elements of Interorganizational culture have been briefly investigated within supplier-buyer relationships in the supply chain risk and resilience literature. For example, supplier-buyer shared vision helps better manage supply disruption (Manhart et al. 2020).

Despite research calls on organizational and interorganizational culture (Revilla and Saenz, 2017), interorganizational culture in supplier-buyer relationships is still mainly assumed to exist in isolation, especially while striving for resilience in the supply chain management literature. Nevertheless, given the growing number of players involved in supply chains, cultures are embedded in multi-tier supply chain networks. Thus, the literature lacks a theoretical articulation of what and how interorganizational cultural elements influence the SCRES of multi-tier supply chain networks. Examining the relationship between interorganizational culture and the SCRES' most cited elements (i.e., collaboration, flexibility, visibility, velocity) (Ali et al., 2017; Jüttner and Maklan, 2011) is a sound approach to start the investigation.

Consequently, the third research question guiding this thesis is:

- How do interorganizational culture elements influence the SCRES elements of collaboration, flexibility, visibility, and velocity in a disrupted multi-tier supply chain network?

1.3.4 A supply network view of SCRES

The supply chain management literature has recently shifted its attention from a dyadic view to a supply network view to analyze how supply network structures impact behaviors and performance (Kim et al., 2011). A supply network is a collection of nodes (i.e., facilities) and arcs (i.e., transportation linking facilities) (Borgatti and Li,

2009). Nodes consist of suppliers, manufacturers, service providers, and customers linked by arcs/ties in the form of physical flows (e.g., materials) or contractual relationships (Kim et al., 2011). The literature discusses disruptions at two levels of analysis: the node/arc-level investigates nodes individually and/or arcs consisting of a dyad with two nodes, while the network-level examines the wider structure (Kim et al., 2011). This study grounds its supply network perspective on a focal node network encompassing a focal/lead buyer and a set of suppliers with direct or indirect ties to the focal firm (Borgatti and Li, 2009).

SCRES at the supply network-level has been largely overlooked (Kim et al., 2015). A firm's failure to mitigate supply disruptions is usually due to a lack of understanding of the supply network it is embedded in (Kim et al. 2015). This explains why supply chain risk management needs to be network-wide (Christopher and Peck, 2004), and why buyers are urged to select and evaluate suppliers based on their embeddedness in larger networks of suppliers (Kim et al., 2011; Roehrich et al., 2023). An example of a large supplier network impacting the entire supply chain is Toyota, whose North American truck production stopped over a component disruption in a Japanese plant (Kim et al. 2015). Promoting a supply-network view of supply chains and interorganizational cultures, this work focuses on node/arc disruptions and how they affect the SCRES elements of collaboration, flexibility, visibility, and velocity of the supply network. Conceptualizing supply networks in the form of material and informational flows, this work looks at the extent to which two nodes and a supply network are culturally aligned as the key mechanism impacting SCRES.

1.4 Research philosophy and strategy

This section discusses the methodological and theoretical underpinnings of the research presented in this thesis. Researchers have to choose appropriate methods for data collection and analysis determining the overall research approach and data analysis strategy of their work. Blaikie (2007) emphasizes that research aims to create new knowledge on investigated phenomena, but the choice of theoretical and methodological research background is influenced by the observed phenomena or reality. Saunders, Lewis, and Thornhill (2009) point to key decisions a researcher must make to define a research strategy and methodology in this chronological order:

- The research philosophy: positivism, realism, interpretivism, or pragmatism.

- The research approach: deductive or inductive.
- The research strategy: experiment, survey, case study, action research, etc.
- The method: mono method, mixed method, or multi-methods.
- The time horizon: cross-sectional or longitudinal.
- The data collection and analysis tools and techniques.

The researcher's personal beliefs about reality and the objectives of the research impact the positioning of the research philosophy and approach. Ontology and epistemology are two branches of philosophy discussing this topic. Ontology focuses on the nature of existence and the impact of personal beliefs on the researcher's ability to produce new knowledge, while epistemology examines the influence of personal values on research objectives. An ontological and epistemological assessment is necessary to define research philosophy and strategy.

This section reviews key philosophical concepts for scientific research in the social sciences and empirical research. It focuses on the ontological and epistemological assumptions used in this work while discussing their practical implications in the research philosophy and strategy of this thesis. Finally, this section dives into the feasibility of the research, its effectiveness in answering research questions, and potential ethical issues.

1.4.1 Definitions: ontology and epistemology

Ontology is defined as the branch of philosophy “that deals with the nature of being, or what exists; the area of philosophy that asks what reality is and what the fundamental categories of reality are” (Newman, 2014: p. 94). Thinking about ontology forces the researcher to answer questions on the nature of the real world and the research objective to define an effective research strategy. In empirical research design, assumptions on the nature of reality are critical.

Two main views exist on the nature of reality: realism and nominalism. Realists believe in an objective reality that can be captured without human interpretation. Critical realists, on the other hand, argue that objective reality cannot be observed through the subjective lens of the researcher (Sanders, Lewis and Thornill, 2009). Critical realists suggest that controls may be needed to track the effective reality hidden under the observer's contamination or subjectivity (Newman, 2014). Critical realism is a

combination of pure realism and nominalism. In contrast to realists, nominalists asserts that external reality is not truly external to observers, and that researchers only observe the world through their subjectivity, which shapes their interpretation of reality (Denscombe, 2010; Bhattacherjee, 2012). Nominalists believe that cultural and social influences significantly impact individual perceptions of reality, and that these influences can never be completely removed.

A researcher's ontological position can be purely realist, assuming reality can be seen and read, or purely nominalist, acknowledging the influence of socio-cultural influences and personal values. Researchers often find themselves in between these extremes, largely based on their personal beliefs. Ontological position can range from objectivism, where social entities are considered independent from social actors, to subjectivism, where social entities are considered social constructs that can be interpreted through the exploration of social agents' behaviors (Newman, 2014).

The different ontological stances that a researcher can select are as follows (Newman, 2014):

- Positivism views social reality objectively arguing that general laws can be established as seen in the natural sciences.
- Pure realism considers social reality objective and not influenced by the observer's social relationships.
- Interpretivism investigates the real world and agent actions from pre-existing theoretical schemes.
- Pragmatism believes that research questions directly drive the ontological stance in empirical research.

In social science and management studies, data collection is often contaminated directly or indirectly by the researcher (Drucker-Godard et al., 2011), particularly in field and case study research involving interviews (Holmes, 2020). As such, although practical and less prone to philosophical debates, a positivist stance is difficult to hold in social science and management studies.

Epistemology is a branch of philosophy that is crucial in research definition. It focuses on the creation of knowledge and "how we know what we know or what are the most

valid ways to reach truth" (Newman, 2014: p. 95). Epistemology addresses two key issues consisting of how knowledge is created and how it can be evaluated.

Epistemology and ontology are interconnected. Indeed, the ontological position of a researcher greatly influences the researcher's answers to epistemological questions. A realist approach asserts that knowledge is created through a careful investigation of reality, independent of the observer's point of view. This idea can be validated or invalidated by subsequent observations, allowing the researcher to deduce general laws explaining objectively the real world. On the other hand, a nominalist view sees reality as observed from the researcher's interpretative schemes. This approach allows for induction, where an observation is described and interpreted based on pre-existing schemes. Nevertheless, the same reality can be interpreted from different schemes, creating different understandings of the same observation. Realists use deductive logic, observing reality to develop hypotheses, while nominalists use inductive logic, comparing observation with pre-existing theoretical schemes.

1.4.2 Philosophical approach

The ontological and epistemological views are crucial for defining research methodology. Despite the complexity of using scientific methods in social sciences, adopting scientific rigor has proven effective, forcing researchers to explicitly state their theoretical hypothesis and methodological choices (Newman, 2014).

Newman (2014) discusses the advantages and challenges of using the scientific method in the social sciences and proposes three approaches that differ ontologically and epistemologically:

- Positivist social science.
- Interpretative social science.
- Critical social science.

First, positivist social science is based on causal laws derived from general theories, analyzing and measuring phenomena objectively. Positivists view reality as self-evident and social agents as rational and individualistic. Positivists have a deterministic view of reality and perceive the social sciences as objective and not influenced by values. Second, the interpretive social science approach assumes

reality is a social construct and aims to understand social processes generated by individual interaction. For interpretivists, evidence is context-specific, and inductive reasoning prevails over deductive reasoning. Interpretivists believe human behavior is driven by will. Third, the critical social science approach views social reality as complex, focusing on its interplay in behavior and change processes, with the primary goal of triggering societal changes and promoting individual empowerment and human freedom.

1.4.3 Philosophical ontology, epistemology, and approach used

This section discusses the ontological and epistemological assumptions underlining the research methodology of this thesis to explain how it contributes to creating knowledge on the phenomena under investigation.

The paradigm used throughout this thesis is empiricism. The researcher firmly believes that the research questions drive directly the ontological position. As such, this thesis adopts the ontology of pragmatism to deal with the nature of reality. Indeed, the nature of the phenomena under investigation is underexplored in the literature, suggesting that deductive thinking using the literature to develop hypotheses for testing and generalization purposes is impractical. Dealing with intricate phenomena, this research focuses on how collaborative interorganizational relationships, cognitive capital, and interorganizational cultures operate to minimize supply chain risks and create SCRES. The research questions focus on the “how” things work, and the research answers developed in this thesis develop the “how” and explain the “why” things work the way they work. In this study, the epistemology is interpretivist seeking context over statistical generalization. Due to the underexplored nature of the phenomena under investigation, this work develops propositions that were induced from observations based on pre-existing schemes and contexts. However, these propositions could be tested in the future leading to potential deduced generalizations. The methodology of this research is inductive enabling meso- and micro-level analysis. In summary, this thesis uses a philosophical approach based on interpretative social science.

1.4.4 Research strategy used

Research philosophy choices directly impact the research strategy, which is the action plan designed by the researcher to achieve specific research objectives. It must be suitable, feasible, and ethical (Denscombe, 2010). Common research strategies include experiments, surveys, case studies, action research, grounded theory, ethnography, phenomenology, and archival research. Each strategy has its own objectives and must be carefully selected to be suitable, feasible, and ethical.

Consistent with the research philosophy described earlier, the research strategy selected for this thesis consisted of one systematic literature review to map the research field, and two cross-sectional single case studies to examine the phenomena under investigation. Based on a knowledge-thickening explanatory process, the case study technique enables unfolding research for theory generation and testing and is well suited to answer “why” and “how” research questions (Yin, 2018). The case studies from this thesis revolve mainly around semi-structured interviews through phenomenological or narrative inquiry seeking subjective, descriptive, interpretive, but also explanatory understanding. Grounded theory with open, axial, and selective coding was used to analyze all interviews.

Finally, the created knowledge of the phenomena under investigation is derived inductively based on a researcher-centred method, as researcher’s values, role, identity, and experience are expected to directly influence the research analysis (Denscombe, 2010). This is particularly true in the research presented in this thesis, as the researcher was an executive in the two organizations examined in the two case studies.

Ethical concerns should be discussed in the research strategy. The research strategy of this thesis is ethical: anonymity was guaranteed at all stages, data collected was treated as confidential, and participants were informed about the research's nature and role. Measures were taken to maintain the data confidentiality of the companies studied in the cases.

1.4.5 Operationalizations and theoretical lenses used

Different constructs and theoretical lenses were used in this thesis to anchor data, analysis, and findings in the literature, and generate theoretical contributions. In Paper

1, the social capital theory helped categorize collaborative interorganizational relationships and identify how they influence environmental, demand, manufacturing, supply, informational, transportation, and financial supply chain risks. In Paper 2, the social capital theory was used to clarify what cognitive capital is and understand how it impacts the SCRES temporal capabilities to prepare, respond, recover, and learn in a buyer-supplier context. Finally in Paper 3, an element of cognitive capital, namely interorganizational culture, is investigated using the definitions of organizational and interorganizational cultures. Through balance theory, the role of aligned and misaligned interorganizational cultural elements in the SCRES elements of collaboration, flexibility, visibility, and velocity is examined in a supply network.

1.5 Research methodology

The research methodologies used in Papers 1, 2, and 3 are presented in the following sections.

1.5.1 Systematic literature review

Paper 1 is presented in Chapter 2 and follows the evidence-based systematic literature review technique, scientifically systematizing the data research process (Briner and Denyer, 2012). The paper followed three sequential steps: (1) locating relevant articles, (2) assessing and selecting studies, and (3) synthesizing the selected studies. The literature search was executed across three databases consisting of EBSCO, ABI/Inform, and Scopus using relevant keywords and search strings. Through a methodological process, 126 articles from 27 peer-reviewed journals were selected for final review in the period between Year 1995 and Year 2020. The detailed systematization of the data research process is detailed in Chapter 2. An update to Paper 1 is provided in Appendix A3. This update examines papers between February 2020 and June 2024, consolidating relevant papers published after Paper 1's submission to and publication in SCMIJ.

1.5.2 Empirical studies

The first empirical paper (i.e., Paper 2) examined the role of cognitive capital in SCRES and the second empirical paper (i.e., Paper 3) laser focused on a specific aspect of cognitive capital, namely interorganizational culture and its role in the resilience of

multi-tier supply chain networks. Both studies are qualitative case studies developing sets of propositions.

1.5.2.1 Empirical setting

Drawing upon the suggestion to explore the underexamined cognitive capital dimension in Paper 1, the first empirical paper (i.e., Paper 2) investigated the role of cognitive capital in SCRES during the COVID-19 pandemic. A large multi-billion-dollar electronics manufacturer was considered for Paper 2 and provided an ideal setting for the following reasons. First, the manufacturer had a global presence with a fragmented dispersed supply base and a diverse product and service portfolio that spanned multiple industries, enabling to compare different patterns of supply and demand fluctuations. Second, the buying firm's geographically dispersed supply chain provided an appropriate setting to investigate the alignments of meaning, values, or goals that may have emerged due to different geographical locations or cultural differences. Finally, being embedded in the company, one of the authors had exceptional access to the manufacturer's supply chain team.

Following the insight of Paper 2 to investigate the overlooked concept of culture in SCRES, the second empirical paper (i.e., Paper 3) explored the role of interorganizational culture in SCRES in multi-tier supply chain networks during the COVID-19 pandemic. Paper 3 analyzes the supply network of the US-based industrial lubricant division of a large chemical multinational. Consisting of the lead buyer/manufacturer and 21 multi-tier suppliers, this network was chosen for two reasons. First, one of the researchers had access to the supply chain and operations executives in the organization and had built relationships with a myriad of suppliers. Second, heavily affected by various COVID-driven disruptions, the lead buyer had a vast supply network composed of numerous suppliers spread over the US, which provided a unique research opportunity to explore interorganizational culture in SCRES at the supply network-level.

1.5.2.2 Data collection process

In Paper 2, the study was mainly based on 40 semi-structured interviews in a manufacturing multinational over four months in 2020. An interview protocol was established leveraging broadly defined themes in open-ended questions to enable

exploration, avoid confusion for professionals, and trigger follow-up questions requiring explanative responses. Held over Microsoft Teams, all interviews were recorded and fully transcribed. A few phone calls and emails were used after transcription for clarification. Data triangulation was possible thanks to information available in the form of shared presentations, ad-hoc meetings, emails, but also phone calls, which increased the reliability and validity of the results (Yin, 2018).

In Paper 3, the study was mainly based on 83 semi-structured interviews in a supply network of 22 chemical companies (i.e., one lead buyer, and 21 suppliers) over nine months in 2022. On the buyer side, 20 individuals were interviewed. On the supplier side, for each organization, three individuals were interviewed. The same interview protocol was used for the buyer and suppliers using open-ended questions with broad themes to enable understanding, exploration, and follow-up questions. Interviews were recorded using Microsoft Teams and were transcribed. For data triangulation, information in buyer-supplier project presentations, meetings, emails, and phone calls were gathered for 20 months between 2021 and 2022. Embedded in the lead buyer's organization, one researcher collected data from participatory observations when the researcher collaborated with suppliers (i.e., 36 meetings, 29 hours). Data from non-participatory observations were collected, as well, when the same researcher acted as a facilitator or observer (i.e., 15 meetings, 12 hours).

1.5.2.3 The analysis

In the first empirical paper (i.e., Paper 2), the data analysis was based on an open-coding procedure, followed by axial and selective coding processes that brought to light different main elements of cognitive capital and their respective roles in SCRES. Cognitive capital elements emerging from the study were categorized using the seminal social capital framework developed by Nahapiet and Ghoshal (1998). Used in the supply chain literature (Johnson et al., 2013), this view separates cognitive capital into shared codes, languages, and narratives (Nahapiet and Ghoshal, 1998). The SCRES framework examined in the study was based on the SCRES temporal capabilities to prepare, respond, recover, and learn (Ali et al., 2017; Hendry et al., 2019; Jüttner and Maklan, 2011; Scholten and Schilder, 2015). The interviews were collected during the pandemic. Quotes involving cognitive capital's elements were organized using the cognitive capital framework and linked to the SCRES temporal

capability framework in two different situations emerging and consisting of increased or decreased demand levels. The thematic analysis, patterns, and interview transcriptions were recorded in a database (i.e., NVivo 12), helping with the systematization of substantial textual data (Johnson et al., 2013).

In the second empirical paper (i.e., Paper 3), the Gioia methodology (Gioia et al., 2013) was used to determine the interorganizational cultural elements influencing the four most common SCRES elements discussed in the literature consisting of collaboration, flexibility, visibility, and velocity (Ali et al., 2017; Jüttner and Maklan, 2011). The paper examined interorganizational cultural alignments embedded in the material, financial, and informational flows existing between all actors in the supply network. Quotes including aligned and misaligned interorganizational cultural elements were sorted and connected to the four SCRES elements. Disruption events constituted narratives impacting SCRES elements differently. Every collected narrative or story had respondents, organizations, cultural alignments and/or misalignments, and impacted SCRES elements. A disruption event and associated narrative was modeled by connecting the organizations of the disruption-driven story in a diagram or supply network where nodes represented the organizations and links/arcs characterized cultural alignments/misalignments. Using balance theory, the nature of the cultural relationship between actors for every cultural element was characterized in these diagrams with a (+) for cultural alignment or a (-) for cultural misalignment based on the data findings. Interviews were transcribed and followed a thematic and data analysis recorded in a database (i.e., NVivo 12).

1.6 Summary of contribution

Paper 1 is a literature review that contributes theoretically to the supply chain and social capital literature. It classifies CIRs impacting SCRs using the social capital lens and provides an up-to-date synthesis of the interrelationships between CIRs and different SCRs. The review suggests future research avenues, including the underexplored role of cognitive capital in SCRs and resilience. Furthermore, the results of this SLR bring a consolidated view of CIRs and SCRs that can help supply chain practitioners better understand and adjust their current collaborative relationships to mitigate different SCRs.

Paper 2 is a case study that contributes theoretically to the supply chain risk and resilience literature. It extends the understanding of cognitive capital by identifying its underlying relevant elements and their interrelationship with the four SCRES capabilities of prepare, respond, recover, and learn. The study further adds to the buyer-supplier relationship literature by identifying new elements of cognitive capital embedded in buyer-supplier relationships. The insights of this study can help practitioners capitalize on and/or develop various facets of cognitive capital embedded in their relationships with their suppliers to enhance their organization's ability to prepare for, respond to, recover, and learn from supply chain disruptions.

Paper 3 is a case study that explores the application of balance theory to resilient interorganizational cultures from a supply network perspective. The case extends the SCRES literature by offering a theoretical articulation of what and how interorganizational cultural elements influence the SCRES of a multi-tier supply network. It maps all aligned and misaligned cultural elements to explain how interorganizational culture enables the four SCRES elements of collaboration, flexibility, visibility, and velocity. This study identifies with the proponents of cultural alignment and not the advocates of cultural complementarity. Practitioners are invited to assess the cultural resiliency of their supply network by grasping the essential role of interorganizational culture and expanding their cultural understanding from a buyer-supplier viewpoint to a supply network perspective. This can help professionals make more informed decisions regarding joint practices, partner selection and evaluation, contractual terms, etc.

Firms are increasingly utilizing CIRs to manage SCRs and improve SCRES. However, there is a lack of synthetic theoretical understanding of how various aspects of CIRs affect different SCRs. Answering this research gap, Paper 1 is a systematic literature review using the social capital lens to explain how structural, relational, and cognitive capital in CIRs influence SCRs. The review reveals that social capital dimensions positively and negatively affect different SCRs. It also reveals that perceived SCRs can influence structural and relational capitals. This literature review calls for further research on the underexplored cognitive capital dimension embedded in CIRs and its role in managing SCRs and shaping SCRES. Cognitive capital is a challenging dimension to operationally separate from other social capital dimensions and is a

crucial aspect of CIRs. Using a buyer-supplier case study during a global disruption, Paper 2 investigates how cognitive capital impacts SCRES, revealing different cognitive capital elements that enable SCRES temporal capabilities to prepare, respond, recover, and learn. In its research agenda, Paper 2 highlights culture as a fundamental element of cognitive capital. Remaining misunderstood in the SCRES literature, the role of culture in supply network resiliency is scarce, but essential for SCRES. Paper 3 explores this topic with a case study analyzing the role of interorganizational culture in SCRES in a multi-tier supply chain network. The paper identifies how aligned and misaligned interorganizational culture elements, such as shared values, impact the SCRES elements of collaboration, flexibility, visibility, and velocity.

1.7 Publications, conference presentations, and future plans

This thesis consists of three independent papers. The paper format was chosen to be used in this thesis because the conclusion of each paper provides research outcomes dissemination. Table 1-1 summarises every paper's submission and publication to peer-reviewed journals, and conference submissions and presentations. Details on future plans for Paper 3 are provided, as well. Submissions to academic journals and conferences provided instrumental feedback improving the development and refinement of every paper, but also the coherence of the ideas developed in this thesis.

Paper	Title	Journal Submission	Conference Submission
1	The role of collaborative interorganizational relationships in supply chain risks: a systematic review using social capital theory.	• Published in *Supply Chain Management: An International Journal* (SCMIJ) after one revision. • Article publication date: 7th December 2020. • Issue publication date: 10th February 2021.	• Early abbreviated version accepted at POMS 2020 but cancelled due to the COVID-19 pandemic.
2	The role of cognitive capital in supply chain resilience: an investigation during the COVID-19 pandemic.	• Published in *Supply Chain Management: An International Journal* (SCMIJ) after one revision. • Article publication date: 22nd June 2022. • Issue publication date: 28th March 2023.	• Early abbreviated version accepted at EurOMA 2021, but not presented due to professional commitments. • Early abbreviated version accepted and presented virtually at POMS 2021.
3	Resilient interorganizational culture in multi-tier supply chain networks: the 'what' and 'how'.	• Submitted to *Supply Chain Management: An International Journal* (SCMIJ) • Article submission date: 20th October 2024.	• Awaiting feedback from SCMIJ's examiners.

Table 1-1 Summary of publications, presentations, and plans

1.8 Thesis structure

The thesis structure is shown in Figure 1-1. Chapters 2 to 4 present Paper 1 to 3, answering the thesis' aim, research questions, and objectives. The thesis is composed of the following Chapters:

- Chapter 2 shows the systematic literature review published in *Supply Chain Management: An International Journal* (SCMIJ) after a revision. This SLR in Chapter 2 is the theoretical foundation that helped develop two other empirical papers in Chapters 3 and 4. To complement this SLR, a few appendices are provided at the end of Paper 1:
    - Table A.1 Journals used for the SLR.
    - Table A.2 Papers and their supply chain risks in the SLR.
    - Appendix A.3 provides an updated SLR consolidating relevant papers published after Paper 1's submission to and publication in SCMIJ. This update examines papers between February 2020 and June 2024.

- Chapter 3 is among the first empirical research papers that examines in depth the role of cognitive capital in SCRES through a case study occurring during the COVID-19 disruption. This paper was accepted and presented virtually at POMS 2021. It was also published in *Supply Chain Management: An International Journal* (SCMIJ) after one revision. In complement, an appendix is provided at the end of Paper 2, delineating the questions used in the interview protocol for this empirical study:
    - Table B.1 Case study interview questionnaire.
- Chapter 4 is devoted to a second empirical research paper that develops a specific aspect of cognitive capital revolving around the idea of resilient interorganizational culture. It investigates what is a resilient interorganizational culture in a multi-tier supply chain network and how it is works. The paper has been submitted to *Supply Chain Management: An International Journal* (SCMIJ) and is pending review by examiners. To complement this study, an appendix is provided at the end of Paper 3 listing the questions used in the interview protocol for this empirical study:
    - Table C.1 Case study interview questionnaire.
- Leaning on the contributions of the systematic literature review and the two other empirical studies, Chapter 5 gives a comprehensive overview of the thesis and includes practical implications, research limitations, but also a directional research agenda.

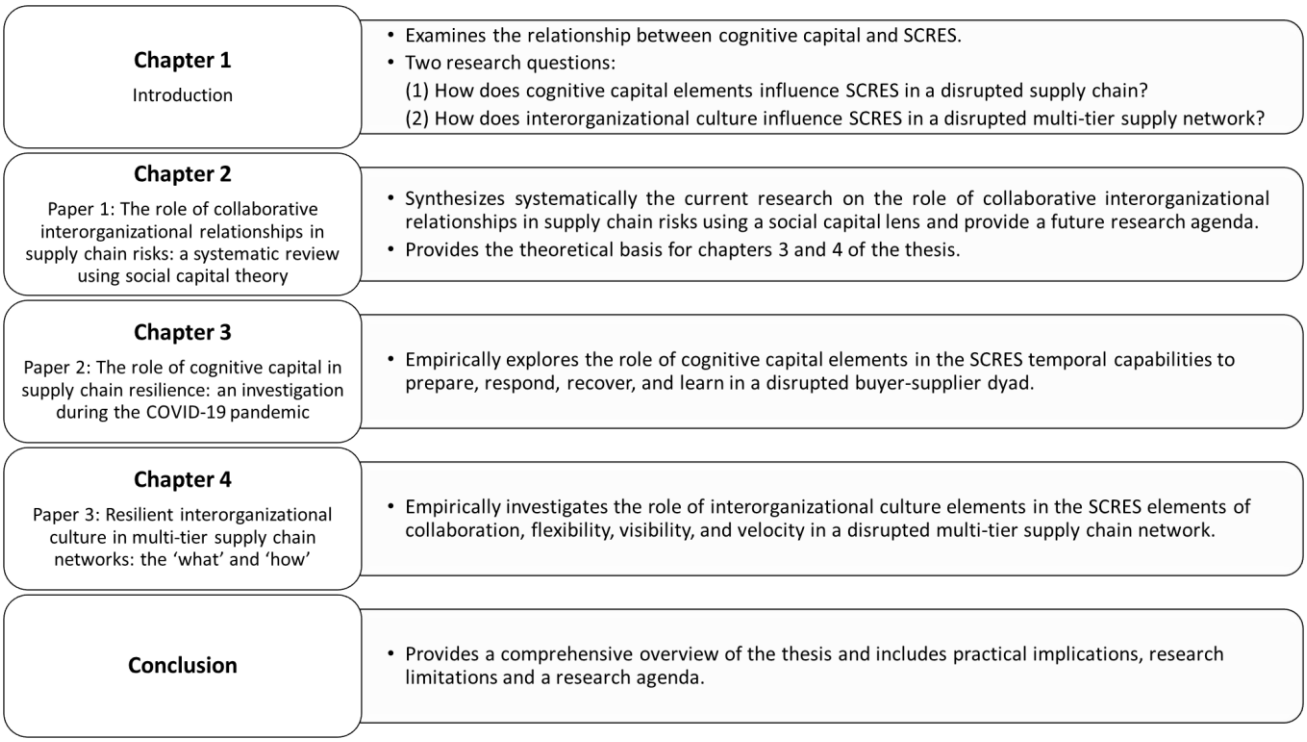

Figure 1-2 Thesis structure

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2. The role of collaborative interorganizational relationships in supply chain risks: a systematic review using social capital theory

Abstract

The role of collaborative interorganizational relationships in supply chain risks: a systematic review using a social capital perspective

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Abstract

Purpose – The purpose of this paper is to systematically review, synthesize and critically evaluate the current research status on the role of collaborative interorganizational relationships (CIRs) in supply chain risks (SCRs) from a social capital perspective and provide an organizing lens for future scholarship in this area.

Design/methodology/approach – This study adopts a systematic literature review approach to investigate 126 articles from 27 peer-reviewed journals between 1995 and 2020.

Findings – This paper investigates supply chain CIRs using a social capital perspective to explain the role of structural, relational and cognitive capital that resides in these relationships in various SCRs (i.e. environmental, supply, manufacturing, demand, information, financial and transportation). The review reveals that the three social capital dimensions uniquely and both positively and negatively affect different SCRs. The findings further suggest that the perceived SCRs can influence the structural and relational capital.

Practical implications – This study calls for practitioners to consider the cognitive alignment with their supply network partners, their relational investments, as well as the interorganizational processes and systems in managing and alleviating SCRs.

Originality/value – This review offers a theoretical articulation of how various aspects of CIRs affect SCRs. Specifically, this study extends the existing understanding of the role of social capital in SCRs through offering a synthesis of dominant findings and discourses, and avenues for future research.

Keywords Social capital, Supply chain risk, Interorganizational relationships, Collaboration, Systematic review

Paper type Literature review

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2.1 Introduction

Supply chain risks (SCRs) stem from events causing supply chain irregularities such as interruptions of material or informational flow. These multifold events include devastating environmental and humanitarian catastrophes (Ho et al., 2015) such as the 2004 Indian Ocean tsunami, 2010 Port-au-Prince earthquake, 2017 hurricane Maria, and 2019 COVID-19 pandemic, which can result in diminished business performance impacting stock returns, income, costs, and share price volatility (Hendricks and Singhal, 2005). Given the increasing number of actors involved in the design, production, and delivery of products and services, SCRs go beyond the boundaries of one single firm. Thus, firms increasingly engage and invest in developing and maintaining collaborative interorganizational relationships (CIRs) with upstream and downstream actors to measure and manage their SCRs (Braunscheidel and Suresh, 2009). In particular, extant studies have examined the role of CIRs, such as supplier development (Dahlmann and Roehrich, 2019), joint problem-solving (Scholten and Schilder, 2015), joint planning (Jain et al., 2017), information sharing (Subramanian et al., 2015), reciprocity (Jüttner and Maklan, 2011), and trust (Laeequddin et al., 2009).

While there is a wealth of studies in CIRs and SCRs, the literature still suffers from shortcomings. First, a comprehensive account acknowledging the multidimensionality of CIRs in SCRs is still lacking. Indeed, CIRs remain fragmented and unconsolidated throughout the literature. Additionally, existing studies have used meta-concepts (e.g., collaboration, integration, bridging), blending different dimensions of CIRs in, and preventing the distinction between unique aspects of CIRs. Second, the role of CIRs in SCRs remains divergent and unconnected as CIRs can influence positively and negatively different SCRs. For example, information sharing can decrease supply risks (Lavastre et al., 2012), but also increase informational leakages to rivals (Zhang et al., 2011). SCRs can also influence CIRs. For instance, a buyer's perception of supply risks can negatively influence the level of information shared with a supplier (Dekker et al., 2013).

In a literature where significant findings are still scattered, a synthetic theoretical articulation of how various aspects of CIRs affect different SCRs is still absent. Indeed, over the last two decades, several literature reviews have examined the concept of

SCRs. However, supply chain risk research being relatively nascent, most literature reviews to date have only explored conceptual definitions, typologies, or frameworks of SCRs (e.g., Tang, 2006), supply chain risk management (e.g., Colicchia and Strozzi, 2012), and supply chain resilience (e.g., Ali et al., 2017a). Early stages of research require definitional and conceptual development, but supply chain risk research has lately matured from within, enabling a shift from conceptual framing of SCRs' nature to a more in-depth understanding of risk mitigation levers such as CIRs.

Adopted by strategic management to understand social relationships between groups (Nahapiet and Ghoshal, 1998), social capital theory challenges the Porterian thesis explaining supplier-buyer behaviors with profit maximization objectives. Contributing to operations management, where the focus has been more on optimization than social interaction, this theory has recently spelled out effectively how supply chain communities behave (Matthews and Marzec, 2012) and provides a pertinent theoretical framework to explain supplier-buyer relationships.

As such, this work (1) adopts a social capital lens grounded in the work of Nahapiet and Ghoshal (1998) to explain the role of CIRs in SCRs in supplier-buyer dyads and when these are deep-seated in supply networks, and (2) provides a research agenda. In synthesizing the consolidated findings, this paper follows the evidence-based systematic literature review technique, scientifically systematizing the data research process (Briner and Denyer, 2012), to answer the following review question: using a social capital perspective, how can we understand the effect of collaborative interorganizational relationships on supply chain risks?

The key contributions of this review are theoretical and practical. Although promising and extensively used in the social and strategy fields, the social capital theory has been occasionally used in supply chain management (Krause et al., 2006; Lawson et al., 2007). Therefore, first, from a theoretical perspective, the present study extends the supply chain and social capital literature by explaining how CIRs interrelate with different SCRs. It also provides future research directions. Second, from a practical perspective, managers would greatly benefit from better understanding the reciprocity between CIRs and SCRs to make risk-aware business decisions such as joint practice, partner selection, supplier development, contractual terms, sourcing practices, relationship closeness, and network configuration.

2.2 Research methodology and descriptive findings

2.2.1 Locating relevant articles

Relevant articles were found in databases consisting of EBSCO, ABI/Inform, and Scopus. A set of different keywords around CIRs and SCRs was determined. CIRs included words such as "interorganizational", “supplier-buyer", "relation", "cooperation", "coordination", "collaboration", or "integration". Supply chain risk included the word "supply" combined with "risk", "resilience", "resilient", "resiliency", "robust", or "robustness". All these words were arranged to build a string (see Table **2-1**) using boolean operators, proximity connectors to narrow results, and asterisks to include word alternatives.

CRITERIA	DECISION
Databases	EBSCO, ABI/Inform and Scopus
Search targets	Titles, abstracts and keywords
Field of search	Business and Management domain
Nature of documents	Scholarly articles
Language of studies	English
String for "interorganizational relationship" keywords combined with : - **Asterisks** - **Boolean operator "OR"**	interfirm OR interorgani?ation* OR "firm to firm" OR "business to business" OR relation* OR cooperat* OR coordinat* OR coopetition OR share OR shared OR sharing OR partner* OR alliance* OR collaborat* OR integrat*
Boolean operator "OR" to add next string:	OR
String using paired words for "interorganizational relationship“ combined with: - **Asterisks** - **Boolean operator "OR"** - **Proximity operator "WITHIN"**	(supplier* OR vendor* OR seller* OR manufacturer*) WITHIN 3 WORDS OF (buyer* OR dealer* OR distributor* OR customer* OR retailer*)
Boolean operator "AND" to overlap previous strings with next string:	AND
String for "supply chain risk or Supply chain resilience" keywords combined with” - **Asterisks** - **Boolean operator "OR“** - **Proximity operator "WITHIN"**	supply* WITHIN 8 WORDS OF (resilien* OR robust* OR risk*)

Table 2-1 Research string

2.2.2 Studies selection and assessment process

The scope of the research targeted abstracts, titles, and keywords in scholarly articles written in English in the Business and Management field, up to February 2020. Two thousand thirty articles were identified, and their abstracts were screened. A high proportion of simulation and modeling papers looked at contract optimization

minimizing risks. These studies were excluded to focus on broader social aspects of CIRs. Four hundred and fifty-six articles were determined to be congruent. Subsequently, the trusted journal quality rating published by the Chartered Association of Business Schools (CABS) in 2018 was used. Due to the high number of articles, quality consideration, and effort to render the search more replicable, all articles with a quality rating of 3, 4, or 4* were selected (i.e., 179 articles). These articles were screened for qualitative, methodological, and contribution eligibility (Miles and Huberman, 1994). Finally, 126 articles were kept. The process described is in Figure 2-1.

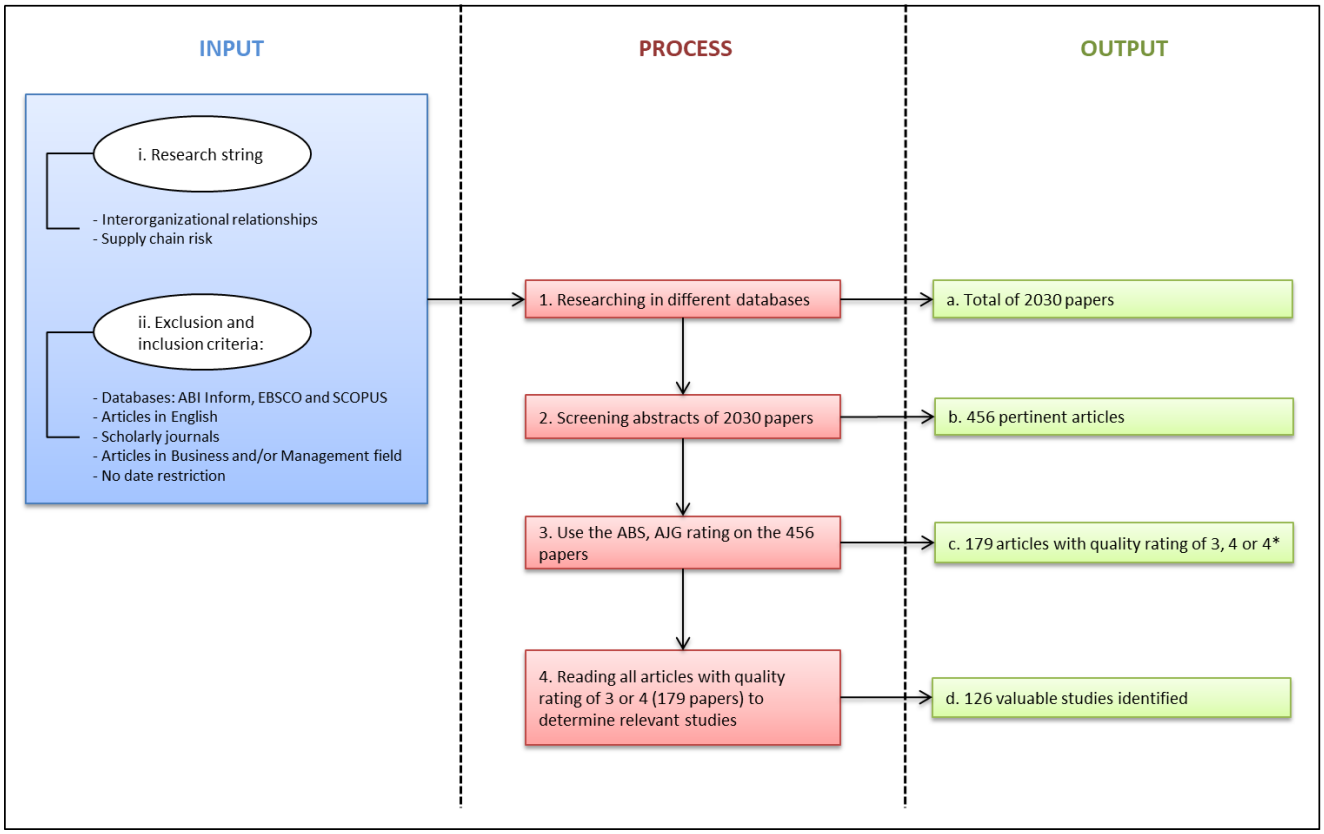

Figure 2-1 Studies selection process flowchart

2.2.3 Data extraction and synthesis of the selected studies

2.2.3.1 Descriptive analysis

Twenty-seven unique journals with CABS rating of three and more were found from the 126 articles collected. Three journals represented about 52% of the sample, with Supply Chain Management: An International Journal, International Journal of

Production Research, and International Journal of Production Economics, respectively sharing the first, second, and third positions.

The first paper found in our SLR is from 1995. Since then, the number of publications has steadily increased.

The methodologies used in all 126 studies were surveys (34.9%), case studies (25.4%), modeling-focused (15.9%), conceptual (11.1%), literature reviews (8.7%), and public dataset-based (4%).

Authors affiliated with 31 countries. The top three most represented countries were the USA (21.3%), UK (20.7%), and Australia (6.9%).

The top three industries studied were Manufacturing (43.8%), Food (10%) and Transportation (6.3%)

2.2.3.2 Thematic coding process

Social capital theory highlights that the sum of all resources associated with the network of relationships or social capital is critical in the management of social affairs. The theory aims at understanding behaviors of individuals and groups at multidimensional levels (Nahapiet and Ghoshal, 1998) and has been lately used effectively in the supply chain and operations domains to explain supplier-buyer intricate relationships (Matthews and Marzec, 2012). Social capital consists of structural, relational, and cognitive dimensions. These dimensions embedded in CIRs play a role in mitigating, but also creating SCRs. This review separates and grounds CIRs' elements in the social capital theory's dimensions (see Table 2-2) to clarify how different collaborative behaviors affect SCRs differently.

First, the structural capital consists of systems, routinized practices, or regular patterns of interactions structuring interorganizational communication and joint action (Lawson et al., 2007; Carey et al., 2010) by ways of formal and informal methods (Roden and Lawson, 2014). These interorganizational practices cover a broad spectrum of processes such as information sharing, supplier evaluation, and supplier development (Krause et al., 2006); or social events, joint workshops, cross-functional teamwork, team-building exercises, and co-location (Lawson et al., 2007; Carey et al., 2010). Hence, the nature of structural capital revolves around routinized practices.

Consequently, the review identifies structural capital embedded in CIRs as buyer-led, supplier-led, and joint practices. Throughout the sample of papers, buyer-led practices comprised supplier management including supplier development and supplier performance management (Fan and Stevenson, 2018; Jüttner and Maklan, 2011), and sourcing practices covering sole-sourcing (Waters-Fuller, 1995), single-sourcing (Tukamuhabwa et al., 2015), and multi-sourcing (Chopra and Sodhi, 2004). Supplier-led practices encompassed customer portfolio management (Hua et al., 2011). Joint practices were associated with scripted processes of supply chain risk management, planning, problem-solving, information, and knowledge sharing, decision-making (Stone and Rahimifard, 2018), best practice sharing (Gallear et al., 2015), co-location (Habermann et al., 2015), and contracts (Kleindorfer and Saad, 2005). Structural capital deals with collaborative practices, but also the network-level configuration that they shape. Acting as an information transmission platform influencing the range of information accessibility in the network (Nahapiet and Ghoshal, 1998), network-level configuration enables information circulation between organizations. It is connected in the sample to the ideas of supply-base complexity with supplier differentiation, number of suppliers, and supplier interaction levels (Choi and Krause, 2006), and overall network structure or scale-free network configuration (Statsenko et al., 2018).

Second, relational capital describes particular personal relationships that people or communities develop through a history of interactions (Nahapiet and Ghoshal, 1998). Roden and Lawson (2014) operationalized relational capital with interaction closeness, trust, respect, friendship, and reciprocity. In this study, the relational dimension refers to trust (Laeequddin et al., 2009), reciprocity (Liu et al., 2018), and conceptually combines interaction closeness, respect, and friendship into the idea of relationship closeness (Chowdhury and Quaddus, 2015). Despite information sharing's association with the relational dimension of social capital in strategic management research (Kim et al., 2015a), this study links information sharing with structural capital because of its routinized nature in supply chain research (Krause et al., 2006).

Third, cognitive capital represents resources providing shared representations, interpretations, meanings, values, goals, and understanding developed via participative and continuous sense-making processes (Krause et al., 2006; Nahapiet and Ghoshal, 1998). From the sample, the two main components of cognitive capital

are (1) shared codes and language, and (2) shared narrative (Johnson et al., 2013). Shared codes and languages represent goals, key performance indicators, sector language, task ownership, standardization, training, standards, and tacit understanding (Fan and Stevenson, 2018; Johnson et al., 2013). Shared narratives comprise past adaptive responses to issues (Johnson et al., 2013), shared corporate culture (Fan and Stevenson, 2018), company values, philosophies, business approaches and capabilities, management styles, (Chowdhury et al., 2019), and national cultures (Gupta and Gupta, 2019; Manhart et al., 2020).

Theoretical lens	Theoretical sub-dimensions	Elements of sub-dimensions extracted from sample			
Social capital: sum of all resources available through the network of relationships (Nahapiet and Ghoshal, 1998)	**Structural capital:** Network-level configuration and systems, practices or regular patterns of interactions structuring interorganizational communication (Krause *et al*., 2006; Lawson *et al*., 2007; Carey *et al*., 2010) by ways of formal and informal methods (Roden and Lawson, 2014)	**Supplier-buyer practices**	Buyer-led practices	Supplier management	Supplier performance management Supplier development
				Sourcing practices	Strategic outsourcing Multi-sourcing Sole-sourcing Single-sourcing
			Supplier-led practice	Customer portfolio management	
			Joint practices	Information and knowledge sharing Joint supply chain risk management Joint planning Joint problem solving Joint decision making Best practice sharing Co-location Contract	
		Network-level configuration	Supply-base complexity	Supplier differentiation Number of suppliers Supplier interaction levels	
			Overall network structure	Scale-free network structure	
	Relational capital: close interaction, trust, and reciprocity (Carey *et al*., 2010)	**Relationship closeness**	Respect Frienship Interaction level		
		Reciprocity	Risk and revenue sharing		
		Trust			
	Cognitive capital: shared representations, interpretations, meaning, values, goals, and understanding developed via participative and continuous sense making processes (Krause *et al*., 2006)	**Shared codes and language**	Goals and key performance indicators Sector language, standards and tacit understanding Task ownership, standardization, and training		
		Shared narrative	Past adaptive responses to issues Corporate shared culture, philosophies, values, approach, management styles, and capabilities National culture		

Table 2-2 Dimensions of CIRs derived from Nahapiet and Ghoshal (1998)

Additionally, throughout this review, SCRs were categorized to highlight the granularity of interactions between CIRs and SCRs. The sample at hand indicates an underpinning split between macro and micro-risks, referred respectively as catastrophic/disruption and operational risks (Tang, 2006). Consequently, this review uses the supply chain risk classification from Ho et al. (2015), where macro and micro risks prevail (see Figure 2-2). Macro-risks are rare external natural and human-made events, such as tsunamis, earthquakes, wars, or terrorism. Micro-risks are repetitive events emanating from internal activities or relationships within the supply chain, consisting of demand, manufacturing, supply, and infrastructural risks. Manufacturing risks relate to the inherent ability to produce goods and services within firms. Demand and supply risks refer to downstream and upstream uncertainties around a firm. Finally, informational, transportation and financial risks are infrastructural risks.

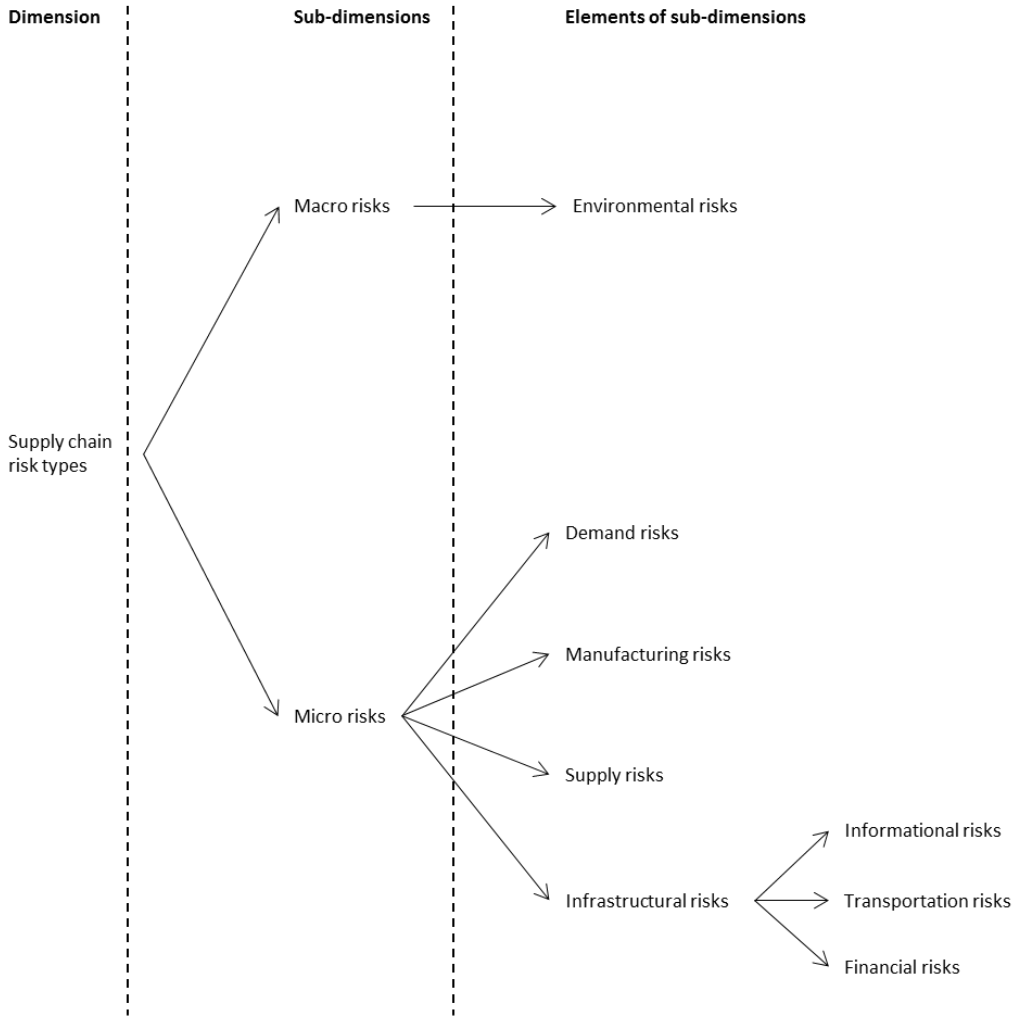

Figure 2-2 Supply chain risk typology based on Ho et al. (2015)

2.3 The role of CIRs in SCRs

CIRs are examined through the social capital dimensions (see Table 2-2). As to SCRs, the supply chain risk classification from Ho et al. (2015) is used (see Figure 2-2).

2.3.1 The role of CIRs' structural capital in SCRs

Structural capital refers to supplier-buyer practices and network-level configuration shaped by these practices (Carey et al., 2010). First, supplier-buyer practices consist of (1) buyer-led practices (i.e., supplier development, supplier performance management, strategic outsourcing, multi-sourcing, sole-sourcing, single-sourcing), (2) the supplier-led practice of customer portfolio management, and (3) joint practices (i.e., information and knowledge sharing, joint supply chain risk management, joint planning, joint problem-solving, best practice sharing, co-location, joint decision-making, contract). Second, the network-level configuration includes (1) supply-base complexity (i.e., supplier differentiation, number of suppliers, supplier interaction levels), and (2) overall network structure or scale-free network structure.

2.3.1.1 Buyer-led and supplier-led practices interplay with SCRs

The buyer-led practices of supplier development and supplier performance management enable risk visibility (Jüttner and Maklan, 2011; Manhart et al., 2020), which helps to contain supply risks' propagation to downstream networks of buyers (Zhang et al., 2018). Supplier development can reduce disaster risks (Dahlmann and Roehrich, 2019; Hu et al., 2019; Sawyer and Harrison, 2019), and mitigate supply risks (Chowdhury et al., 2019; Fan and Stevenson, 2018; Zhao et al., 2013), as it trains suppliers to be proactively aware of problems such as supply quality risks (Tse et al., 2019) or slave labor (Gold et al., 2015). The more supply, manufacturing, and transportation risks increase, the more buyers' SCRs awareness rises, which elevates supplier development (Jajja et al., 2018). Supplier performance management can restrict environmental, supply, and demand risks via improved risk detection, contingency intelligence, and visibility (Brusset and Teller, 2017). It can also apprehend buyers' manufacturing and supply risks (Cheng and Lu, 2017) like suppliers' opportunism to produce fraudulent products (Duhadway et al., 2020) or non-quality products (Tse et al., 2019).

Strategic outsourcing is the decision for a buyer to select an external source to process a task. In times of recession, this practice can alleviate disruption risks at the network-level as it builds flexibility, risk-sharing, and risk absorption (Jüttner and Maklan, 2011).

Multiple-sourcing creates supply redundancy used by buyers to mitigate supply risks (Aboah et al., 2019; Ali et al., 2017b; Gaur et al., 2019; Tan et al., 2019; Zhao et al., 2019a) or environmental disasters (Sawyer and Harrison, 2019) such as droughts (Sá et al., 2019) or earthquakes (Todo et al., 2015). Chopra and Sodhi (2004) conceptually highlighted the advantage of multiple-sourcing for buyers facing supply risks. Multiple-sourcing dominates for low-impact and high-frequency supply disruptions or when the supply risk aversion is high (Namdar et al., 2017). Urciuoli et al. (2014) encouraged European oil and gas supply chains to source their energy from different countries to avoid over-dependency on a few suppliers resulting in loss of power, disadvantageous contracts, and replenishment risks. Nevertheless, multi-sourcing can still create supply risks in networks, notably in the construction industry, where high levels of multiple-sourcing can handicap a buyer's visibility and control of suppliers' opportunism (Rudolf and Spinler, 2018).

Sole-sourcing mingled with just-in-time, and single-sourcing have been determined to be potentially damaging. Sole-sourcing, combined with just-in-time, may increase financial risks for suppliers who could invest in facilities or vehicles, creating dependence on the buyer (Waters-Fuller, 1995). In the case of single-sourcing, buyer's dependency could drive supply risks up because of the lack of alternative suppliers when needed (Chopra and Sodhi, 2004; Tukamuhabwa et al., 2015).

The supplier-led practice of customer diversification can reduce suppliers' financial and forecast risks. Hua et al. (2011) indicate, in an agent-based modeling study, that retailer diversification reduces retailers' non-payment risk, lowering manufacturers' bankruptcy risk. Along these lines, Chopra and Sodhi (2004) associate more customers in a network to less receivable risks for the supplier, minimizing downstream financial risks' propagation upstream. Moreover, customer diversification enables risk pooling, which reduces suppliers' earnings forecast error (Hu et al., 2018).

2.3.1.2 Joint practices' interrelationships with SCRs

Joint SCRM practices encompass multiple shared procedures between partners targeting the control of SCRs (Ritchie and Brindley, 2007) such as environmental,

supply discontinuity, and manufacturing risks (Kauppi et al., 2016), but also cybersecurity risks (Colicchia et al., 2019a). They are the most effective strategies to manage SCRs (Lavastre et al., 2014) and are highly discussed throughout the literature. Surveys in France (Lavastre et al., 2014), India (Mishra et al., 2016), Austria, Germany and Switzerland (Durach and Machuca, 2018), and 69 other countries (Revilla and Saenz, 2017) evidenced that buyers pursuing joint SCRM strategies with their suppliers obtain lower levels of quality, delivery, and supply disruptions than those who do not pursue them. Indeed, joint SCRM practices ameliorate risk information sharing and assessment (Fan et al., 2017), which empowers partners' anticipative capability to detect supply risks (Lima et al., 2018; Manhart et al., 2020; Stone and Rahimifard, 2018; Bevilacqua et al., 2019) and builds strong partnerships reassuring suppliers seeking minimum future contracts uncertainty with their buyers (Ritchie and Brindley, 2007).

Joint planning is a cooperative capability used to plan and cope with environmental risks (Dubey et al., 2020; Jain et al., 2017), like the weak rule of law (Wiengarten et al., 2016), but also supply risks (Chowdhury et al., 2019, Dubey et al., 2019; Hu et al., 2019; Lima et al., 2018; Manhart et al., 2020; Stone and Rahimifard, 2018; Bevilacqua et al., 2019) including lead time fluctuation, forecast inaccuracy, and on-time delivery (Sinha et al., 2004). Joint planning enables stock pooling, which decreases supply and demand risks among partners (Cohen et al., 2000). An example of joint planning used to decrease the bullwhip effect is collaborative planning, forecasting, and replenishment (CPFR) systems (Chopra and Sodhi, 2004). In a concern to minimize informational risks, partners have been continuously using this planning technique to allow transparency and risk identification (Kleindorfer and Saad, 2005). CPFR helps suppliers and buyers reduce inventory shortage risks via forecast sharing (Raghunathan, 1999). It can also avoid anticipatory inventory deployment and enable postponement strategies reducing new product launch risks such as demand variability and overstocking (Bowersox, 1999). Other examples of joint planning practices such as vendor-managed inventory or efficient customer response can improve transparency, brainstorming, and risk detection, altogether palliating environmental, supply and demand risks (Brusset and Teller, 2017). Joint planning influences SCRs, but SCRs can influence joint planning as well. Supply,

manufacturing, and transportation risk levels can increase a firm's joint planning with both customers and suppliers for better coordination (Jajja et al., 2018).

Based on decision, resource, and synchronization abilities, joint problem-solving is a synergetic practice highly effective against environmental (Scholten and Schilder, 2015), demand (Chen et al., 2013), and supply risks (Chowdhury et al., 2019; Kalaitzi et al., 2019; Lima et al., 2018; Manhart et al., 2020; Stone and Rahimifard, 2018; Bevilacqua et al., 2019) such as specifications, lead times, quantity requirements, and forecasts consistency (Chen et al., 2013). Grötsch et al. (2013) found a positive correlation between joint problem-solving philosophy and buyer's proactiveness in detecting supplier insolvency risks in the German automotive industry. SCRs can shape joint problem-solving as well. Indeed, supply and environmental risk influence joint problem-solving between organizations. A survey of buyers from Dekker et al. (2013) showed that supplier monitoring problem risks and the environmental risk of technological unpredictability reduce joint problem-solving with suppliers. In parallel, environmental variability, lack of competition, and supplier risks linked to part complexity increase joint problem-solving. Besides, Hajmohammad and Vachon (2016) suggested that buyers prefer to mitigate a high level of perceived supplier sustainability risk (i.e., ecological or social misconduct) via an open dialogue strategy based on joint planning.

Joint decision-making is a crucial risk mitigation practice in situations of high environmental risks (i.e., natural hazards, terrorism, political instability), supply discontinuity, manufacturing risk (Kauppi et al., 2016; Subramanian et al., 2015), but also demand and financial risks (Subramanian et al., 2015). Used in food waste management, joint decision-making can bridge unconnected parties or structural holes, enabling supply chain circularity and environmental risk reduction (Ciulli et al., 2019). Strategic horizontal and vertical collaboration in decision-making are vital coordination factors that can alleviate SCRs such as Hurricane Katrina (Scholten et al., 2014), but also inflation, political instability, supply disruption, and local food demand increase due to the Brexit constitutional changes (Hendry et al., 2019). Joint decision-making optimizes supplier-buyer alignment needed against disaster (Sawyer and Harrison, 2019), customer’s demand variability (Zhao et al., 2013), and supply risks (Chowdhury et al., 2019; Dubey et al., 2019; Hu et al., 2019; Kalaitzi et al., 2019; Manhart et al., 2020; Zhao et al., 2013). In a simulation, Levalle and Nof (2015) discuss

the practice of resilience by teaming based on joint decision-making where buyers select low-cost suppliers to make them work together to yield a higher combined quality of service. The study found that resilience by teaming boosted the standard and post-disruption quality of service with almost no cost increase. Joint decision-making reduces SCRs, but SCRs can influence joint decision-making too. Indeed, according to a survey from Jajja et al. (2018), a firm's perceived supply, manufacturing, and transportation risks can increase the firm's level of decision-making with suppliers and customers to control these SCRs.

Information sharing generates transparency (Ali et al., 2017a; Cohen et al., 2000; Colicchia and Strozzi, 2012; Colicchia et al., 2019b). Lack of transparency is an informational risk that creates uncertainty between partners. Information sharing appeases this risk by facilitating communication and visibility (Brandon-Jones et al., 2014; Gunasekaran et al., 2015; Jain et al., 2017), which are used, for instance, against demand volatility, price erosion (Subramanian et al., 2015), or supply risks (Aboah et al., 2019; Chowdhury et al., 2019; Colicchia et al., 2019b; Dubey et al., 2019; Hu et al., 2019; Kalaitzi et al., 2019; Lima et al., 2018; Manhart et al., 2020; Stone and Rahimifard, 2018; Bevilacqua et al., 2019). Knowledge sharing has similar visibility effects, enabling the identification and mitigation of supply-side risks (Chen et al., 2016; Dabhilkar et al., 2016; Scholten and Schilder, 2015; Scholten et al., 2019; Tukamuhabwa et al., 2015), and political risks emanating from strife and economic hardships (Gölgeci and Kuivalainen, 2020). Information sharing enables the containment of environmental, manufacturing, and supply risks (Kauppi et al., 2016; Subramanian et al., 2015), but also demand, informational, and transportation risks (Liu et al., 2018). In disaster relief operations, for example, information sharing allows feedback loops between hastily formed humanitarian organizations and helps aid groups to assess resource availability and recovery needs (Kumar and Havey, 2013), notably through blockchain technology (Dubey et al., 2020). Information sharing facilitates risk identification and assessment through operational data exchange (Lavastre et al., 2012), decreasing supply and environmental risks (Kleindorfer and Saad, 2005; Liu et al., 2018; Urciuoli et al., 2014). Information sharing can help quickly identify (a) manufacturing and supply quality risks in raw materials in any supply tier (Tse and Tan, 2011), (b) supply risk of modern labor slavery, (c) demand risk of a bad reputation, and (d) information leakage risk (Stevenson and Cole, 2018). Although

information sharing can benefit partners (Du et al., 2003), it can also have nefarious informational risks for partners, such as infrastructure breakdown (Chopra and Sodhi, 2004; Smith et al., 2007), cybersecurity risks (Bhimani and Ncube, 2006; Colicchia et al., 2019a; Finch, 2004), information distortion (Kwak et al., 2018), and leakages to rivals (Zhang et al., 2011) via social media or production systems (Colicchia et al., 2019b). Excessive information transparency can increase financial risks for suppliers. A case study in the British defense industry revealed that supplier-buyer open book relations could cause buyers to push their costs to their suppliers (Johnsen et al., 2009). Nevertheless, in specific cases such as humanitarian crisis or CO2 emission control, knowledge and information management capabilities between partners have to be built to coordinate forces and mitigate disaster risks (Dahlmann and Roehrich, 2019; Rasouli, 2018; Sawyer and Harrison, 2019; Scholten et al., 2014). Consequently, the pros and cons of information and knowledge sharing on SCRs are typically contextual. The literature also highlights that SCRs can modulate information-sharing levels. In a multi-country survey, Arnold et al. (2010) discovered that the more the supply chain partner's B2B e-commerce risks increase, the lower the level of information sharing was, due to uncertainty. In another survey, Dekker et al. (2013) show that the environmental risk of technological unpredictability and supplier monitoring problem risks negatively influence buyers' information sharing with suppliers. In parallel, other environmental and supply risks such as environmental variability, lack of competition, and part complexity positively affect information sharing levels. An additional survey of Jajja et al. (2018) found that manufacturing firms facing supply, manufacturing, and transportation risks increase information sharing with their partners to decrease SCRs.

The joint practices of best practice sharing and co-location can mitigate SCRs. Buyers sharing environmental and ethical best practices with their suppliers can better identify relational and supply performance risks (Gallear et al., 2015). Additionally, the practice of co-location, when two partners decide to do business in the same location, helps lower supply lead times and supply disruption duration for buyers (Habermann et al., 2015).

Contracts can help minimize environmental and supply risks. Non-performance penalties built into contracts can be buyers' vehicle against natural disasters, strikes, economic disruptions, and terrorism (Kleindorfer and Saad, 2005) or supply risks (Hu

et al., 2019; Kalaitzi et al., 2019) such as quality of supply (Tse et al., 2019). Specific risk distribution contracts can mitigate supply and demand risk propagation in networks. Revenue sharing contracts are generally more effective in mitigating customer or supplier propagated bankruptcy risks than price discount and quantity flexibility contracts (Sun et al., 2012). A case study in the Food industry in Scotland highlighted that horizontal collaboration between producers and vertical collaboration between processors and retailers via contracts reduced supply, manufacturing, and demand risks in the network (Leat and Revoredo-Giha, 2013). Contracts can reduce SCRs, but SCRs perception can influence contracts, as well. A survey of American and Brazilian firms found that buyers managing their perceived supplier's financial risk are more likely to re-negotiate payment terms improving supplier working capital and shrinking supply disruption risks (Oliveira and Handfield, 2017). Eckerd and Girth (2017) examined the US government's risk management choice while designing 240,000 contracts aimed at mitigating supplier risks. The findings concluded that when mission criticality and service complexity are low (low supply risk), suppliers tend to agree to fixed-price contracts, thus bearing all the risks. Whereas, in high mission criticality (high supply risk), the US government tends to agree to incentive contracts. When service complexity is high (high supply risk), cost-reimbursement, and incentive contracts were preferred.

2.3.1.3 Interaction between network-level configuration and SCRs

Deep-seated in CIRs, network configuration is structural and includes (1) supply-base complexity (Choi and Krause, 2006), and (2) overall supply network structures.

Supply-base complexity influences supply risks in networks. Using complex adaptive system theory, Choi and Krause (2006) defined supply-base complexity as the focal firm's (1) supplier differentiation in terms of cultures, practices, capabilities, and geographical dispersion, (2) number of suppliers, and (3) supplier interaction levels. Although conceptual, the paper stipulates that for a focal firm, there is a positive quadratic relationship between its supply-base complexity and supply risk. Indeed, low complexity could prevent a focal firm from accessing new and varied technologies and create supply disruption risk when single-sourcing is preferred. On the other hand, high complexity could make the focal firm lose control over its suppliers, and increase unreliable deliveries, thus exacerbating supply risks. The number of suppliers is a

supply-base complexity dimension connected to the buyer-led practices of single, sole, and multi-sourcing previously discussed in **3.1.1**. A component of supply-base complexity, supplier differentiation, in terms of capability, can reduce environmental risks. In a case study of the South Australian mining industry, Statsenko et al. (2018) show, through complex adaptive system theory, that a large number of interconnected multi-sector organizations in the supplier-base helps with complementary partnerships adding to the reconfiguration ability of the mining network during economic downturns. Supplier differentiation, in terms of dispersion, is also an element of supply-base complexity. Lorentz et al. (2016) show that supplier dispersion has an inverse U-shaped relationship with supply risk, with buyers increasingly ready for growing internationalized supplier dispersion and associated supply risks. Generally, low supply dispersion means low supply risks for buyers (Lei et al., 2019) who prefer dependable, responsive, and geographically close suppliers for quick problem-solving (Ellegaard, 2008). However, high to moderate supply dispersion can help mitigate environmental risks when the risks are not close to the disrupted supply network. Todo et al. (2015), in a survey studying a Japanese earthquake, noticed that networks with firms outside of the area impacted saw a quicker recovery for moderately damaged firms. Therefore, contexts drive supplier dispersion's relationship with SCRs. Supplier interaction, another dimension of supply-base complexity, can influence supply risks for buyers. Indeed, in a case study of British food companies, Touboulic et al. (2014) highlight that two suppliers can combine forces against a buyer's request to pursue shared sustainability goals.

A specific network configuration, embedding CIRs, can contain supply and environmental risks more efficiently. This configuration is scale-free supply networks, defined by a relatively small number of highly connected hubs and a large number of nodes with few connections (Statsenko et al., 2018). These networks recover better from supply disruptions than random networks because they have lower costs, higher fill-rates, and lower inventory needs (Kim et al., 2015b; Ledwoch et al., 2018; Zeng and Yen, 2017). Day (2014) suggests that the assessment of metrics in scale-free networks like clustering, connectedness, short-path, and high-path redundancy can help assess disaster risks. Likewise, Li et al. (2019) point to specific centrality indicators going beyond a scale-free characterization and highlighting essential network nodes. These resilience indicators can offer a better understanding of supply

disruption propagation and consist of degree (important vertices), betweenness (shortest path), and closeness (node proximity ratio).

2.3.2 The role of relational capital in SCRs

Relational capital refers to mutual respect, friendship, interaction level, trust, and reciprocity (Nahapiet and Ghoshal, 1998; Roden and Lawson, 2014). Relationship closeness covers what Nahapiet and Ghoshal (1998) called mutual respect, friendship, and interaction level. Trust is a partner's threshold level of risk-bearing capacity (Laeequddin et al., 2009), and reciprocity alludes to shared risks and benefits.

2.3.2.1 Interactions between relationship closeness and SCRs

The interaction between relational closeness and SCRs is complex. Indeed, relationship capital appears to have an inverted U-shaped relationship with supply-side resilience, where the switch into the upward curvilinear relationship occurs when buyers develop relationship closeness with their suppliers (Fan and Stevenson, 2019). Building or improving relationships is one of the most preferred strategies to mitigate all SCRs (Chowdhury and Quaddus, 2015; Daultani et al., 2015; Govindan and Chaudhuri, 2016; Lam and Bai, 2016; Yang et al., 2018). Close relationships establish a mutual understanding between network-partners enabling better collaboration and visibility (Johnson et al., 2013). Healthy relationships make supply network structures more resilient (Day, 2014) to SCRs such as political and economic instability (Gölgeci and Kuivalainen, 2020), or supply risks (Chowdhury et al., 2019) like suppliers' opportunistic fraud (Duhadway et al., 2020), respect of sustainability obligations (Bird and Soundararajan, 2018), disruption (Dubey et al., 2019; Kalaitzi et al., 2019), and quality issues (Tse et al., 2019). Relationship closeness strengthens supplier-buyer communication and improves supply risk identification (Fan and Stevenson, 2018; Zhao et al., 2013), notably when suppliers are involved early in product development (Khan et al., 2012). Close relationships decrease demand variability when suppliers work with customers (Zhao et al., 2013; Zhao et al., 2019b), diminish the bullwhip effect (Billington, 2010) through purchase volume and reduced supply-base, and help alleviate supply coordination risks in just-in-sequence activities (Wagner and Silveira-Camargos, 2012). The quality of relationships invested in a given upstream tier can generate better relationships with downstream tiers. Indeed, a buyer investing in better relationships with suppliers can lower supply risk costs linked to opportunism and

disruption, and become more competitive, which subsequently makes downstream partners more inclined to establish stronger relationships (Cruz and Liu, 2011). Moreover, buyers building relationships with suppliers can preserve mutual knowledge and build entry barriers against competitors (Bigdeli et al., 2018). Sometimes, because of a close relationship, a supplier becomes financially dependent on the buyer, which can decrease the buyers' financial risks. Kim and Henderson (2015) show that supplier's dependency can reduce financial risks for the buyer by increasing returns on assets and sales. Nevertheless, co-dependent relationships can create SCRs as entire supply chains can crash if one partner operationally fails (Zeng and Yen, 2017). In a Dutch food case study, Scholten and Schilder (2015) suggested that mutual supplier-buyer dependency indirectly drives financial risk as one or both parties could devote specific investments. Buyer's dependency on suppliers can exacerbate the bullwhip effect for those suppliers (Zhao et al., 2019b), and decrease suppliers' financial risks only to a certain point. Indeed, Kim and Henderson (2015) show that buyer's dependency can reduce financial risks for suppliers by increasing returns on assets and sales. However, the financial benefits from buyer's dependency decrease as inventory increases. Dependency can also create a power imbalance between buyers and suppliers, which can materialize through unequal sharing of sustainability investments and financial risks to the advantage of the dominant partner (Touboulic et al., 2014). Relationship closeness influences SCRs, but it can also be affected by SCRs. According to a survey of manufacturers in Hong Kong, perceived supply risks in quantity, quality, and lead-time can trigger buyers to develop guanxi with critical suppliers to contain supply risks (Cheng et al., 2012).

2.3.2.2 Reciprocity's role in SCRs

Throughout the literature, reciprocity considered mainly risk sharing, commonly used by partners to mitigate environmental, supply, demand, informational, and transportation risks (Liu et al., 2018; Rudolf and Spinler, 2018). Shared risks enable loss dispersion, risk absorption (Jüttner and Maklan, 2011), responsiveness, and readiness, which altogether improve resilience in situations of disasters (Chowdhury and Quaddus, 2016; Dubey et al., 2020) and supply risks (Chowdhury et al., 2019; Hu et al., 2019; Manhart et al., 2020). In a supply network simulation, Zeng and Yen (2017) discuss how supply, manufacturing, demand, and transportation risks can be shared among partners, leading to increased centricity (center nodes diffuse risks to

nodes nearby), ultimately improving network organization and recoverability. Reward sharing is another form of reciprocity, which, when combined with risk-sharing, can coordinate supplier-buyer process alignments and reduces manufacturing quality risks for buyers (Tse et al., 2018). SCRs can also influence reciprocity. In a survey, Jajja et al. (2018) show that a firm's elevated supply, manufacturing, and transportation risks can trigger the firm to increase risk and revenue sharing among partners for cost-efficiencies.

2.3.2.3 Interrelations between trust and SCRs

Trust enhances supplier-buyer collaboration (Dubey et al., 2020), reducing supply and demand risks from malicious actors (Fan and Stevenson, 2018). Trust helps to mitigate supply risks (Chowdhury et al., 2019; Dabhilkar et al., 2016; Dubey et al., 2019; Jain et al., 2017; Tse et al., 2019) such as falsified drugs (Lima et al., 2018), or disruptions across industries and countries (Chen et al., 2016; Ha et al., 2011; Rajesh et al., 2015; Ritchie and Brindley, 2007; Vlajic et al., 2012) like manufacturing in China, where trust can also reduce environmental, demand, manufacturing, and financial risks (Subramanian et al., 2015). However, excessive trust can trigger opportunism exemplified by buyers negotiating supply prices, and suppliers increasing their selling prices (Laeequddin et al., 2009). SCRs can also affect trust. Sambasivan et al. (2013) found that suppliers and buyers with a strong perception of opportunistic behavior have a lower level of trust. Similarly, Laeequddin et al. (2009) highlight that trust exists when there is no significant risk, thereupon, suggesting that partners should work on reducing risks to strengthen trust rather than building trust to minimize risks.

2.3.3 The role of cognitive capital in SCRs

Cognitive capital refers to shared codes, languages, and narratives (Nahapiet and Ghoshal, 1998). This dimension helps to mitigate SCRs, but in excess can become collectively blinding as group thinking can prevent buyers from developing innovative ideas to identify supply risks (Fan and Stevenson, 2018).

2.3.3.1 Shared codes and languages in SCRs

In a case study of the Grayrigg derailment in the UK, shared codes and languages appear in the form of supplier-buyer goals, key performance indicators, sector language, task ownership, standardization, and training. These essential elements

drastically improve collaboration and communication, and establish explicit and tacit understanding (Johnson et al., 2013), which helps improve supplier-buyer absorptive capacity, shared understanding, but also cognitive efforts needed in supply risk identification (Fan and Stevenson, 2018) and mitigation (Chowdhury et al., 2019).

2.3.3.2 Shared narratives in SCRs

Nahapiet and Ghoshal (1998) associate shared narratives with stories, myths, and metaphors sustaining meaning in communities. Specifically, in the management of the Grayrigg rail crash in the UK, shared narratives helped to invigorate network collaboration, facilitate the identification and resolution of complex problems by recalling past adaptive responses, and enhance visibility by enticing the curiosity for resource location and status (Johnson et al., 2013). Corporate shared culture is also a shared narrative consisting of company values, philosophies, approaches to business dealings, management styles, and business capabilities (Chowdhury et al., 2019). Suppliers and buyers use shared corporate culture to help tacit and explicit understanding and cognitive effort in supply risk identification (Fan and Stevenson, 2018) and mitigation (Chowdhury et al., 2019). National culture is another shared narrative that appears to impact collaboration strategies in supply disruption management (Manhart et al., 2020). Different countries, based on their individualism, collectivism, and feminism levels, seem to have differences in their risk-taking and negotiation approaches, but research remains poor in this domain (Gupta and Gupta, 2019).

2.4 Concluding discussion, future research agenda, and contribution

Summarizing the findings, this section answers this research question: using a social capital perspective, how can we understand the effect of CIRs on SCRs?

2.4.1 Discussion on current literature

Synthesizing detailed findings from Chapter 3, Table 2-3, and Table 2-4 present unique interaction properties between CIRs and SCRs. Four main ideas transpired from the literature. First, the structural capital of CIRs appears to affect positively and negatively SCRs. Indeed, buyer-led practices of supplier development, supplier performance management, and strategic outsourcing reduce buyers' SCRs (Jüttner and Maklan, 2011), while sole-sourcing (Waters-Fuller, 1995) and single-sourcing

(Tukamuhabwa et al., 2015) can increase them. Multi-sourcing looks to have a positive (Chopra and Sodhi, 2004), but also a negative effect on buyers' SCRs (Rudolf and Spinler, 2018). The supplier-led practice of customer portfolio management reduces SCRs for suppliers (Hua et al., 2011). Joint practices of supply chain risk management, planning, problem-solving, information and knowledge sharing, decision-making (Stone and Rahimifard, 2018), best practice sharing (Gallear et al., 2015), co-location (Habermann et al., 2015), and contracts (Kleindorfer and Saad, 2005) decrease supplier-buyer SCRs. However, information sharing can raise them (Bhimani and Ncube, 2006). Supply-base complexity seems to have a curvilinear relationship with buyers' SCRs (Choi and Krause, 2006). Scale-free network configurations enable better mitigation of network-level SCRs (Statsenko et al., 2018). Second, the relational capital of CIRs seems to influence positively and negatively SCRs. Relationship closeness (Chowdhury and Quaddus, 2015), trust (Fan and Stevenson, 2018), and reciprocity (Liu et al., 2018) mitigate SCRs, but can also exacerbate them (Fan and Stevenson, 2019). Third, cognitive capital, with shared codes, languages, and narratives, appears to help in the mitigation of SCRs (Johnson et al., 2013). However, cognitive capital can also develop collective blinding preventing partners' out-of-the-box thinking (Fan and Stevenson, 2018). Fourth, SCRs can influence the structural capital of supplier development, joint planning, joint decision-making (Jajja et al., 2018), joint problem-solving, information sharing (Dekker et al., 2013), and contracts (Eckerd and Girth, 2017). SCRs can also influence the relational capital of relationship closeness (Cheng et al., 2012), reciprocity (Jajja et al., 2018), and trust (Sambasivan et al., 2013).

Pinpointing the state of current research, Table 2-5 counts the number of papers per CIR and SCR. The literature probed some social capital dimensions of CIRs more than others. First, structural capital is at the forefront, specifically with (1) information sharing and joint planning, (2) supplier development, supplier performance management, and multi-sourcing, and finally (3) network characteristics with a relatively low number of papers. The examination of strategic outsourcing, sole-sourcing, single-sourcing, customer diversification, best practice sharing, and co-location was low. Relational capital came second as the most frequent dimension discussed in the sample, with relationship closeness being the number one element

dissected. Other relational elements were reasonably analyzed. Finally, cognitive capital was by far the less scrutinized dimension.

In the sample, supply risk was the most considered risk, followed by environmental, demand, informational, and manufacturing risks. The frequency of papers dealing with financial and transportation risk studies was the lowest.

CIRs			Macro risks	Micro risks					
							Infrastructural risks		
Dimensions	**Elements**	**Sub-elements**	**Environmental**	**Supply**	**Manufacturing**	**Demand**	**Informational**	**Financial**	**Transportation**
Structural capital	Buyer-led practices	Supplier development	↓	↓					
		Supplier performance management	↓	↓	↓	↓			
		Strategic outsourcing	↓						
		Multi-sourcing	↓	↓↑					
		Sole-sourcing						↑	
		Single-sourcing		↑					
	Supplier-led practice	Customer portfolio management				↓		↓	
	Joint practices	Joint SCRM	↓	↓	↓	↓	↓		
		Joint planning	↓	↓		↓	↓		
		Joint problem solving	↓	↓		↓			
		Joint decision making	↓	↓	↓	↓		↓	
		Information/knowledge sharing	↓	↓	↓	↓	↓↑	↑	↓
		Best practice sharing		↓					
		Co-location		↓					
		Contract	↓	↓	↓	↓			
	Supply-base complexity	Supply-base complexity		↓↑					
		Supplier capability differentiation	↓						
		Supplier dispersion differentiation	↓	↓↑					
		Supplier interaction		↑					
	Overall network structure	Scale-free structure	↓	↓					
Relational capital	Relationship closeness		↓↑	↓↑	↓	↓↑	↓	↓↑	↓
	Reciprocity		↓	↓↑	↓	↓	↓		↓
	Trust		↓	↓↑	↓	↓↑		↓	
Cognitive capital	Shared codes and language		↓	↓↑					
	Shared narrative		↓	↓↑					

Captions: ↓ Decrease. ↑ Increase.

Table 2-3 CIRs influence SCRs

		CIRs								
		Structural capital						Relational capital		
		Supplier development	Joint planning	Joint problem solving	Joint decision making	Information and knowledge sharing	Contracts	Relationship closeness	Reciprocity	Trust
Macro risks	Environmental			↓↑		↓↑				↓
Micro risks	Supply	↑	↑	↓↑	↑	↓↑	X	↑	↑	↓
	Manufacturing	↑	↑		↑	↑			↑	
	Demand									↓
	Informational					↓				
	Transportation	↑	↑		↑	↑			↑	

Captions: ↓ Decrease. ↑ Increase. X Influence.

Table 2-4 SCRs influence CIRs

CIRs			Macro risks	Micro risks						Total per:		
				Infrastructural risks								
Dimensions	**Elements**	**Sub-elements**	**Environmental**	**Supply**	**Manufacturing**	**Demand**	**Informational**	**Financial**	**Transportation**	**Sub-element**	**Element**	**Dimension**
Structural capital	Buyer-led practices	Supplier development	2	7	1				1	**8**	**41**	**203**
		Supplier performance management	1	9	2	1		1	1	**15**		
		Strategic outsourcing	1							**1**		
		Multi-sourcing	2	10						**12**		
		Sole-sourcing						1		**1**		
		Single-sourcing		1						**1**		
	Supplier-led practice	Customer portfolio management				1		2		**3**	**3**	
	Joint practices	Joint SCRM	1	10	1	1	2			**15**	**150**	
		Joint planning	5	11	1	6	1		1	**25**		
		Joint problem solving	2	9		1				**12**		
		Joint decision making	6	13	3	3		2	1	**28**		
		Information/knowledge sharing	11	22	3	3	15	2	2	**58**		
		Best practice sharing		1						**1**		
		Co-location		1						**1**		
		Contract	1	7	1	2				**11**		
	Network characteristics	Supply-base complexity	3	2						**5**	**9**	
		Scale-free network structure	1	3						**4**		
Relational capital	Relationship closeness		4	19	3	7	3	4	3	**43**	**91**	**91**
	Reciprocity		5	8	3	3	2		4	**26**		
	Trust		3	17	1	1		1		**22**		
Cognitive capital	Shared codes and language		1	2						**3**	**7**	**7**
	Shared narrative		1	3						**4**		
		Total	**50**	**155**	**19**	**29**	**23**	**13**	**13**	**302**		

CAPTION

- No papers
- One paper only
- Two or more papers

Table 2-5 Number of articles in CIRs and SCRs

2.4.2 Suggestions for further research

First, theoretically, social capital is a valuable theory enabling the isolation of different dimensions of CIRs in the context of SCRs. Using this lens raises the precision and clarity of research as it avoids mixing different dimensions in various operationalizations found in the literature, such as meta-concepts like integration, collaboration, and bridging. With rare studies combining all three dimensions, the social capital theoretical lens provides a holistic view of the multidimensionality of CIRs, which can help organizations identify, sustain, and develop specific social capital dimensions for valuable partnerships. Making use of social capital theory in supply chain collaboration could enable the discovery of dimensions compensating others, providing insights into how different social capital dimensions interact and accumulate in the context of SCRs. Throughout the literature, in each study, specific SCRs were investigated. However, in supply chains, some risks can lead to other risks, which highlights a need for a global supply chain risk index while studying CIRs. In developing this index, the endogeneity of actual versus perceived risks should be addressed.

Second, ample information on the structural and relational dimensions of CIRs was available in the SCRs literature. Nevertheless, research on cognitive capital remains limited, despite the dimension's embeddedness and importance in other social capital dimensions (Nahapiet and Ghoshal, 1998). Only five pieces were found in the sample highlighting some elements of cognitive capital (Chowdhury et al. 2019; Fan and Stevenson, 2018; Gupta and Gupta, 2019; Johnson et al., 2013; Manhart et al., 2020) such as shared languages, narratives, codes, and cultures. How these elements interrelate, and their roles in SCRs remain superficial in the literature, despite research calls on cultural congruence, for instance (Revilla and Saenz, 2017). Indeed, Gupta and Gupta (2019) point out how little we know about the influence of national cultures (e.g., individualistic, collectivist, feminist) on risk-taking behaviors like willingness to report errors, negotiation coalition, opportunism, uncertainty avoidance, lies, and governance preferences. Cognitive and structural capitals influence relational capital (Carey et al., 2010; Tsai and Goshal, 1998), but counter-intuitively, structural capital does not affect cognitive capital as groups can share values and beliefs without interacting (Tsai and

Goshal, 1998). Could cognitive capital antecede structural capital, hence setting off both structural and relational capitals? Investigating sub-dimensions of cognitive capital, how they interact, but also impact relational and structural capital in affecting SCRs is yet to be achieved. Qualitative work could help thoroughly operationalize cognitive capital and understand it contextually and longitudinally in the face of SCRs such as the COVID-19 pandemic. Also, qualitative research focused on shared languages, for instance, could use ethnomethodology or symbolic interactionism to study how language or body language interrelates with CIRs and SCRs. Furthermore, quantitative research could be beneficial, for example, in assessing how cognitive capital embedded in CIRs accounts for the variation of SCRs or resilience.

Third, the literature revealed a high number of dyadic articles. The embeddedness of dyads in networks shows that dyads and networks affect each other. However, empirical approaches, in network contexts, were scarce in the sample. Making use of network position characteristics and connectedness indicators could be valuable to understand how CIRs affect SCRs like late delivery or bad reputation. Social network analysis, through relationship intensity valuations in graphs (e.g., trust intensity or power imbalance), would be a helpful tool to study relationships between network-level CIRs, SCRs, and associated propagations. The work could consist of complete network mappings of focal firms' suppliers with information collected from both buyers and suppliers instead of only reporting buyers' perspectives, as seen in most dyadic studies thus far.

2.4.3 Theoretical and practical contributions

To date, the multiplexity of CIRs and their interactions with SCRs remain scattered and unconsolidated. This review fills this gap by offering a theoretical articulation of how various aspects of CIRs affect SCRs differently.

Theoretically, the contributions of this review are threefold. First, this study extends the supply chain and social capital literature. Indeed, the classification of CIRs through the lens of social capital could be useful for future research to determine the role and complexity of CIRs in SCRs. Second, this review provides an up-to-date synthesis of the

interrelationships between CIRs and different SCRs. Third, this paper suggests future research avenues.

Practically, the insights of this review can become tools for managers to clarify the relational context of their organizations and make potential relationship adjustments alleviating SCRs. Managers making risk-aware decisions can support their organizations to make the right choices in different areas such as joint practices, partner selections, supplier management, contractual terms, sourcing practices, relationship closeness, and network configurations.

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APPENDICES A for Paper 1

Table A.1 Journals used for the SLR

Journal	CABS Rating			Number of publications	% of Publication
	3	4	4*		
Supply Chain Management: An International Journal	30			30	23.8%
International Journal of Production Research	20			20	15.9%
International Journal of Production Economics	16			16	12.7%
International Journal of Operations and Production Management		14		14	11.1%
Decision Support Systems	4			4	3.2%
Journal of Operations Management			5	5	4.0%
Journal of Supply Chain Management	5			5	4.0%
Decision Sciences	3			3	2.4%
Production Planning and Control	3			3	2.4%
Transportation Research Part E: Logistics and Transportation Review	2			2	1.6%
Transportation Research Part A: Policy & Practice	2			2	1.6%
MIT Sloan Management Review	2			2	1.6%
Management Accounting Research	1			1	0.8%
European Journal of Operational Research		1		1	0.8%
Omega (United Kingdom)	1			1	0.8%
IEEE Transactions on Engineering Management	3			3	2.4%
Production and Operations Management		3		3	2.4%
The Journal of Product Innovation Management		1		1	0.8%
European Journal of Information Systems	1			1	0.8%
International Business Review	1			1	0.8%
Journal of Regional Science	1			1	0.8%
Computers in Industry	1			1	0.8%
Industrial Marketing Management	1			1	0.8%
Journal of Accounting and Public Policy	1			1	0.8%
Journal of Business Ethics	2			2	1.6%
Business Strategy and the Environment	1			1	0.8%
Journal of Business Research	1			1	0.8%
Total	**98**	**19**	**5**	**126**	**100%**

Table A.2 Papers and their supply chain risks in the SLR

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Aboah *et al.* (2019)		Literature review		Network, dyadic		• Supply disruption					
Ali *et al* . (2017a)		Literature review		Network, dyadic					• Transparency risks		
Ali *et al* . (2017b)		Case study	Australian citrus industry	Network, dyadic	• Climatic risks • Environmental catastrophes	• Supply-demand mismatch		• Supply-demand mismatch		• Economic losses (e.g. high cost of doing business) • Bad debts • Price volatility • Currency rate changes	• Transportation risks
Arnold *et al* . (2010)		Survey	Companies from diferent industries	Dyadic					• Partner's technical, application-user, business-level, and financial viability components of B2B e-commerce risks for buyer		
Bevilacqua *et al* . (2019)	Domino theory	Case study	Spanish and Italian fashion	Network		• Supply disruption					
Bhimani and Ncube (2006)		Modeling		Dyadic					• Cyber risks for suppliers and buyers		
Bigdeli *et al* . (2018)		Case study	UK road industry	Network				• Competition risks			
Billington (2010)		Conceptual		Dyadic				• Bullwhip risk for buyer			
Bird and Soundararajan (2018)	Prospect theory	Conceptual		Dyadic		• Supply risk : contractual performance of sustainability obligations					
Bowersox (1999)		Conceptual		Dyadic				• Product launch risks (demand variability) for suppliers			
Brandon-Jones *et al* . (2014)	Resource-based view	Survey	UK manufacturing plants	Dyadic					• Transparency risks		
Braunscheidel and Suresh (2009)		Survey	Companies from diferent industries	Dyadic			Business' level risk: • Business processes • Internal controls and policies				

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Brusset and Teller (2017)	Resource-Based View	Survey	French companies	Dyadic	• External risk perception (political, social, environmental, and economic)	• Supplier risk perception		• Customer risk perception			
Chen *et al*. (2013)	The Theory of Swift, Even Flow (Schmenner and Swink 1998), knowledge-based view	Survey	Manufacturing companies in Australia	Dyadic				• Demand risks (specifications and lead times requirements, and forecasts consistency) for supplier			
Chen *et al*. (2016)	Information-based view, knowledge-based view and relation-based view	Case study	Chinese suppliers and Australian buyers (4 dyads) in surf sportwears and manufacturing	Dyadic		• Delivery on time					
Cheng and Lu (2017)	Trajectory and resource-based perspectives	Survey	Taiwanese manufacturing firms	Dyadic		• Supply risk	• Production risk				
Cheng *et al*. (2012)	Social capital theory	Survey	Manufacturing companies in Hong Kong	Dyadic		• Buyers' perceived supply risks (quantity, quality and lead time)					
Choi and Krause (2006)	Transaction cost, complexity	Conceptual		Network		• Supply risk					
Chopra and Sodhi (2004)		Conceptual		Network, dyadic		• Supply disruption risk • Dependency risk		• Bullwhip effect • Forecast error risk for supplier	• IT infrastructure breakdown for buyers and suppliers	• Receivable risks for the supplier	
Chowdhury and Quaddus (2015)		Modeling	Ready-made garment companies of Bangladesh	Dyadic	• Hazards • Economic shocks	• Supply delay • Opportunistic behaviors from supplier	• Production planning	• Demand fluctuations • Opportunistic behaviors from buyer	• Non-real time information		• Port congestion • Customs
Chowdhury and Quaddus (2016)		Survey	Apparel manufacturing companies in Bangladesh	Dyadic	• Disaster						
Chowdhury *et al*. (2019)	Social capital	Survey	Apparel manufacturing companies in Bangladesh	Dyadic		• Operational supply risk (quality, lead time, volume, capacity, fair price)					
Ciulli *et al*. (2019)	Social network theory	Case study	Food	Network	• Environemental risk: flow of food waste between disconnected actors						

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Cohen *et al*. (2000)		Case study	Saturn's service part operations	Network		• Inventory shortage risks					
Colicchia and Strozzi (2012)		Literature review		Dyadic					• Risk identification during disruption		
Colicchia *et al*. (2019a)		Case study	Multinationals: manufature, logistics provider, retailer	Network, dyadic					• Cyber risks for suppliers and buyers		
Colicchia *et al*. (2019b)		Literature review		Network, dyadic					• Risk of leakage of information (e.g. social media, global cyber-physical systems, production systems)		
Cruz and Liu (2011)		Modeling		Network		• Opportunistic behaviors from supplier	• Production inconsistency in quality, time or yield risks for supplier and buyers	• Opportunistic behaviors from buyer			
Dabhilkar *et al*. (2016)		Case study	Firms from different industries	Dyadic	• Natural disaster • War • Terrorism • Fire	• Disruptions • Supplier bankruptcy • Delays • High-capacity utilization at supply source • Inflexibility of supply source • Poor quality or yield at supply source • Procurement risk • Single source • Industry-wide capacity utilization	• Labor disputes • Industry-wide capacity utilization	Forecast risk due to: • Long lead times • Seasonality • Product variety • Short life cycles • Small customer base	• Systems risk • Information distortion	• Exchange-rate risk	
Dahlmann and Roehrich (2019)	Information-processing theory	Survey	2,330 unique firms from 69 countries and 51 industry groups	Network, dyadic		• Climate change risks, greenhouse gas emissions					
Daultani *et al*. (2015)		Modeling		Network		• Supply risks: quantity, quality, time, cost of material , opportunism	• Production inconsistency in quality, time or yield	• Forecast errors • Opportunism			
Day (2014)	Complex adaptive system, complexity science	Conceptual	Hastily formed networks that begin interaction after the disaster event	Network	• Disasters impacting networks	• Multi-echelon overly selfish and/or malicious behaviors		• Multi-echelon overly selfish and/or malicious behaviors			

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Dekker *et al*. (2013)		Survey	Japanese manufacturing firms and part suppliers	Dyadic	• Environmental variability, and lack of competition perceived by buyer	• Asset specificity (i.e. investments in human or physical assets) • Transaction size (i.e. indication of exposure to potential opportunism and of coordination requirements) perceived by buyer • Part complexity perceived by buyer • Technological unpredictability					
Du *et al*. (2003)		Modeling	Three-level supply chain network	Network					• Information leakages		
Dubey *et al*. (2019)	Resource-based view	Survey	Manufacturing firms	Dyadic		• Supply risk					
Dubey *et al*. (2020)	Information processing theory and relational view	Survey	International NGOs engaged in disaster relief operations	Dyadic	• Disaster						
Duhadway *et al*. (2020)	Transaction cost economics, agency theory, and the fraud triangle	Survey	Australian manufacturing industry	Dyadic		• Supplier's opportunism/fraud : product quality fraud, pricing/invoicing fraud, and corruption					
Durach and Machuca (2018)	Relational view theory	Survey	Many industries in Austria, Germany and Switzerland	Dyadic		• Supply risk for buyer					
Eckerd and Girth (2017)	Resource dependence theory and transaction cost economics	Public dataset	240,000 buyer–supplier contracts from 22 service areas	Dyadic		• Mission criticality • Service complexity					
Ellegaard (2008)		Case study	Owner-managed manufacturing companies	Network		• Supply risk for buyer					
Fan and Stevenson (2018)	Social capital, signalling theory	Case study	Chinese manufacturers	Network, dyadic		• Suppliers' risk signals					
Fan and Stevenson (2019)	Social capital, boundary spanning theory	Survey	Chinese manufacturers	Dyadic		• Supply risk for buyer					

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Fan *et al*. (2017)	Information processing theory	Survey	Chinese manufacturing firms	Dyadic		• Risk sharing		• Risk sharing	• Risk information sharing		
Finch (2004)		Case study	UK companies	Dyadic					• Information system security risks for buyers and suppliers		
Gallear *et al*. (2015)		Survey	Companies from diferent industries	Dyadic		• Buyers' management's appreciation of performance and relational risks in collaboration					
Gaur *et al*. (2019)		Modeling		Network		• Supply disruption					
Gold *et al*. (2015)		Conceptual		Network		• Slave labor or other exploitative risks for buyer					
Gölgeci and Kuivalainen (2020)		Survey	Turkish firms	Dyadic	• Political risks: political strife and economic hardships						
Govindan and Chaudhuri (2016)		Conceptual	Cement company in the southern part of India	Dyadic	• Legal risk	• Quality risk • Lead time • Flexibility risks • Disruption		• Planning and forecasting risks • Opportunistic behavior from the client		• Payment risk for suppliers	
Grötsch *et al*. (2013)	Contingency theory, social exchange theory	Survey	Automotive firms in Germany	Dyadic		• Supplier insolvency risk					
Gunasekaran *et al*. (2015)		Conceptual		Dyadic					• Transparency risk for suppliers and buyers		
Gupta and Gupta (2019)		Coneptual		Dyadic		• Supply disruption					
Ha *et al*. (2011)		Survey	Korean firms	Dyadic		• Risk sharing		• Risk sharing			
Habermann *et al*. (2015)		Survey	Manufacturing firms	Dyadic		• Supply disruption duration for buyer					
Hajmohammad and Vachon (2016)	Agency and resource dependence theories	Conceptual		Dyadic		• Supplier sustainability risk: suppliers' ecological or social misconducts • High supplier-buyer dependency		• High supplier-buyer dependency • Buyer dominance			
Hendry *et al*. (2019)	Dynamic capability theory	Case study	Food	Network, dyadic	• Brexit influencing constitutional change in UK • Political instability	• Supply disruption		• Local demand increase in the UK		• Inflation	

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Hu *et al*. (2018)	Graph theory	Public dataset		Network				• Demand volatility: earnings forecasts			
Hu *et al*. (2019)	Information processing theory	Survey	International Manufacturing firms	Network, dyadic		• Supply risk					
Hua *et al*. (2011)	Agent based model	Modeling		Network				• Bankruptcy risks coming from retailers			
Jain *et al*. (2017)	Information processing theory, high reliability theory, social exchange theory	Survey	Indian firms	Dyadic	• Unexpected disruptive events	• Supply disruption	• Manufacturing disruption	• Demand disruption	• Informational disruption	• Financial disruption	• Transportation disruption
Jajja *et al*. (2018)	Resource Based View, Dynamic Capabilities View	Survey	Manufacturing companies	Network, dyadic		• Supplier risk	• Manufacturing risk				• Transportation and delivery risks
Johnsen *et al*. (2009)		Case study	UK defence industry	Dyadic						• Buyers pushing costs to suppliers	
Johnson *et al*. (2013)	Social capital theory	Case study	The Lambrigg UK rail crash	Network	• Rail crash						
Jüttner and Maklan (2011)		Case study	Cabling, chemical products, and wood/timber	Network, dyadic	• Recession caused by financial crisis	• Supplier in solvencies		• Major demand decline	• IT failure		
Kalaitzi *et al*. (2019)	Resource dependence theory	Survey	Various manufacturing companies	Dyadic		• Raw material supply risk: the scarcity of natural resources					
Kauppi *et al*. (2016)	Information processing theory and the complementarity	Survey	Manufacturiers within the assembly industry from different countries	Dyadic	• Natural hazard • Terrorism • Political instability	• Supply discontinuity	• Equipment failure				
Khan *et al*. (2012)		Case study	Fashion industry	Dyadic		• Misinterpretation of trends later in productions stage from supplier					
Kim and Henderson (2015)	Social capital	Public dataset	Triads of US public companies: focal firm with one supplier and one customer	Network						• Returns on asset and sales for buyer	
Kim *et al*. (2015b)	Graph theory	Modeling		Network		• Supply disruption risk					
Kleindorfer and Saad (2005)		Conceptual	Chemical industry	Dyadic	Natural disasters: • Strikes • Economic disruptions • Acts of purposeful agents (e.g. terrorism)				• Transparency of information for suppliers and buyers		

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Kumar and Havey (2013)		Conceptual	2011 Japanese tsunami	Network	• Disaster						
Kwak *et al*. (2018)		Survey	Companies from diferent industries	Dyadic					• Information distortion		
Laeequddin *et al*. (2009)	Social exchange theory, transaction cost Theory	Survey	Packaged food products supply chain in United Arab Emirates	Dyadic	• Local legislation • Commercial laws • Contracts	• Demand responsiveness and technology from supplier • Opportunistic behaviors from supplier • Perception • Loyalty • Credibility • Reliability • Dependability		• Opportunism from buyer • Loyalty • Credibility • Reliability • Dependability			
Lam and Bai (2016)		Case study	Shipping lines and major shippers	Dyadic	• Natural disaster • Piracy/terrorism				• IT systems risk		• Congestion in port • Port state control • Ship collision or sinking • The condition of cargo-handling equipment • Problems with document interpretation
Lavastre *et al*. (2012)		Survey	French companies	Dyadic		• Quality problem • Delivery problem • Supply disruption					
Lavastre *et al*. (2014)		Survey	French companies	Dyadic		• Quality problem • Delivery problem • Supply disruption		• Bullwhip effect/forecast error risk • Overstocking for supplier			
Leat and Revoredo-Giha (2013)		Case study	Scotland's major pork supply chains	Network		• Supply risks in the network	• Quality	• Demand risks in the network			
Ledwoch *et al*. (2018)	Agent-based modeling	Modeling		Network		• Supply disruption risk					
Lei *et al*. (2019)	Complex network theory	Modeling		Network		• Supply risks in the network					

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Levalle and Nof (2015)	Collaborative control theory	Modeling		Network		• Quality of service for buyer					
Li *et al*. (2019)	Graph theory	Modeling		Network		• Supply disruption propagation					
Lima *et al*. (2018)		Literature review		Dyadic		• Counterfeit risks of falsified medicines					
Liu *et al*. (2018)	Resource-Based View	Survey	Taiwanese liner shipping companies	Dyadic	• Disaster risks (war, terrorism, etc.) • Regulatory risk	• Counterfeited medicines		• Demand risk	• Information or communication systems interruption		• Ship shutdown • Road infrastructure destruction or interruption
Lorentz *et al*. (2016)		Survey	Manufacturing, trading and logistics service provision in Finland	Network		• Supply risk for buyer					
Manhart *et al*. (2020)	Resource dependence theory, information processing theory	Literature review		Network, dyadic		• Supply disruption risk					
Mishra *et al*. (2016)	Resource dependence theory, social exchange theory	Survey	Indian manufacturing firms	Dyadic		• Supplier issues: quality problem, delivery problem and supply disruption					
Namdar *et al*. (2017)		Modeling		Network		• Supplier risk					
Oliveira and Handfield (2017)	Enactment Theory	Survey	Firms in North America and Brazil	Dyadic		• Supply disruption risk					
Raghunathan (1999)		Modeling	Model with a manufacturer and two independent non-competing retailers	Network		• Inventory shortage risk					
Rajesh *et al*. (2015)	Grey theory	Case study	Electronic companies in India	Dyadic		• Supply risks for buyers					
Rasouli (2018)		Literature review		Network, dyadic	• Enviromental disaster						
Revilla and Saenz (2017)		Survey	Data from 69 countries	Dyadic	• Hazard • Recession	• Supply disruptions	• Labor risks • Product quality	• Sales collapse		• Price collapse • Currency	• Carrier failure
Ritchie and Brindley (2007)	Agent-based	Case study	UK agriculture equipment manufacturer, and one of the top-three UK construction companies	Dyadic		• Quality risks for buyer		• Uncertainty risk for supplier: future contracts guarantee from buyer			

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Rudolf and Spinler (2018)	Grounded theory	Survey	Large scale engineering and construction projects	Dyadic	• Law and regulations • Standards and codes • Natural events	• Supply performance, operations, experience, and expertise • Contractual terms and conditions • No mindset of "pain/gain sharing" • Opportunism risks from supplier		• Planning and forecasting	• Communication		Supply chain configuration
Sá *et al* . (2019)		Case study	Brazilian agri-food supply chains	Network	• Drought						
Sambasivan *et al* . (2013)	Transaction cost theory, resource-based theory, contingency theory, social exchange theory, and Kelley's personal relationship theory	Survey	Malaysian companies from diferent manufacturing industries	Dyadic		• Opportunistic behaviors from supplier		• Opportunistic behaviors from buyer			
Sawyerr and Harrison (2019)	High reliability theory	Literature review		Network, dyadic	• Disaster risk						
Scholten and Schilder (2015)		Case study	Food processing industry in the Netherlands	Dyadic	• Unexpected disruptive events	• Supplier-buyer dependency • Supply disruption	• Manufacturing disruption	• Supplier-buyer dependency • Demand disruption	• Informational disruption	• Investment by supplier or buyer to bond with other party • Financial disruption	• Transportation disruption
Scholten *et al* . (2014)	Network theory	Case study	The Voluntary Organisations Active in Disaster (VOAD) group in El Paso, Texas	Network	• Supply chain disaster risks						
Scholten *et al.* (2019)		Case study	Commercial service providers and manufacturers, non-for profit organizations	Dyadic	• Supply risk						
Sinha *et al* . (2004)		Case study	Aerospace with mutliple tiers	Network		Supplier risks: • Lead time fluctuation • Forecast inaccuracy • On-time delivery					
Smith *et al* . (2007)		Conceptual		Network					• Infrastructure breakdown or security risks for all partners embedded in IT networks		

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Statsenko *et al*. (2018)	Complex Adaptative System	Case study	South Australian mining	Network	• Economic downturns	• Supply disruption					
Stevenson and Cole (2018)		Conceptual	UK Economy	Network		• Risks of modern labor slavery		• Bad reputation in multiple echelons	• Information leakage in multiple echelons		
Stone and Rahimifard (2018)		Literature review	Agri-food	Network, dyadic		• Agri-food supply risks					
Subramanian *et al*. (2015)	Social control theory	Survey	Chinese manufacturing sector	Dyadic	• Human, political and societal complexities • Cultural differences • Laws	• Supply risk • Quality issues for buyer	• Lack of knowledge	• Demand volatility		• Price erosion	
Sun *et al*. (2012)	Agent based model	Modeling		Network		• Bankruptcy propagation risks emanating from suppliers		• Bankruptcy propagation risks emanating from customers			
Tan *et al*., 2019	Graph theory	Modeling	Singaporian manufacturing (computers, perfumes, cosmetics, toilet preparations)	Network		• Supply disruption					
Todo *et al*. (2015)		Survey	Japanese earthquake	Network	• Earthquake						
Touboulic *et al*. (2014)	Resource dependence theory	Case study	UK food company/food sector	Network		• Horizontal relationships amid suppliers: risks to the advantage of the dominant partner (suppliers) • Sustainability-related risk for buyers				• Unequal sharing of sustainability investments	
Tse and Tan (2011)		Case study	Toy manufacturing company in China	Network		• Visibility of quality risks of raw materials in any tier of the supply network	• Manufacturing processes in any tier of the supply network				
Tse *et al*. (2018)	Agency theory	Survey	Chinese manufacturers	Dyadic			• Manufacturing quality risk				
Tse *et al*. (2019)	Agency theory	Survey	Chinese manufacturers	Dyadic		• Supply quality risk					
Tukamuhabwa *et al*. (2015)	Complex adaptive systems	Literature review		Dyadic		• Supply disruption when single sourcing					

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Urciuoli *et al*. (2014)		Case study	Oil and gas	Network, dyadic	Security risks: • Piracy • Terrorism • Political instability/conflicts	• Buyers' loss of power (e.g. less advantageous contracts) • Continuous replenishment risks • Over-dependency on few suppliers					
Vlajic *et al*. (2012)		Case study	Meat processing industry in the Netherlands	Dyadic		• Supply risks for buyers					
Wagner and Silveira-Camargos (2012)		Case study	14 car-manufacturing plants located in Germany	Network		• Supply-side risks for buyer					
Waters-Fuller (1995)		Literature review		Dyadic		• Dependence for the buyer • Supply disruption for buyer when sole sourcing				• Increased suppliers investment risks	
Wiengarten *et al*. (2016)		Survey	Plants from 19 countries in Europe, Asia and North America	Dyadic	• Weak rule of law (i.e. high risk) environments						
Yang *et al*. (2018)		Survey	Maritime sector	Dyadic		• Partner relationship management (selection of low risk partners)	• Human, and facitlity management		• Information management		• Cargo management
Zeng and Yen (2017)	Resource-based view and transaction cost theory	Modeling		Network		• Supply commitment risk • Sole sourcing risk • Inventory shortage risk • Material quality risk • Late to market risk	• Manufacturing stoppage risk • Strike risk	• Flawed co-forecasting risk • Finished goods shortage risk			• Logistics disruption risk
Zhang *et al*. (2011)		Modeling		Dyadic					• Leakages to rivals for suppliers and buyers		

Authors	Theory used	Methodology	Industry/context	Unit of analysis	Macro risks	Micro risks					
									Infrastructural risks		
					Environmental	Supply	Manufacturing	Demand	Informational	Financial	Transportation
Zhang *et al*. (2018)	Domino effect (Hertz 1998)	Survey	Chinese automotive-related companies	Network		• Supplier's disruption risk (quality, cost, delay, relation break out) • Distributor's market risk (quality of customer service decreases, delivery to customers is not timely)	• Manufacturer's production risk			• Distributors' financial risk (capital and/or budge) • Manufacturer's financial risk (inventory, exchange rate, production cost)	• Distributors' logistics risk (transportation planning and optimization)
Zhao *et al*. (2013)		Survey	Manufacturing plants in ten countries from three industries	Dyadic		• Supply delivery risk		• Demand variability risks			
Zhao *et al*. (2019a)	Complex adaptive systems	Modeling	Aerospace: Boeing	Network		• Supply disruption					
Zhao *et al*. (2019b)		Public dataset		Dyadic				• Supplier bullwhip effect			

APPENDIX A.3 - Updated SLR using papers from February 2020 to June 2024

Paper 1 is a literature review that was published in 2021. It used articles that were published in and before February 2020. Being a part-time student, this thesis is being submitted in 2024. As such, this appendix is a needed attempt to update the SLR/Paper 1 that consolidates the literature between February 2020 and June 2024.

1. Research methodology and descriptive findings

1.1 Locating relevant articles

Following the same SLR protocol delineated in Paper 1, relevant articles were found in the following databases: EBSCO, ABI/Inform, and Scopus. The same set of keywords around collaborative interorganizational relationships and supply chain risks was determined (see research string in **Table 2-1**).

1.2 Studies selection and assessment process

Paper 1 is a literature review with papers from 1995 to February 2020. This updated literature review targets abstracts, titles, and keywords in scholarly articles written in English in the Business and Management field, from February 2020 to June 2024. The same research string used in Paper 1 returned 3,278 unique articles across all databases. Subsequently, the abstracts of the 3,278 articles were read. Out of the 3,278 papers, 752 were selected based on abstract appropriateness. Then, the trusted journal quality rating published by the Chartered Association of Business Schools (CABS) in 2021 was used. Due to the high number of articles, quality consideration, and effort to render the search more replicable, 214 articles with a quality rating of 3, 4, or 4* were selected out of the 752 papers. The 214 articles were fully read and screened meticulously for qualitative, methodological, and contribution eligibility (Miles and Huberman, 1994). Finally, 132 articles were kept. The process described is in **Figure A3**.

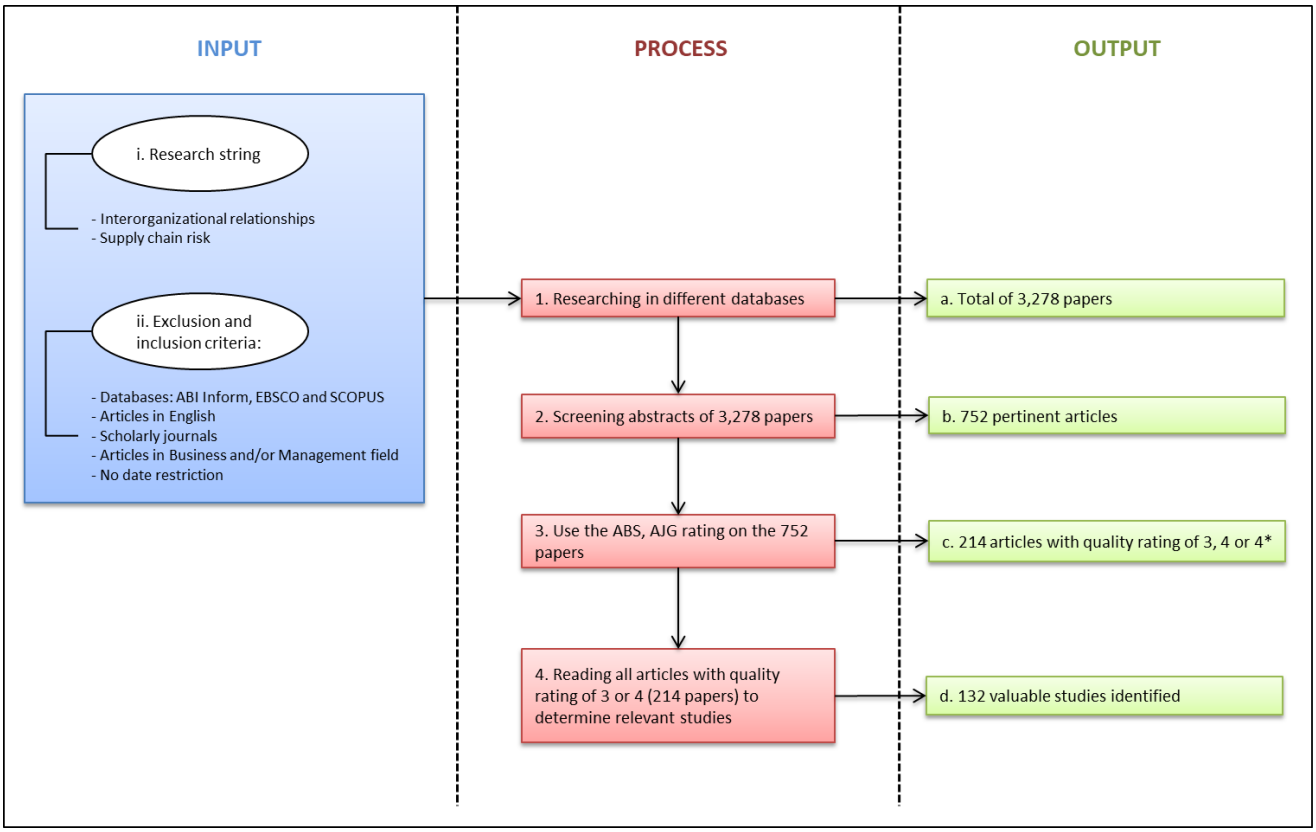

Figure A3. Studies selection process flowchart

1.3 Data extraction and synthesis of the selected studies

1.3.1 Descriptive analysis

20 unique journals with CABS rating of three or more were found from the 132 articles collected **(Table A3)**. Six journals represented about 64% of the sample. *Supply Chain Management: An International Journal* came at the first position (i.e., 27 articles), while *International Journal of Operations and Production Management*, and *International Journal of Production Economics,* shared the second position with the same number of articles (i.e., 15 papers each). At the third position, *IEEE Transactions on Engineering Management*, *Journal of Business Research*, and *Production Planning and Control* shared the same number of articles (i.e., 9 papers each).

Journal	# of Papers	%
Supply Chain Management: An International Journal	27	20.5%
International Journal of Operations and Production Management	15	11.4%
International Journal of Production Economics	15	11.4%
IEEE Transactions on Engineering Management	9	6.8%
Journal of Business Research	9	6.8%
Production Planning and Control	9	6.8%
International Journal of Production Research	8	6.1%
Journal of Purchasing and Supply Management	6	4.5%
Journal of Operations Management	5	3.8%
Technological Forecasting and Social Change	5	3.8%
Transportation Research Part E: Logistics and Transportation Review	5	3.8%
Business Strategy and the Environment	3	2.3%
Industrial Marketing Management	3	2.3%
Journal of Business Logistics	3	2.3%
Journal of Cleaner Production	3	2.3%
Annals of Operations Research	2	1.5%
Journal of Supply Chain Management	2	1.5%
British Journal of Management	1	0.8%
California Management Review	1	0.8%
Journal of Banking & Finance	1	0.8%
Total	**132**	**100.0%**

Table A3. Journals used for the updated SLR

Between February 2020 and June 2024, an abundance of work was published on the role of collaborative interorganizational relationships in supply chain risks. From a methodological standpoint, out of the 132 papers, 58 were surveys, 33 were case studies, 16 were public database-based, 9 were literature reviews, and the rest was a combination of simulations, fuzzy methods, and mixed methods. 41 papers dealt with COVID-19 related supply chain risks. All supply chain risks were discussed: environmental, supply, demand, manufacturing, transportation, informational, and financial. Diverse industries in different areas of the world (e.g., Africa, Australia, China, Europe, India, Malaysia, Turkey, UK, US) were probed, including aerospace, agri-food, automotive, construction, electronics, food, healthcare, retail, and textile. Theoretically, multiple theories were used such as complex adaptive system theory, complexity theory, dynamic capability theory, information processing theory, institutional theory, resource dependence theory, resource-based view theory, resource orchestration theory, social capital theory, and social exchange theory.

1.3.2 Thematic coding process

The findings of this updated SLR will be presented using the structure of Paper 1 (Daghar et al., 2021). Collaborative interorganizational relationships discussed in the recent literature will follow the social capital lens, while supply chain risks will be split between environmental, demand, manufacturing, supply, informational, transportation, and financial risks (Ho et al., 2015).

Social capital theory highlights that the sum of all resources associated with the network of relationships or social capital is critical in the management of social affairs. The theory aims at understanding the behaviors of individuals and groups at multidimensional levels (Nahapiet and Ghoshal, 1998) and has been lately used effectively in the supply chain and operations domains to explain supplier-buyer intricate relationships (Matthews and Marzec, 2012). Social capital consists of structural, relational, and cognitive dimensions. Social capital enables organizations to mitigate supply chain risks (Aslam et al., 2024). Collaborative relationships are divided into three categories consisting of structural, relational, and cognitive capital.

Structural capital refers to supplier-buyer practices and network-level configuration shaped by these practices (Carey et al., 2010). Supplier-buyer practices consist of buyer-led, supplier-led, and joint practices (Daghar et al., 2021). Relational capital refers to mutual respect, friendship, interaction level, trust, and reciprocity (Nahapiet and Ghoshal, 1998; Roden and Lawson, 2014). Cognitive capital refers to shared codes, languages, and narratives (Nahapiet and Ghoshal, 1998). This dimension helps to mitigate SCRs (Daghar et al., 2023), but in excess can become collectively blinding as group thinking can prevent buyers from developing innovative ideas to identify supply risks (Fan and Stevenson, 2018).

2. Findings

Specific collaborative interorganizational relationships reducing supply chain risks were discussed in the literature such as joint decision-making (Münch et al., 2022), information sharing (Gölgeci and Kuivalainen, 2020; Li et al. 2023; Sadeghi et al., 2024) or joint supply

chain risk management (Guerra et al., 2023; Pereira et al., 2020). Over the past four years, information sharing has been one of the elements of collaborative interorganizational relationships that saw the most drastic research focus with the examination of new enablers enveloped in the notion of Industry 4.0. Industry 4.0 is the integration of intelligent digital technologies into manufacturing and industrial processes to increase information sharing and optimize resource consumption, responsiveness, and human intervention (Brookbanks and Parry, 2024; Singh et al., 2023b). Industry 4.0 is composed of cloud computing, big data, artificial intelligence, simulation, ERP, business intelligence, blockchain, internet of things, autonomous vehicles, robotic, machine-to-machine, 3D printing, smart sensor, RFID, virtual reality, and augmented reality (Huang et al., 2023). Not as established before 2020 in the supply chain risk literature, joint sustainability, and eco-centricity practices became emerging interorganizational collaborative relationship elements with a proven positive influence on supply chain and environmental risks (Eggert and Hartmann, 2022; Laguir et al., 2023).

The operationalization of collaborative interorganizational relationships took also the form of multidimensional concepts such as external integration, bridging/buffering, and supply chain collaboration and coopetition. External integration and bridging/buffering strategies are externally focused idea-building relationships to coordinate activities and mitigate supply chain risks. External integration (Lin and Fan, 2024; Munir et al., 2020; Senna et al., 2023) includes sub-elements like information sharing, joint planning (Liu et al., 2024); trust (Giannoccaro and Iftikhar, 2020), and relational closeness (Jiang et al., 2023b). Bridging is about connecting and jointly working with partners. It encompasses information and resource sharing, relational closeness, joint planning, joint decision-making, relational closeness, and coopetition. Buffering is a philosophy aiming at buffering against supply disruptions via multiple sourcing and risk-mitigating inventory policies (Holgado and Niess, 2023; Spieske et al., 2022). The concept of supply chain collaboration includes sub-elements such as information sharing, business continuity plans, joint planning, joint decision-making (Michel et al., 2023; Shukla et al., 2022; Wu et al., 2023), joint problem solving (El Baz et al., 2023; Li et al., 2023; Huang et al., 2023). Supply chain collaboration enables partners to plan and execute supply chain operations toward common goals and mutual benefits (Um and Han; 2020; Nikookar et al., 2024b).

Enabling open-ended resource interactions across organizations instead of a limited internal focus, supply chain collaboration is a critical element in any strategy (Bygballe et al, 2023). It mitigates supply chain risks (Khayat et al., 2020; Kumar et al., 2021; Li et al., 2023; Nikookar et al., 2024b) such as sustainability-related risks emanating from their first and lower-tier suppliers (Kähkönen et al., 2023). Supply chain collaboration enables groups to come together to alleviate disruptions (Bharat et al, 2024; Gebhardt et al., 2022; Sawyerr and Harrison, 2020; Scala and Lindsay, 2021) and develop agility (Poberschnigg et al., 2020) across industries like the humanitarian sector (Michel et al., 2023) or agri-food supply chains (Rosales et al., 2020; Zhao et al., 2023a). Supply chain collaboration reduces the risks and uncertainties in circular supply chains (De Lima and Seuring, 2023) and is essential to fostering real-time information sharing and visibility (Singh et al., 2023a), and building antifragility (Nikookar et al., 2024b). Coopetition is cooperation/collaboration between competing companies. It consists of joint problem-solving, information sharing, joint decision-making, and cost-sharing (Durach et al., 2020). Coopetition can be beneficial in alleviating turbulence (Massari and Giannoccaro, 2021). In fact, coopetition between two first-tier suppliers increases the first-tier supplier's capability to be resilient to disruptive events emanating from a lower-tier source (Durach et al., 2020).

2.1 The role of collaborative interorganizational relationships' structural capital in supply chain risks

Structural collaborative interorganizational relationships impacting supply chain risks remained similar before 2020 and after 2020. Lately, the new collaborative practice of joint sustainability effort appeared, while industry 4.0 sub-elements rose to enable the collaborative practice of information sharing.

2.1.1 Buyer-led and supplier-led practices interplay with supply chain risks

Buyer-led practices include supplier development, supplier performance management, strategic outsourcing, multi-sourcing, sole-sourcing, and single-sourcing (Daghar et al., 2021).

The buyer-led practices of selecting, managing, and developing suppliers are key in managing potential buyer supply risks (Ngo et al., 2024). Supplier performance experienced by the buyer is negatively related to supply disruption frequency, duration, and intensity (Burkhart and Bode, 2024). Managing suppliers can reduce environmental hazard risks (Ngo et al., 2023), and is a more predictive than reactive strategy (Shishodia et al., 2020)

The buyer-led practices of nearshore outsourcing and multi-sourcing reduce supply-related ambiguities (Van Hoek and Dobrzykowski, 2021; Shishodia et al., 2020). Buyers that select geographically close suppliers tap into robust supply chain networks able to compress lead times (Sytch et al., 2022). In a case study and simulation, Huq et al. (2020) find that insource/nearshore outsourcing strategies offset the benefits of low-cost production outsourcing/offshoring strategies because of the high total cost of acquisition of distant operations and their hidden costs. According to Van Hoek (2020), COVID-19 put in perspective the need to balance global sourcing with nearshore and local sourcing using multiple sources and information technology to leverage better immediate information availability. Building up inventories and using alternative suppliers are instrumental contingencies during peak demand and crisis that enable faster recovery processes (Van Hoek, 2021; Singh et al., 2023a). During a supply disruption, buyers with a diversified supply base can increase their inventory availability and profitability (Lin et al., 2021). In fact, multi-sourcing generates a higher profit net present value than single-sourcing when a supply chain disruption occurs (Gaur et al., 2020). Buyers need to balance their multi-sourcing strategies and find the right number of suppliers as supply concentration has an inverted U-shaped effect on organizational resilience. Indeed, multi-sourcing allow for contingency plans, but supply concentration minimizes supply risks through tight-knit buyer-supplier relationships and a bolstered resource base (Ren et al., 2024).

Supplier-led practice is linked to customer portfolio management (Daghar et al., 2021). The supplier-led practice of customer portfolio management significantly reduces the risk of both demand and supply disruptions, particularly when customers are great in range and geographies (Cagri et al., 2023). During COVID-19, the effect of supply chain

disruptions on financial performance and risk was lower for suppliers with a higher customer diversification level (Wang et al., 2023). Customer concentration impacts supply chain risks differently depending on the disruption phase. For example, suppliers with a concentrated customer base performed worse during the first year of the COVID-19 pandemic when disruptions were significant. During this disruption, suppliers with low customer concentration managed their supply chain risks more effectively, resulting in higher operating performance than their benchmark firms (Jiang et al., 2023a, Park et al., 2024). However, during the recovery phase of COVID-19, firms with concentrated customer bases could collaborate more effectively with major customers, improving operating performance. (Park et al., 2024).

2.1.2 Joint practices' interrelationships with supply chain risks

Joint practices encompass information and knowledge sharing, joint supply chain risk management (SCRM), joint planning, joint problem-solving, best practice sharing, co-location, joint decision-making, and contract (Daghar et al., 2021).

Environmental challenges raise information processing needs (Jat et al., 2023). Information sharing is instrumental in mitigating supply chain risks (Harju et al., 2021; Lemke et al., 2024). However, a balance between too much and not enough information sharing is necessary in certain circumstances. For example, Zheng et al. (2024) discovered that there is an inverted U-shaped relationship between supply chain transparency and idiosyncratic risks linked to exposure of competitive insights and reputational damage affecting financial stocks. Overall, information sharing emphasizes the creation of shared interpretation (Yu et al., 2022), which is vital in shared understanding and problem-solving. Information sharing is key in the development of organizations with a high number of suppliers in need of decision-making velocity such as JD.com (Shen and Sun, 2021). Real-time information positively influences the management of supply chain risks (Akhtar et al., 2022; Esfahbodi et al., 2023) in all industries. As buyers strengthen relationships and exchange data with their suppliers, they can access relevant information that detects and diagnoses supply disruptions effectively, improving inventory turnover (Pandey et al., 2022). Investigating the Dutch

national railway critical infrastructure industry, Van den Adel et al. (2021) find that an increase in cross-boundary information exchange between organizations inside the network can help cope with large-scale disasters (Van den Adel et al., 2021). Indeed, information sharing creates supply chain transparency, which drives knowledge creation and mediates the relationship between a firm's risk management and responsiveness (Morgan et al., 2023). Transparent information-sharing schemes mitigate the informational risks and uncertainties inherent in information flows (Bak et al., 2023) and help companies jointly make appropriate decisions alleviating supply chain risks (De Lima and Seuring, 2023; Faruquee et al., 2023; Qi et al., 2023). Through government coordination via integration of production, distribution, and sales during COVID-19, information sharing enabled the Taiwanese medical mask industry to create supply chain visibility, flexibility and velocity palliating against supply and demand risks (Li et al., 2023).

Information sharing and supply chain visibility are foundational resources for digital capabilities (Ivanov, 2024), notably in the healthcare (Tiwari et al., 2024), food (Sezer et al., 2024) and manufacturing sectors (Gu et al., 2021). Lately, information sharing has been seen to reduce cyber risks (Sadeghi; Azadegan, 2023). Information sharing and joint SCRM allow for intra-and interorganizational communication and processing of risk relevant data, necessary to cope with cyber risks (Ghadge et al., 2020). The use of technology can facilitate information sharing and collaboration needed to fight supply chain risks (Harju et al., 2021; Luo et al., 2023a; Sharma et al., 2020; Ye et al., 2023). For instance, IT-based supply chain finance initiatives help service providers mitigate financial risks such as buyer-supplier financing costs (Lam and Zhan, 2021). During a crisis, supply chain digitalization can increase cost-effectiveness, enhance information and communication efficiency (Tiwari et al., 2024; Zhao et al., 2023b), and reduce the supplier's financial risk (Chen et al., 2024). Barcode, blockchain, DNA-based tech, IoT, isotopic tech, magnetic tracing, nano-capsules, RFID, and WSN are new digital traceability-based information sharing tools that improve supply chain risk awareness, proactiveness, trust, reliability and security, while facilitating real-time tracking and risk identification (Razak et al., 2021). Data-driven digital transformation has a positive impact on supply chain risk management (Papanagnou et al., 2022). Digitalization includes for example big data and industry 4.0. Big data predictive analytics can improve information

sharing, visibility, and disruption coping mechanisms (Bag et al., 2022; Belhadi et al., 2022). Industry 4.0 encompasses IoT, blockchain tech, and ML technologies positively impacting supply chain operational and financial performance (Qader et al., 2022), data availability (Birkel and Hartmann, 2020), and supply chain risk management (Centobelli et al., 2023; Qader et al., 2022; Nakandala et al., 2023; Senna et al., 2023; Singh et al., 2023a Zelbst et al., 2024).

Knowledge management supports supply chain risk management (Waqas et al., 2022). Knowledge management includes knowledge sharing, which is a form of joint practice in which partners share information, processes, skills, and expertise. This practice can help alleviate supply chain risks (Heldt and Beske-Janssen, 2023; Junaid et al., 2023; Lusiantoro et al., 2022) and build robust supply networks through tacit knowledge creation and exchange (Scholten et al., 2023). For example, in the smartphone industry, knowledge-sharing routines and governance mechanisms based on social-welfare logic reduce forced labor risks in the extended upstream supply chains (Vanpoucke and Klassen, 2023).

The higher the supply chain risks, the more likely it is that a firm will engage in supply chain risk management (Waqas et al, 2022). Joint supply chain risk management mitigates supply chain risks (Guerra et al., 2024). Supplier-initiating risk management behavior can reduce supply-side risks (Fan et al., 2020). Effective risk management enables supply chain visibility and flexibility, which are critical to anticipate and prepare for disruptions (Statsenko et al., 2023) such as cyber risks (Ghadge et al., 2020)

Joint planning mitigates supply chain risks (Rajani et al., 2022). For example, collaborative planning, forecasting, and replenishment (CPFR) is a well-known joint planning practice that anticipates demand, and plans supply accordingly to avoid supply and demand risks (Wang and Zhao, 2022). Predictive emergency planning is another joint planning practice that positively moderates the relationship between data-driven digital transformation and supply risk (Papanagnou et al., 2022). The integration of buyer-supplier e-commerce platforms in terms of planning and logistics has positive impacts on supply chain risk management (Qi et al., 2023). Indeed, recently, AI-based joint-planning

tools at JD.com have exhibited high levels of collaboration, information sharing, demand risk mitigation, and agility (Shen and Sun, 2023).

Joint problem-solving and joint decision-making improve routine and extraordinary risk management capabilities (Li et al., 2023), which can be highly valuable to manage supply chain risks (Faruquee et al., 2021). Joint decision-making is an antecedent for recovery strategy (Yaroson et al., 202) and can aid in the development of resilient supply chains (Sawyerr and Harrison et al., 2020). In fact, joint decision-making velocity with suppliers, particularly, is an important capability to quickly respond to changing environments. (Münch and Hartmann, 2022)

Contractual governance has a positive effect on supply chain risk mitigation. Supply chain collaboration plays a mediating role between contractual governance and supply chain risk alleviation (Wu et al., 2023). Companies use transactional (contract) governance mechanisms to learn from past incidents, anticipate, and respond better to supply chain piracy threats, becoming more resilient over time (Freitas et al., 2023).

2.1.3 Interaction between network-level configuration and supply chain risks

The network-level configuration includes supply-base complexity (i.e. supplier differentiation, number of suppliers, and supplier interaction levels); and the overall network structure or scale-free network structure (Daghar et al., 2021).

The structure of supply networks in collaborative interorganizational relationships influences the management of supply chain risks. For example, the relationship between trust and risk management is moderated by the network topology. Indeed, trust is beneficial in local, small-world, block-diagonal, and random supply topologies. However, in centralized, diagonal, and hierarchical topologies, trust only helps lessen supply chain risks at a moderate level (Giannoccaro and Iftikhar, 2020).

Certain types of supply networks handle supply chain risks differently. Examples of these networks are circular networks involving supply returns. Disruptions inside circular flows have a greater ripple effect than those occurring outside circular flows (Park et al., 2021). However, in some circumstances, circular networks are more resilient. In fact, Scheller et

al. (2023) show in a simulation and case study of multiple European automotive companies that circular factories outperform resiliently all network structures in the short term due to the in-house production of batteries and short transportation distances.

Network characteristics can explain supply risk propagation better than network type (i.e., random, small-world, scale-free) and average degree. Decision-makers need only focus on a few selected influential key characteristics such as the collinearity impact (Li et al., 2020), the firm's clustering coefficient, the firm's structural holes (Luo et al., 2023b) or supply chain complexity (Ali et al., 2023). Supply chain complexity consists of the number of suppliers, the number of customers, and the supplier geographical dispersion (Iftikhar et al., 2024) Supply chain complexity has a direct, positive influence on supply chain risk (Iftikhar et al., 2024), and negatively moderates the influence of interfirm social capital on the management of extreme events (Ali et al., 2023). A buying firm experiences a greater disruption impact when supply complexity and product complexity are higher (i.e., larger number of suppliers and parts). A buying firm experiences an enhanced disruption recovery when supply complexity and logistics complexity are higher (i.e., larger number of suppliers and a larger number of carriers upstream) (Wiedmer et al., 2021). Thus, the number of suppliers and their dispersion impact risk management. Indeed, the greater the number of direct and indirect relationships connected to a firm, the longer the time to recover from disruption at the firm's site. Also, the greater the supply chain echelon distance between a firm's site and the OEM, the longer the time to recover from a disruption at the firm's site. In fact, a greater number of direct and indirect relationships connected to a firm's site has an inverse-U relationship with the recovery time of the firm (Guntuka et al., 2024). From a business continuity perspective, supplier differentiation in terms of response diversity was found to be more positively associated with the maintenance of food sales than supplier differentiation in terms of supplier type diversity (Kahiluoto et al., 2020).

2.2 The role of relational capital in supply chain risks

Relational capital refers to mutual respect, friendship, interaction level, trust, and reciprocity (Nahapiet and Ghoshal, 1998; Roden and Lawson, 2014). Relationship

closeness covers what Nahapiet and Ghoshal (1998) called mutual respect, friendship and interaction level. Trust is a partner's threshold level of risk-bearing capacity (Laeequddin et al., 2009) and reciprocity alludes to shared risks and benefits.

Strong social connections among the actors can inherently reduce supply risks (Aslma et al., 2024; Umar et al., 2023). Personal relationships and relational closeness mitigate supply chain risks (Nikookar et al., 2024a). For example, SMEs' ability to mitigate climate risks highly depends on social capital through relational investments (Ali and Gölgeci, 2021). Relational commitment and reciprocity positively affect risk-based communication quality, which positively impacts supply chain risks (Saglam et al., 2022). Buyer's risk-reward sharing-based procedural justice is positively related to suppliers' internal social performance, which can diminish supply operational risk (Alghababsheh et al., 2023). Thus, relational governance can help reduce supply risks (Wu et al., 2023), but only to a certain extent. In fact, tightly coupled supply chains based on strong relationships can be vulnerable. They often limit the flexibility of the supply network (Statsenko et al., 2023).

Trust is a main supply chain risk mitigation strategy (Abushaikha et al, 2021; Pereira et al., 2020; Najafi-Tavaniet al., 2022) and is highly valuable to develop agility (Poberschnigg et al., 2020). When trustworthy information is communicated and shared among trading partners, they can rely on jointly developed procedures minimizing vulnerabilities to quickly recover from supply chain disruptions (Patel et al., 2022; Singh et al., 2023b; Yu et al., 2022). Yaroson et al. (2021), show that in Pharmaceutical supply chains, the absence of trust reduces supply chain partners' satisfaction and as such increases the potential for conflict, which can limit information sharing and the ability to plan and respond promptly.

2.3 The role of cognitive capital in supply chain risks

Cognitive capital refers to shared codes, languages, and narratives (Nahapiet and Ghoshal, 1998). Shared codes and languages are means through which people discuss and share information. They are mechanisms organizing sensory data via perceptual categorization, establishing a frame of reference to examine and interpret the environment (Nahapiet and Ghoshal, 1998). Examples of shared codes and languages

are shared goals, vision, cognition, ambition, training understanding sector jargon (Daghar et al., 2023). Shared narratives are myths, stories, and metaphors providing, creating exchanging, and preserving rich sets of meanings (Nahapiet and Ghoshal, 1998). Examples of shared narratives are prior disruption experiences, shared culture, identity, norms, values, philosophies, or management styles (Daghar et al., 2023).

To minimize supply risks, supply chain leaders are urged to establish and communicate management goals to suppliers by treating suppliers' problems as their own, while sharing values of common interests, respect, trust, and obligations to help supply chain disruption mitigation capabilities. Overall, shared goals and values instill pride in suppliers through respect and trust and establish a standardized or obligatory level of communication needed to manage risks (Shin and Park 2021).

Past experiences shape cognition and prepare individuals for another disruption. Supply chain memory consisting of past disruption experiences and shared knowledge reduces significantly supply risks. Interestingly, the late increase in digital technology utilization is drastically impacting supply chain memory and thus risk management (Alvarenga et al., 2023).

Leadership style is a cognitive capital element (i.e. shared narrative) that influences the way supply chain risks are managed (Daghar et al., 2023). For example, transformational leadership is based on idealized influence, inspirational leadership, intellectual stimulation, and individualized consideration, while the transactional leadership style revolves around contingent rewards and management by exception. A customer's transformational and transactional leadership affects a supplier's trust, which influences the supplier's relational flexibility and specific investments mitigating supply disruptions (Verghese et al., 2022).

Corporate culture is another shared narrative that can impact supply chain risk management. Risk management culture is positively associated with firm risk reduction (Ali et al., 2023). Cultural supplier-supplier and supplier-customer similarities reduce communication costs, foster altruistic behavior, and strengthen mutual trust, ultimately leading to improvements in supplier cost efficiency, investment, and innovation (Ding et

al., 2024). With the late rise of digital-based informational risks, information security culture is instrumental to mitigate information leakage and foster effective information sharing (Wong et al., 2023). Digital organizational culture has positive effects on both absorptive capacity and supply chain risk-coping mechanisms (Rodríguez-González et al., 2023). National culture also impacts how supply chain risks are managed. For instance, in agrifood supply chains, hierarchical cultural orientation (e.g., China) generates sense-making and collectiveness and further leads to synergy across all stakeholders, thereby contributing to supply chain response and recovery. Under an egalitarian cultural orientation (e.g., Spain) that places self-interest ahead of group goals, organizations are encouraged to make decisions based on their situational understanding, which contributes to their response and recovery (Zhao et al., 2024).

3. Discussion and Conclusion

Overall, the literature on collaborative interorganizational relationships in supply chain risks has progressed after February 2020 compared with what was found in Paper 1, prior to February 2020. Indeed, the literature rightly identifies the new themes of industry 4.0, joint sustainability efforts, COVID-19 effects, and new inverted U-shaped relationships between collaborative interorganizational relationships and supply chain risks.

Information sharing is the element of collaborative interorganizational relationships that was the most researched in the 132-paper sample used in this updated SLR. New information-sharing enablers were discussed through the concept of industry 4.0, with digital technologies including big data, artificial intelligence, blockchain, internet of things, and augmented reality (Huang et al., 2023). Influencing positively supply chain and environmental risks, joint sustainability and eco-centricity practices became emerging interorganizational collaborative relationship elements in the literature (Eggert and Hartmann, 2022; Laguir et al., 2023). Tools and processes mitigating COVID-related supply chain risks were highly discussed in the literature with a total of 31% of papers considering COVID-19 risks. COVID-19 highlighted the need to balance global sourcing with nearshore, and local sourcing using multiple sources and information technology to accelerate information sharing (Van Hoek, 2020). The recent literature unearthed a few

inverted relationships between collaborative interorganizational relationships and supply chain risks. Indeed, there is an inverted U-shaped relationship between supply chain transparency and idiosyncratic risks because of the exposure of competitive insights and reputational damage affecting financial stocks (Zheng et al., 2024). Also, from a supply network perspective, a greater number of direct and indirect relationships connected to a firm's site has an inverse-U relationship with the recovery time of the firm (Guntuka et al., 2024).

From a research agenda standpoint, Paper 1 suggested the use of social capital theory to study the role of supply chain collaboration in supply chain risks, and highlighted how limited research on cognitive capital's operationalization and connections with supply chain risks is. Paper 1 invited researchers to map focal firms' supply networks with information collected from both buyers and suppliers instead of only reporting buyers' perspectives as mostly seen throughout the literature. Papers 2 and 3 are answers to these calls from Paper 1 that the literature has not probed. Paper 2 examines cognitive capital thoroughly in a case study and attempts to grasp how cognitive capital elements impact SCRES preparedness, responsiveness, recovery, and learning. Paper 2 calls for research on the cognitive capital element of culture and its interrelationships with SCRES' most cited enablers (i.e., collaboration, flexibility, visibility, velocity) (Jüttner and Maklan, 2011). Paper 2 also suggests the same supply network mapping discussed in Paper 1, with data collected from both suppliers and buyers during a disruption. Paper 3 answers this call by investigating the role of interorganizational culture in SCRES at the multi-tier supply network-level. Although the number of papers adopting a supply network view has increased in the literature, the differences between how buyer-led networks build SCRES and how supplier-led networks build theirs remain underexamined. The supply chain literature can still benefit from different perspectives of analysis as suggested in Paper 2, notably with the social network analysis, social psychology lenses, or multi-level studies examining the ramifications of both individual and organizational levels (Lumineau and Schilke, 2018). As proposed in Paper 3, an interesting area of investigation for future work is the connections between interorganizational cultural elements through large-scale survey data. Additionally, understanding what triggers supply networks to transition from culturally aligned to misaligned or vice versa and why is essential to understand how

resilient supply networks are formed and work. Another appealing research topic is how the embeddedness of cultural elements in social capital can influence SCRES.

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3. The role of cognitive capital in supply chain resilience: an investigation during the COVID-19 pandemic

Abstract

The role of cognitive capital in supply chain resilience: an investigation during the COVID-19 pandemic

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Abstract

Purpose – Research on the "black box" of cognitive capital remains limited in supply chain resilience (SCRES) literature. Drawing from an in-depth single case study of a major consumer electronics multinational facing the COVID-19 disruption, this paper aims to develop a clearer picture of cognitive capital's elements while contextualizing how they interact with SCRES temporal capabilities to prepare, respond, recover and learn.

Design/methodology/approach – Consisting of 40 in-depth interviews collected during a four-month period, this single case revolves around the buyer's view across 36 multiregional buyer–supplier dyads, spanning 17 product and service categories. Data were processed during the pandemic, while findings discuss pre- and intra-crisis events based on two scenarios: the impact of disruption on category demand, comparing sudden pandemic-driven product and service demand fluctuations (i.e. increase, decrease); and the geographical proximity of the supplier relative to the buying firm.

Findings – The case unveils different elements of cognitive capital (e.g. shared goals, assumptions, values, kinesics language, multilingualism, virtual negotiation, prior disruption experience, shared process capabilities) during a major global disruption, suggesting that different cognitive capital elements influence positively and differently SCRES' temporal capabilities. Overall, buying firms are urged to build on cognitive capital to improve SCRES preparation, response, recovery and learning.

Originality/value – This paper extends the understanding of cognitive capital in buyer–supplier relationships by identifying its elements and offering a theoretical articulation of how they enable episodically the four SCRES temporal capabilities under contingencies of increased and decreased demands, and suppliers' geographical proximity.

Keywords Supply chain resilience, Social capital, Cognitive capital, Buyer–supplier relationships, Interorganizational relationships

Paper type Research paper

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3.1 Introduction

Given the growing number of disruptions and players immersed in global supply chains, firms are increasingly looking to develop supply chain resilience (SCRES) or the adaptive ability to prepare for, respond to, recover from, and learn from turbulences (Hendry et al., 2019). However, the increasing number and the geographical dispersion of actors involved in the design and delivery of products and services have demanded firms move beyond their organizational boundaries and engage and invest in relationships with various external upstream and downstream actors to achieve SCRES (Christopher and Peck, 2004; Scholten and Schilder, 2015). Previous studies have investigated the role of collaborative interorganizational relationships, and the social capital embedded within or available through these relationships in driving SCRES (Ali et al., 2017; Daghar et al., 2021; Johnson et al., 2013).

Drawing on the three key facets of social capital suggested by Nahapiet and Ghoshal (1998) in their seminal work, operations, and supply chain management scholars have highlighted the importance of structural, relational, and cognitive capital in driving SCRES (Daghar et al., 2021). For instance, research has highlighted the role of structural capital with shared routinized practices such as information sharing, joint decision-making, and joint planning (e.g., Jain et al., 2017; Scholten and Schilder 2015), but also the structure of interactions (i.e., connectivity patterns/overall configuration of relationships) (Choi and Krause, 2006). Similarly, extant studies have examined the role of relational capital through closeness, reciprocity, and trust that parties develop in relationships (e.g., Jüttner and Maklan, 2011). Scholars have also increasingly recognized that meaningful collaboration requires the sharing of context, representations, interpretations, and meaning between parties (i.e., cognitive capital, Johnson et al., 2013). Manifested through shared codes and language, and shared narratives, cognitive capital provides a behavioral framework that can promote synergies and reduce friction among parties (Rossetti and Choi, 2005). Previous studies have suggested that interest harmonization using cognitive capital develops shared understanding and reduces buyer-supplier opportunism (Gittell, 2002), and hence supports collaboration, task completion (Inkpen and Tsang, 2005), and conflict resolution (Christopher and Lee, 2004; Johnson et al.,

2013). In their case study of the Grayrigg derailment, a fatal railway accident that occurred in Northwest England, Johnson et al. (2013) showed that the shared codes and language that exist among parties in terms of shared goals, key performance indicators, sector language, and past adaptive responses improved shared cognitions and identity, establishing rules of coordination and collaborative identification, and thus mitigating supply chain risks.

Despite the significance of cognitive capital in supply chain risk and resilience, the extant literature examining collaborative interorganizational relationships has largely focused on the structural capital and/or relational capital that exist in these relationships (Daghar et al., 2021). Where the supply chain risk and resilience literature has examined the role of cognitive capital, the focus has been predominantly on the four most cited mechanisms that enable SCRES (i.e., collaboration, flexibility, visibility, velocity, Jüttner and Maklan, 2011), overlooking the dynamics and temporal aspects of disruptions (Stone and Rahimifard, 2018). Additionally, recognized as the most challenging dimension to operationally separate from other social capital dimensions (Nahapiet and Ghoshal, 1998; Chowdhury et al., 2019; Krause, 2007; Villena et al., 2011), cognitive capital has remained an elusive concept requiring contextualization.

This study aims to investigate the 'black box' of cognitive capital in the context of supply chain disruptions. It further seeks to clarify and articulate how the cognitive capital that exists in interorganizational relationships can affect parties' ability to prepare for, respond to, recover, and learn from disruptions (i.e., SCRES temporal capabilities, Ali et al., 2017). Adopting an inductive case study approach in a buyer-supplier setting, this paper asks two specific research questions: (1) what is cognitive capital in the context of a supply chain disruption? (2) what is the role of cognitive capital in SCRES temporal capabilities? This study involves a major Japanese multinational electronics company and its dyadic relationships with 36 multiregional suppliers, spanning 17 product and service categories facing severe supply chain disruptions due to COVID-19 pandemic, which affected 95% of global supply chains in 2020 (van Hoek, 2020). The data were collected in 2020 in the US division of the company, four months after the COVID-19 started, allowing both pre- and intra- crisis episodical analysis which compares to the phased approach (i.e.,

mitigation, preparedness, response, recovery) used in the humanitarian supply chain literature (Helferich and Cook, 2002; Kovács and Spens, 2007; Natarajarathinam et al., 2009; Scholten et al., 2014).

This study contributes to supply chain risk and resilience and buyer-supplier relationships research in several ways. First, the paper extends the understanding of the role of the cognitive capital embedded in or available through a buying firm's relationships with suppliers in its SCRES by identifying its underlying relevant elements within a unique global supply chain disruption context resulting in fluctuations in both supply and demand. Second, this study extends the previous literature by unpacking the role of cognitive capital in the temporal SCRES capabilities observed to be at play as the disruption events unfolded. In particular, this study offers a theoretical articulation of how various aspects of cognitive capital enable the four SCRES temporal capabilities to prepare for, respond to, recover, and learn from disruptions. Third, the findings add to the existing research regarding the role of cognitive capital in SCRES by identifying two contingencies that affect the relationships between different aspects of cognitive capital and SCRES capabilities, namely 1) category demand, comparing sudden pandemic-driven product and service demand fluctuations (i.e., increase, decrease) (Chopra and Sodhi, 2004), and (2) the geographical proximity of suppliers relative to the buying firm (Choi and Krause, 2006).

3.2. Theoretical background

3.2.1 Cognitive capital in buyer-supplier relationships: definitions and conceptualizations

Critical in social affairs, social capital is defined as “the sum of the actual and potential resources embedded within, available through and derived from the network of relations possessed by an individual or social unit” (Nahapiet and Ghoshal 1998, p.243). Social capital theory postulates that the access to and use of resources embedded in social networks can lead to a better social and economic return (Granovetter, 1992; Lin, 1999). As a set of resources rooted in relationships, social capital has many facets. Nahapiet and Ghoshal (1998) recommend considering the different facets of these resources in terms of 1) structural, 2) relational, and 3) cognitive capital. Structural social capital has been predominantly characterized in terms of systems, routinized practices (e.g., information sharing, joint decision-making, joint planning), or regular patterns of interactions structuring interorganizational communication and joint actions (Carey et al., 2010; Lawson et al., 2007) by ways of both formal and informal methods (Roden and Lawson, 2014). Structural social capital deals with collaborative practices, but also the network-level configuration that they shape through connectivity patterns and the overall configuration of relationships (Choi and Krause, 2006). Relational capital refers to closeness, reciprocity, and trust developed in relationships (Daghar et al., 2021; Roden and Lawson, 2014).

Cognitive capital, the focus of this study, represents resources providing shared representations, meanings, and values (Daghar et al., 2021). Cognitive capital can be separated into two categories according to the view of Nahapiet and Ghoshal (1998), (1) shared codes and language, and (2) shared narratives (Figure 3-1). As a means through which individuals discuss and share information, shared codes and language organize sensory data through perceptual categorization and establish a framework enabling the examination and interpretation of the environment (Nahapiet and Ghoshal, 1998). As such, shared codes and language represent shared goals, shared key performance indicators, shared vision, shared absorptive capacity, shared task ownership, shared cognition, shared ambitions, standardization, shared curiosity, shared training (Fan and

Stevenson, 2018; Johnson et al., 2013; Tsai and Ghoshal, 1998), but also shared sector language (sectorial jargon) (Fan and Stevenson, 2018; Johnson et al., 2013). Shared narratives involve stories, myths, and metaphors (Nahapiet and Ghoshal, 1998) including shared approaches (Johnson et al., 2013). Accordingly, they comprise shared prior disruption experiences (i.e., past adaptive responses), shared identity (Johnson et al., 2013), shared corporate culture, shared norms (Inkpen and Tsang, 2005), national cultures (Gupta and Gupta, 2019; Manhart et al., 2020), shared company values, shared philosophies, shared business approach, shared capabilities, and shared management styles (Chowdhury et al., 2019, Villena et al., 2011). We detail these cognitive capital elements in Figure 3-1.

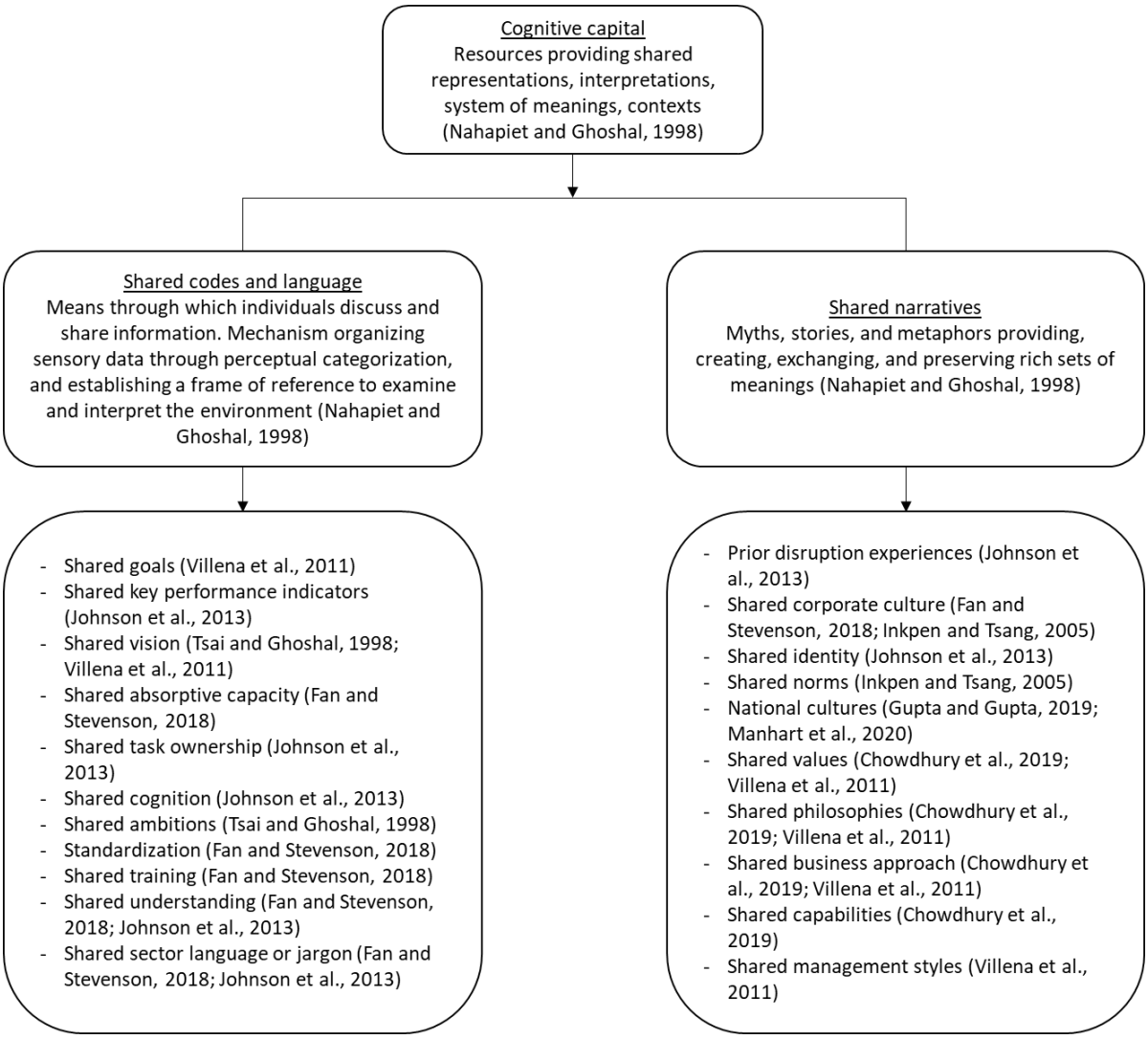

Figure 3-1 Cognitive capital's elements

Overall, cognitive capital's elements developed between actors enable the understanding of information and classification of categories. Through participative and continuous sense-making processes, cognitive capital develops shared understanding and ideas needed to frame the coordination of exchanges and shared thinking processes (Carey et al., 2010; Krause et al., 2006).

3.2.2 A temporal operationalization of SCRES

The notion of resilience has become increasingly salient over the last decades and is applied across a wide variety of disciplines from engineering, ecology, and economics, to social sciences. In the field of engineering, resilience is the ability of a system to absorb shock (maintain the status quo) or bounce back to an equilibrium state (Simmie and Martin, 2010). Drawing from the study of ecosystems, social systems, and the stability and change panarchy framework in the field of ecology, researchers examine how resilient systems recover from disruptions by developing adaptative cycle dynamics consisting of continual transformative reorganization, change adaptation, and regeneration (Adobor, 2020; Gunderson and Holling, 2002). The ecologist Holling (1973) brings to light the existence of multiple stability states in natural ecosystems where event randomness and diversity in temporal and spatial scales prevail. Thus, in social and ecological systems, resilience is about learning how to change, not by keeping the system in a constant state, but by exposing it to a full non-linear range of social and environmental variations to adapt (Walker 2020), learn and self-organize (Folke, 2006; Novak et al., 2021). In the supply chain literature, scholars have predominantly adopted an engineering view of resilience, emphasizing the system's ability to bounce back to an equilibrium state (Sheffi and Rice, 2005). However, in recent years, some supply chain researchers have begun to re-examine this view. Indeed, the perception of one equilibrium state confines supply chain in a fixed state and does not consider the disruption as an opportunity to metamorphose (Wieland and Durach, 2021). In fact, SCRES is the ability to constantly adapt, evolve, and transform to respond to the dynamic multiscale feedbacks existing between organizations, and social and ecological systems (Novak et al., 2021). Drawing on complex adaptive systems, scholars have further introduced the notion of growth in the face of turbulence (Day, 2014), which is enabled by post-disruption learning (Hendry

et al., 2019) and is consistent with the resilience view of adaptation, transformability (Walker, 2020; Wieland and Durach, 2021), as well as antifragility (i.e., going beyond resilience by embracing and learning from a disorder rather than avoiding it) (Nikookar et al., 2021; Taleb, 2012).

Coping with supply chain risks and operational difficulties (Turner et al., 2018), SCRES strategies consist of proactive and reactive approaches (Chowdhury and Quaddus, 2016; Dabhilkar et al., 2016; Turner et al., 2020). The proactive strategy detects the crisis pre-disruption (beforehand), while the reactive strategy repairs the consequences of a disaster or crisis (Grötsch et al., 2013) intra- or post-disruption (during or after the event) (Figure 3-2). As a result, the SCRES proactive strategy is enabled by the SCRES capability to prepare through plan development and implementation. SCRES reactive strategy is enabled by three SCRES capabilities. The first is to respond by evaluating risks and implementing response plans; the second is to recover by resuming or maintaining operations continuity while improving (Hendry et al., 2019; Johnson et al., 2013; Jüttner and Maklan, 2011; Sá et al., 2019; Scholten and Schilder, 2015); Ali et al. (2017) add learning as a third capability strengthening SCRES reactive strategy via lessons learned, continuous improvement and mitigation plans. This is consistent with some recent theorizations of SCRES such as transformability or antifragility that promote the idea of embracing and learning from disorder to achieve growth (Nikookar et al., 2021; Wieland and Durach, 2021). Similarly, scholars adopting dynamic capabilities (Teece et al., 1997) as a theoretical lens highlight the importance of transformation and growth by conceptualizing SCRES capabilities in terms of an ability to (1) sense or recognize threats and opportunities (i.e., ability to prepare and learn), (2) seize or respond to these threats and opportunities (i.e., the capability to respond), and (3) transform or improve, combine, and protect the firm's capabilities (i.e., the capability to recover and learn) (Hendry et al., 2019). In the same vein, the supply chain risk management literature highlights the capabilities of preparation (e.g., prevention), response (e.g., risk detection and assessment, solution planning and implementation), recovery and learning (e.g., continuous improvement) (Kauppi et al., 2016, Sinha et al., 2004). Accordingly, this study considers SCRES as an adaptive capability preparing the supply chain to deal with

unexpected events, respond to disruptions and recover and learn from disruptions through business operations continuity (Ponomarov and Holcomb, 2009).

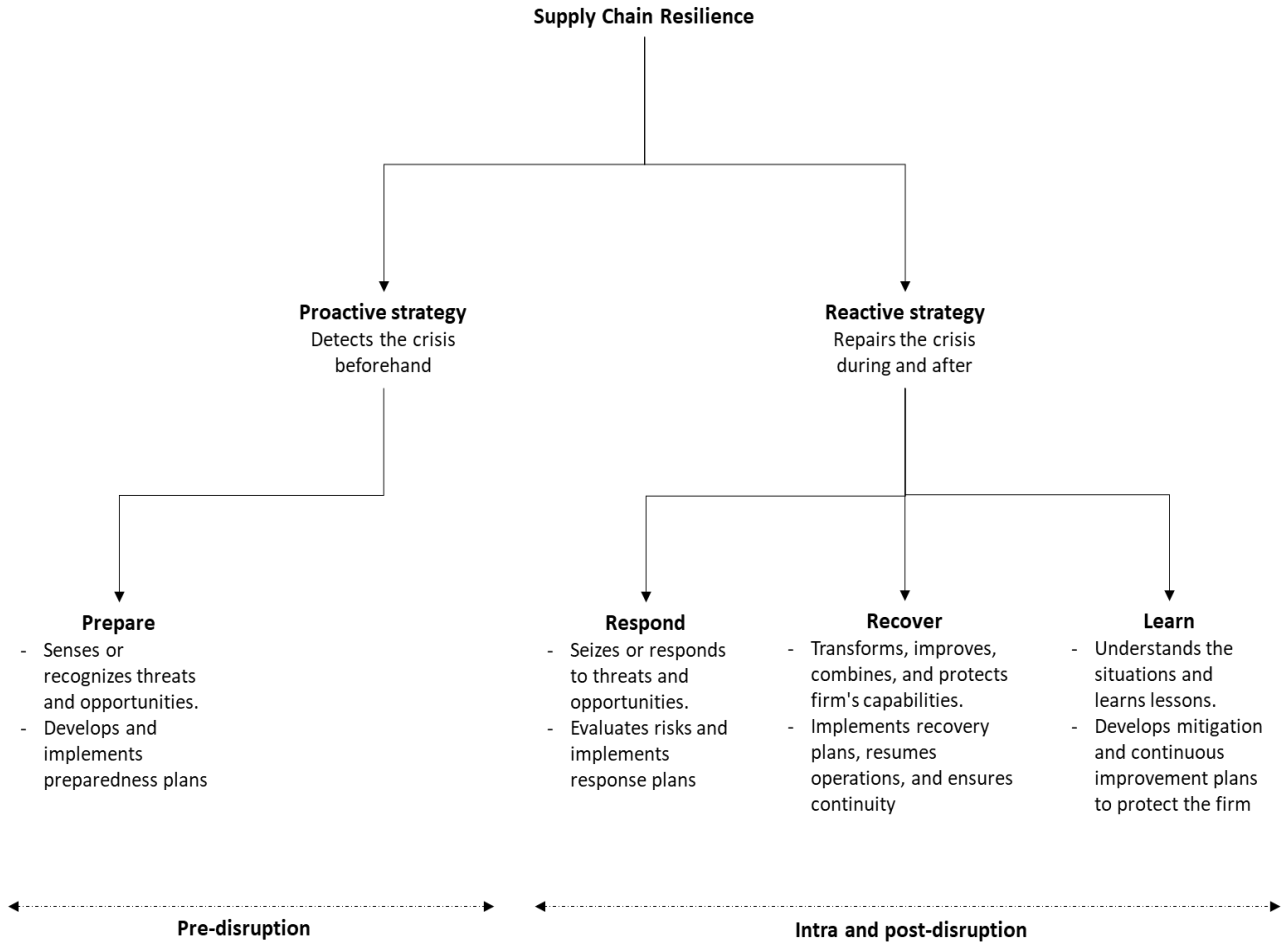

Figure 3-2 Supply chain resilience temporal conceptualization

SCRES capabilities of preparation, response, recovery, and learning are enabled by elements (also referred to as enablers, capabilities, antecedents, dimensions, and measures in the SCRES literature) (Ali et al., 2017; Christopher and Peck, 2004; Hohenstein et al., 2015). The most common SCRES enablers discussed in the literature are collaboration, flexibility, visibility, and velocity (Ali et al., 2017; Jüttner and Maklan, 2011; Johnson et al., 2013, Sá et al., 2019; Scholten and Schilder, 2015). Other than these four enablers, a myriad of other enablers can be found in the supply chain risk and resilience literature such as agility (i.e., velocity, visibility) (Jain et al., 2017; Liu et al., 2018), management support (Chowdhury and Quaddus, 2016; Dabhilkar et al., 2018),

continuity teams, training, past learning (Chowdhury and Quaddus, 2016), risk awareness, supply chain re-engineering (i.e., efficiency, redundancy, robustness) (Scholten et al., 2014), knowledge management, but also social capital (Ali et al., 2017) such as personal relationships, social interactions, sharing of personal concerns, and caring for one another (Nikookar and Yandori, 2021).

3.2.3 The role of cognitive capital in SCRES

The extant literature identifies some cognitive capital elements influencing highly cited SCRES enablers such as collaboration, flexibility, visibility, velocity, agility, or risk awareness.

3.2.3.1 The role of shared codes and language in SCRES

Shared codes and language appear in the form of buyer-supplier goals, key performance indicators, sector language, task ownership, standardization, and training. These essential elements drastically improve collaboration and flexibility needed for SCRES, and establish explicit and tacit understanding (Johnson et al., 2013) used in buyer-supplier absorptive capacity, but also cognitive efforts needed in supply risk identification (Fan and Stevenson, 2018) and mitigation (Chowdhury et al., 2019).

Buyers establishing collaborative codes with their suppliers via goal setting are more prepared for supply chain risks and can see their supply risks decrease (Chen et al., 2013). Training is another component invigorating SCRES agility, collaboration, and supply chain re-engineering (Liu et al., 2018). From a language perspective, Subramanian et al. (2015) have demonstrated through an empirical study that buyer-supplier language differences can be a barrier for multinational OEMs to understand and adapt to Chinese socio-cultural and professional practices.

3.2.3.2 The role of shared narratives in SCRES

Nahapiet and Ghoshal (1998) associate shared narratives with stories, myths, and metaphors sustaining meaning in communities. Investigating the management of the Grayrigg rail crash in the UK, Johnson et al. (2013) suggest that shared narratives of past adaptive responses help solidify network collaboration and the identification and

resolution of complex problems. In addition, the authors propose that shared narratives support the curiosity for resource location and status, enhancing visibility and collaboration.

Shared organizational culture is a shared narrative consisting of company values, philosophies, approaches to business dealings, management styles, and business capabilities (Chowdhury et al., 2019). Shared corporate culture helps mitigate supply chain risks, by supporting the process of shared understanding and cognitive effort needed in supply risk identification (Fan and Stevenson, 2018) and mitigation (Chowdhury et al., 2019). For example, buyer-supplier shared vision is an element of interorganizational culture used to help better apprehend and respond to supply disruption (Manhart et al. 2020). Along the lines of shared corporate culture, supply chain risk management (SCRM) cultures are specific organizational cultures infusing, respectively, the concepts of resilience (Christopher and Peck, 2004), and SCRM (Chowdhury et al., 2019). SCRM culture diffusion, at the firm and buyer-supplier level, is positively related to the risk assessment and analysis capacity (Fan et al. 2017). Indeed, through risk-sharing, continuity teams, risk awareness (Chowdhury et al., 2019), agility (i.e., velocity and flexibility), collaboration, and supply chain re-engineering (Liu et al., 2018), SCRM culture positively impacts SCRES.

Additionally, national culture is another shared narrative that appears to impact collaboration strategies in supply disruption management (Manhart et al., 2020). Different countries, based on their individualism, collectivism, and feminism levels, seem to have differences in their risk-taking and negotiation approaches, but research remains poor in this domain (Gupta and Gupta, 2019).

Overall, the current literature recognizes the role of some cognitive capital elements in SCRES enablers (i.e., collaboration, flexibility, visibility, velocity), but remains limited as to what and how cognitive capital's elements impact the four SCRES capabilities to prepare, respond, recover, and learn. Thus, the aim of this study is to answer the following research questions:

1. What is cognitive capital in the context of a disruption?

2. What is the role of cognitive capital in SCRES temporal capabilities?

3.3 Method

The aim of this study is to shed some light on cognitive capital in buyer-supplier relationships to clarify its underlying elements, but also examine how they connect with the SCRES capabilities to prepare, respond, recover, and learn during a disruption. Cognitive capital, SCRES, and COVID-19 are complex, unique, misinterpretable, and underexplored contemporary real-life phenomena. Consequently, their study lends itself well to the rich and explorative nature of a qualitative case study scouting for meaning and context over causality and positivist generalization (Eisenhardt, 1989).

As an extreme case context enabling potent depictions of phenomenon characteristics (Scholten et al., 2014), the COVID-19 pandemic was an opportunity to examine potential interrelationships between cognitive capital and SCRES. This study adopted a single case study approach of a Japanese multinational electronics company that provides an ideal platform for rich description, in-depth analysis of data, and exploring contextual factors (Yin, 2018). The case study involved an examination of the buying firm's relationships with its 36 multiregional suppliers, spanning 17 product and service categories facing severe supply chain disruptions due to the COVID-19 pandemic. Having multiple suppliers across different product and service categories was deemed appropriate to help capture the buying's firms SCRES capabilities in a diverse set of contexts. This further allowed a much richer analysis identifying suppliers and/or product and service category contingencies. The data were collected over four months, seeking episodical explanation (Helferich and Cook, 2002; Kovács and Spens, 2007; Natarajarathinam et al., 2009; Scholten et al., 2014) before and during COVID-19.

3.3.1 Empirical setting and case study selection

The multinational electronics company (hereafter, ELECTRO Co) was chosen as the focal buying firm for several reasons. First, ELECTRO Co provided an ideal setting as a large multi-billion-dollar electronics manufacturer with a global presence in both developed and emerging markets as well as a fragmented and geographically dispersed supply base that had experienced both supply and demand fluctuations during the pandemic. The

company's diverse portfolio of products and services spanning multiple industries allowed the authors to observe and thus compare and contrast different patterns of supply and demand fluctuations. Furthermore, given the primary focus of this study to unpack the 'black box' of cognitive capital, the buying firm's geographically dispersed supply chain provided an appropriate setting to investigate the alignments of meaning, values, or goals that may have emerged due to different geographical locations or cultural differences. Finally, being embedded in the company, one of the authors had exceptional access to the entire supply chain team supporting the supply and procurement, production and logistics, and transportation activities of a wide range of products and services.

ELECTRO Co develops and manufactures various products and services including rechargeable batteries, automotive and avionics systems, home appliances, construction, televisions, video projectors, cameras, computers, and software. 17 specific product and service categories and a myriad of associated incidents in the context of COVID-19 were identified, enabling the utilization of critical incident analysis (Flanagan, 1954) to understand how individuals viewed and interpreted unfolding events. The case revolves around the buyer or manufacturer's point of view in dyadic settings, consisting of multiple buyer-supplier dyads where the buyer is constant, but the suppliers are different per product and service category. A dyadic approach was selected to examine qualitatively the unexplored connection between cognitive capital and SCRES temporal capabilities.

Table 3-1 uses the supply chain risk framework based on Ho et al. (2015) to describe how the major environmental risk of COVID-19 trickled down to all other supply chain risks (i.e., supply, manufacturing, demand, informational, transportation, financial risks). No pattern emerged from specific supply chain risks, except the demand risk of demand fluctuations (i.e., sharp increases, decreases) discussed next.

From the data emerged two scenarios that contextualize what and how cognitive capital elements surfaced in relationship to SCRES. These two contingencies are (1) sudden product demand fluctuations (increases, decreases) (Chopra and Sodhi, 2004), and (2) the supply-base complexity element of supplier geographical proximity (Choi and Krause, 2006). First, the diversity of product and service categories consisted of 17 different products and service categories with increased or decreased demand:

- Nine categories saw their demand at least double, which made supply and inventory levels drop substantially and rapidly after COVID-19 hit.
- Eight products saw a demand decrease: seven products had a demand level decreased dramatically by at least 50% with consequential supply and inventory levels surging. One category saw a slight 10% demand decrease with inventory and supply levels increasing slowly.

Product	Demand level	Environmental risks	Supply risks	Manufacturing risks	Demand risks	Information risks	Transportation risks	Financial risks
Rugged laptops	↑	• COVID-19's US expansion • US lock-down with social distancing, masks recommendations, etc. • Political Turmoil • Manifestations and riots	• Long lead times • Surge in costs for critical PPE items • Material supply disruption • First and second-tier suppliers shut downs • Single and sole-sourcing • Production and supply flow halt in Asia • Inventory shortages	• Absenteeism • Production line stoppage due to parts and PPE shortages • Overload of emails drowning employees • Management of social distancing measures • COVID-19 contagion	• Increase of obsolete part demand in repairs for all products • Between 100% and 200% demand increase for laptops, handheld devices, tablets, scanners for first responders like the Police, Hospitals, Military, Pentagon, White House • 75% demand increase for Police cameras and video systems • 55% demand increase for registers used in Fast Food restaurants	• Web-based connection • Remote work • Lack of face-to-face meetings • Overabundance of emails overloading personnel • Miscommunication • Lack of communication	• Ports and airports reduction of personnel • Passenger flights dropped down • Transportation rate fluctuations with peaks exceeding 300% • Transportation lanes capacity decrease • Air capacity reduced because of drastic passenger flight cancellations • Unprecedented manpower shortage • Embargoed port terminals: backlog of inbound products not received with congestion • Drivers starting to get more unemployment benefits paying more than actual salaries in logistics and transportation (e.g., drivers, pickers)	• Potential loss of sales revenue due to competition
Handheld Devices								
Tablets								
Scanners								
Registers								
Police Body-Worn Cameras								
Police In-Car Video Systems								
3PL								
PPE								
Medical Cameras	↓	• COVID-19's US expansion • US lock-down with social distancing, masks recommendations, etc. • Hospital restrictions to treat only essential needs			• 10% demand decrease			• Loss of sales revenue due to demand decrease
Food Kiosks		• COVID-19's US expansion • Lock-down with social distancing, masks recommendations, etc. • Remote work. • Closure of restaurants, outdoor entertainments, festivals, movie theatres, concerts, etc.	• Stock piling • Lack of space to store excess inventory		• Between 50% and 95% demand fall, notably for Professional Telephone Systems which will be discontinued			
Counters								
Displays								
Flat Panels								
Projectors								
Sound Systems								
Professional Telephone Systems								

Table 3-1 COVID-19 supply chain risks by product and service category

Second, the suppliers in this case study were geographically dispersed in Vietnam, Malaysia, China, Taiwan, Japan, Germany, UK, Italy, Mexico, Canada, and the USA. Every product consisted of numerous parts and sub-assemblies supplied from multiple suppliers in these countries and assembled or used for repairs in the US (except for third-

party logistics services provided by carriers located in the US). Overall, a total of 36 dyads were represented in the sample (Table 3-2). The purpose of this study is to investigate cognitively embedded relational aspects or the extent to which buyer-supplier dyads share and operate on common cognitive models, typically embodied in shared meaning or categorization systems, which is separate from physical aspects such as firms' physical asset investments embedded in external relationships (e.g., cross-shareholding) and relational aspects (e.g., trust) (Alinaghian et al., 2020). As such, although ELECTRO is a Japanese multinational electronics company based in the US with some suppliers located in Japan, keiretsu relationships or cross-shareholding did not surface in the interviews. Preponderant in the Japanese culture, particularly in the automotive industry (Kosaka et al., 2020), keiretsu relationships are dense groups of buyer-supplier relationships (Kraude, et al., 2018; Matsuo, 2015) where parties leverage each other through higher selling prices, high-quality incentives, contractual exclusivity clauses, and shared new product developments (Todo and Inoue, 2021).

	Number of suppliers in:										
Product	Vietnam	Malaysia	China	Taiwan	Japan	Germany	UK	Italy	Mexico	Canada	USA
Rugged laptops					2						
Handheld Devices				2							
Tablets				1							
Scanners			1								
Registers	1	1									
Police Body-Worn Cameras					1		1			1	1
Police In-Car Video Systems					1		1				1
3PL											3
PPE			1								1
Medical Cameras					1						1
Food Kiosks	1							1	1		
Counters	1							1			
Displays				1	1	1					
Flat Panels				1	1						
Projectors			1	1							
Sound Systems			1								
Professional Telephone Systems									1		
Sub-total of dyads	**3**	**1**	**4**	**6**	**7**	**1**	**2**	**2**	**2**	**1**	**7**
Total number of dyads	**36**										

Table 3-2 Number of dyads by product categories and supplier country

3.3.2 Data collection

The study was mainly based on 40 semi-structured interviews in one manufacturing multinational across 17 different product and service categories and services over a period of four months between June and September 2020. 30 participants provide a credible estimate within one organization (Saunders and Townsend, 2016). Data saturation was reached at 40 interviews. Data triangulation was possible with information available in the form of shared presentations, ad-hoc meetings, emails, but also phone calls. To enable a holistic viewpoint and deep understanding of the supply chain from the buyer's perspective, the individuals selected for the interviews were all working in the US headquarters and experts in either one, two, or three functions of the Supply Chain (i.e., (a) Procurement; (b) Planning: finished goods, repair, and services; (c) Transportation) across different managerial levels (i.e., senior buyer, senior planner, manager, senior manager, director, vice president) (Table 3-3). We acknowledge that functions such as sales and R&D are important to the wider business, but these elements were outside the scope of the study.

Interviewee number	Managerial level	Age	Department	Product Category	Gender	Experience	Interview length in minutes
1	Manager	41-50	Procurement	Police Body-worn Cameras, Police In-Car Video System, Medical Cameras	Male	10+ years	33
2	Senior Manager	41-50	Transportation	3PL, Laptops, Handheld Devices, Tablets, Scanners	Female	10+ years	49
3	Director	41-50	Transportation	3PL, Laptops, Handheld Devices, Tablets, Scanners, Police Body-worn Cameras, Police In-Car Video System, Medical Cameras	Male	10+ years	51
4	Senior Manager	41-50	Supply Chain	ALL	Female	10+ years	37
5	Senior Planner	21-30	Repair	Laptops, Handheld Devices, Tablets, Scanners	Male	4-6 years	34
6	Senior Manager	41-50	Procurement	Laptops, Handheld Devices, Tablets, Scanners	Male	10+ years	47
7	Senior Manager	51+	Transportation	3PL, Food Kiosks, Registers, Counters	Female	10+ years	44
8	Senior Manager	51+	Transportation	3PL, Laptops, Handheld Devices, Tablets, Scanners	Male	10+ years	38
9	Senior Planner	41-50	Supply Chain	Food Kiosks, Registers, Counters	Female	10+ years	31
10	Senior Manager	51+	Transportation	3PL, Professional Telephone Systems, Displays, Flat Panels, Projectors, Sound Systems, PPE	Female	10+ years	38
11	Senior Buyer	31-40	Procurement	Professional Telephone Systems, Displays, Flat Panels, Projectors, Sound Systems	Female	7-9 years	32
12	Manager	51+	Supply Chain	Professional Telephone Systems, Displays, Flat Panels, Projectors, Sound Systems	Female	10+ years	51
13	Senior Planner	31-40	Supply Chain	Laptops, Handheld Devices, Tablets	Male	10+ years	36
14	Senior Planner	41-50	Supply Chain	Police Body-worn Cameras, Police In-Car Video System, Medical Cameras	Female	10+ years	44
15	Senior Planner	41-50	Transportation	3PL, Laptops, Handheld Devices, Tablets, Scanners	Female	10+ years	54
16	Manager	51+	Repair	Professional Telephone Systems, Displays, Flat Panels, Projectors, Sound Systems	Male	10+ years	41
17	Senior Planner	51+	Transportation	3PL, Police Body-worn Cameras, Police In-Car Video System, Medical Cameras	Male	10+ years	43
18	Vice President	51+	Transportation	ALL	Male	10+ years	46
19	Manager	31-40	Procurement	Food Kiosks, Registers, Counters	Male	7-9 years	49
20	Senior Planner	31-40	Transportation	3PL, Food Kiosks, Registers, Counters	Male	4-6 years	34

Interviewee number	Managerial level	Age	Department	Product Category	Gender	Experience	Interview length in minutes
21	Director	41-50	Procurement	Laptops, Handheld Devices, Tablets, Scanners	Female	10+ years	48
22	Manager	51+	Supply Chain	Police Body-worn Cameras, Police In-Car Video System, Medical Cameras	Male	10+ years	42
23	Senior Planner	51+	Repair	Professional Telephone Systems, Displays, Flat Panels, Projectors, Sound Systems	Female	10+ years	36
24	Director	41-50	Supply Chain	ALL	Male	10+ years	76
25	Senior Buyer	41-50	Procurement	Food Kiosks, Registers, Counters	Female	10+ years	46
26	Vice President	51+	Procurement	ALL	Female	10+ years	39
27	Senior Buyer	41-50	Procurement	Food Kiosks, Registers, Counters	Male	10+ years	43
28	Manager	31-40	Supply Chain	Laptops, Handheld Devices, Tablets, Scanners	Male	7-9 years	39
29	Manager	31-40	Repair	Laptops, Handheld Devices, Tablets, Scanners	Female	7-9 years	35
30	Senior Planner	21-30	Supply Chain	Laptops, Handheld Devices, Tablets, Scanners	Female	7-9 years	36
31	Senior Planner	31-40	Supply Chain	Laptops, Handheld Devices, Tablets	Female	7-9 years	45
32	Vice President	51+	Supply Chain	ALL	Female	10+ years	40
33	Manager	41-50	Procurement	3PL, PPE	Male	10+ years	44
34	Senior Planner	51+	Repair	Police Body-Worn Cameras, Police in-car video system, Medical Cameras	Male	10+ years	42
35	Manager	31-40	Procurement	Professional Telephone Systems, Displays, Flat Panels, Projectors, Sound Systems, PPE	Male	10+ years	38
36	Senior Planner	51+	Repair	Food Kiosks, Registers, Counters	Female	10+ years	40
37	Senior Manager	51+	Transportation	3PL, Police Body-worn Cameras, Police In-Car Video System, Medical Cameras	Male	10+ years	42
38	Senior Manager	31-40	Repair	ALL	Male	10+ years	43
39	Director	51+	Transportation	3PL, Food Kiosks, Registers, Counters, Professional Telephone Systems, Displays, Flat Panels, Projectors, Sound Systems, PPE	Male	10+ years	56
40	Senior Buyer	21-30	Procurement	Laptops, Handheld Devices, Tablets, Scanners	Female	4-6 years	32

Table 3-3 Respondent profiles

93% of the interviewees had seven or more years of experience in the Supply Chain organization, while the other 7% had a minimum of four years. The informants were selected jointly with the executive team based on their supply chain expertise and time on the job. No pattern emerged specifically from the employees' time at the organization, function, or managerial levels.

Held over Microsoft Teams, all interviews were recorded and fully transcribed. A few phone calls and emails were used after transcription for clarification. Guided by a literature review based on Daghar et al. (2021), an interview protocol was established leveraging broadly defined themes in open-ended questions to enable exploration, avoid confusion for professionals, and trigger follow-up questions requiring explanative responses. To avoid misinterpretation from the interviewees regarding cognitive capital and SCRES, the question themes were kept comprehensible. Indeed, cognitive capital was investigated using terms such as shared goals, training, shared values, shared narratives, shared ideas, or shared experiences, while ideas of preparation, response, recovery, and learning were used to discuss SCRES around the experienced COVID-19 global pandemic disruption.

3.3.3 Data analysis

The data analysis was based on an open-coding procedure, followed by axial and selective coding processes that brought to light different main elements of cognitive capital. First, shared codes and language consisted of shared goals like increasing sales or deliveries, shared training on inventory surplus and shortage management, shared assumptions encompassed mutual understanding of partners' situations and actions, but also multilingualism or multilingual interactions with suppliers from other regions (e.g., Japan, China), and non-verbal/kinesics (face-to-face) language developed notably with local suppliers through frequent visits. Second, shared narratives embodied shared prior disruption experiences including tsunamis or abrupt increases in demand, shared values (i.e., commitment or integrity, empathy, honesty, fairness, gratitude, team mentality or collaborative mindset, customer-focus), shared philosophies revolving around lean versus high-inventory philosophies (i.e., low and optimized inventory focus versus high and anticipative inventory focus), shared business approaches influenced by social

distancing (i.e., remote working, virtual communication, virtual negotiation), shared capabilities in terms of company structures, processes, or technologies (i.e., company size, number of department, processes, information sharing speed), and buyer-supplier national culture differences experienced through shared multicultural interactions between partners of different countries.

Figure 3-3 highlights the results of this analysis, with the new elements underlined to distinguish them from the literature-derived concepts shown in Figure 3-1. Using the cognitive capital framework in Figure 3-3, the data coding was processed in NVivo 12, helping with the systematization of substantial textual data (Johnson et al., 2013).

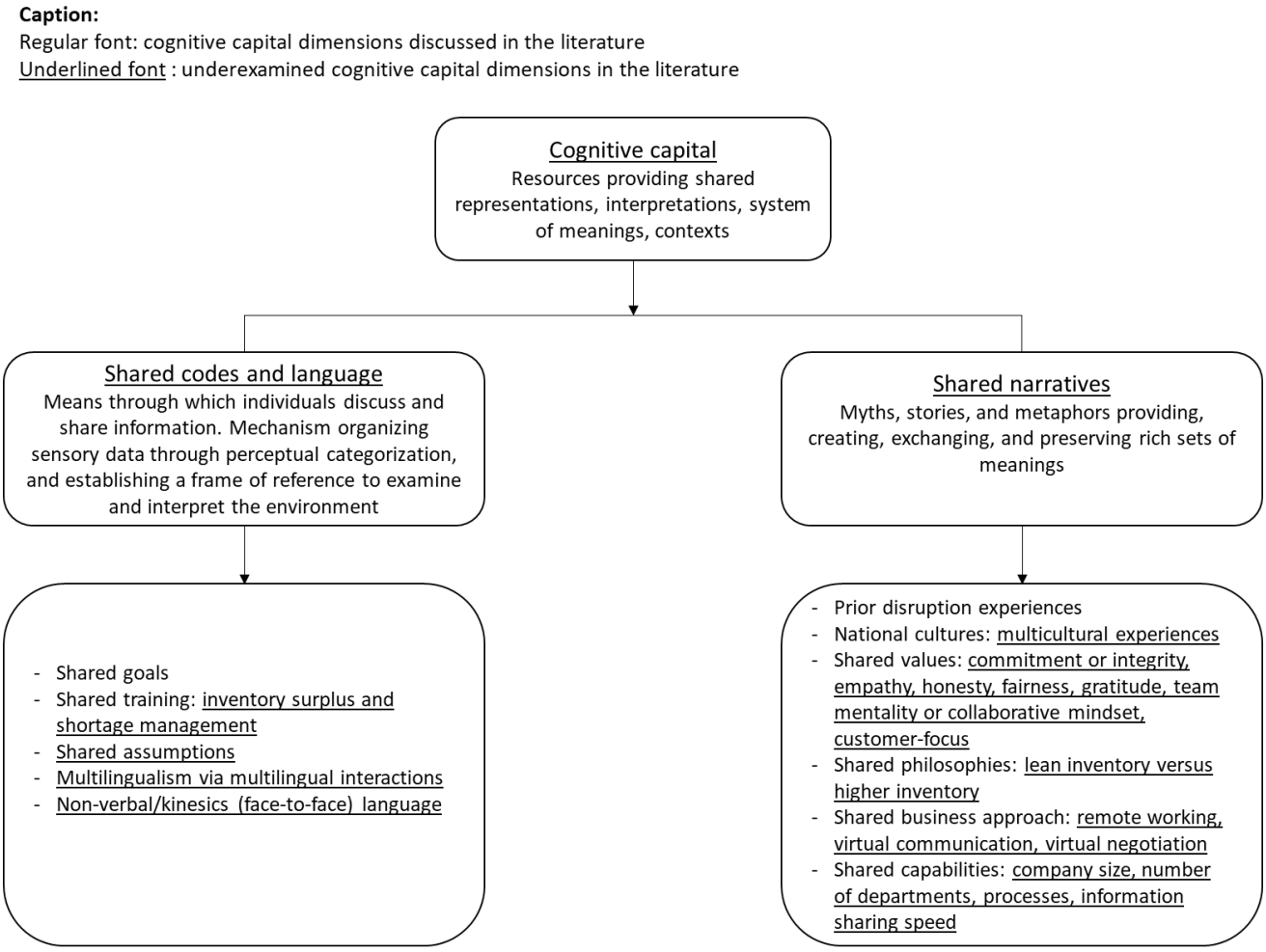

Figure 3-3 Cognitive capital coding and main data-based theme development

To better understand the data collected about cognitive capital elements, the top cognitive capital elements were ranked (Table 3-4) by the percentage of participants discussing them per SCRES temporal capabilities in two different situations emerging and consisting of increased or decreased demand levels. Table 3-4 is only illustrative and informative. It is not a claim or generalization of cognitive capital element importance. In this table, specific cognitive capital elements emerged in the interviews more frequently than others concerning SCRES temporal capabilities (i.e., preparation, response, recovery, learning), and pandemic-driven demand patterns (i.e., increase, decrease). First, in SCRES preparation, prior disruption experiences, honesty, and face-to-face or kinesics language seem to prevail in building relationships regardless of how demand behaves. Second, in SCRES response, shared goals, shared assumptions, and virtual communication are essential when demand increases to promote collaboration geared towards sales, while shared assumptions and values of honesty and empathy become critical in determining what to do with oversupply when demand decreases. Third, in SCRES recovery, shared process capability and team mentality foster problem resolutions whether demand increases or decreases. Shared goals bring partners together when demand increases, enabling shared profit, while shared assumptions are used to clarify contexts when demand decreases, notably when overstocking is a concern. Fourth, in SCRES learning, when demand increases, shared lean philosophy becomes obsolete, training on how to manage shortages turns into a necessity, and values of integrity and commitment become a sign of reliable relationships. When demand decreases, virtual negotiation takes precedence, particularly in stock positioning conflicts, training on how to manage surplus stock becomes relevant, and multilingual interactions, notably with geographically distant suppliers, create bonds propitious to consensus.

SCRES preparation				
Demand level	**Rank**	**Cognitive capital element**	**Cognitive capital dimension**	**Participant %**
↑ Demand	1	Prior disruption experiences	Shared narratives	46%
	2	Face-to-face/kinesics language	Shared codes and language	23%
	3	Honesty	Shared narratives	18%
↓ Demand	1	Prior disruption experiences	Shared narratives	43%
	2	Honesty	Shared narratives	29%
	3	Face-to-face/kinesics language	Shared codes and language	14%

SCRES response				
Demand level	**Rank**	**Cognitive capital element**	**Cognitive capital dimension**	**Participant %**
↑ Demand	1	Shared goals	Shared codes and language	47%
	2	Shared assumptions	Shared codes and language	31%
	3	Virtual communication	Shared narratives	21%
↓ Demand	1	Shared assumptions	Shared codes and language	62%
	2	Honesty	Shared narratives	34%
	3	Empathy	Shared narratives	21%

SCRES recovery				
Demand level	**Rank**	**Cognitive capital element**	**Cognitive capital dimension**	**Participant %**
↑ Demand	1	Shared process capability	Shared narrative	52%
	2	Shared goals	Shared codes and language	34%
	3	Team mentality	Shared narrative	30%
↓ Demand	1	Shared assumptions	Shared codes and language	43%
	2	Team mentality	Shared narrative	25%
	3	Shared process capability	Shared narrative	21%

SCRES learning				
Demand level	**Rank**	**Cognitive capital element**	**Cognitive capital dimension**	**Participant %**
↑ Demand	1	Lean versus high inventory philosophy	Shared narrative	49%
	2	Training on inventory shortage management	Shared codes and language	25%
	3	Integrity or commitment	Shared narrative	19%
↓ Demand	1	Virtual negotiation	Shared narrative	25%
	2	Training on inventory surplus management	Shared codes and language	25%
	3	Multilingual interactions	Shared codes and language	25%

Table 3-4 Top cognitive capital elements per SCRES temporal capability

The SCRES capability framework (i.e., prepare, respond, recover, learn) based on Ali et al. (2017) and others (Hendry et al., 2019; Johnson et al., 2013; Jüttner and Maklan, 2011;

Sá et al., 2019; Scholten and Schilder, 2015) highlighted action verbs per SCRES capability (Figure 3-2).

The interviews were collected during the pandemic. Quotes involving cognitive capital's elements (Table 3-5) were organized using the cognitive capital framework in Figure 3-3 and SCRES action verbs in Figure 3-2. Pre-COVID experiences were connected to SCRES preparation, while intra-COVID experiences were linked to SCRES response, recovery, and learning offering an episodical view (Helferich and Cook, 2002; Kovács and Spens, 2007; Natarajarathinam et al., 2009; Scholten et al., 2014).

Dimension	**Sub-dimension**		**Illustrative quote**
Shared codes and language	Shared goals		*"The suppliers need to share our objectives so that we can go beyond what are our contractual obligations look like, right? You need to have the same to build a relationship. If you're on completely different paths, it's never going to work. Yeah, unless you can find some common ground. So, I think having the same goals matters a lot for strategic partnership and if they're not aligned, then we are going to have issues in that partnership. When your goals align, you get thing done quicker". Senior Manager, interviewee 10*
	Training	Inventory surplus/shortage management	*"I was not trained for this crisis. I do think it would be helpful to have predicted a crisis. We would have managed some of our inventories differently. When there's a crisis, you just react to it, you learn through experience. Ah, you put out the fire, you take care of it". Senior Planner, interviewee 9*
	Shared assumptions		*"When they started telling me why the situation is what it is, then I started understanding the reasons. That is the evolving part of the relationship. And now, since we are on the same page, we are continuing to move forward with our strategic partnership, even if we are finding them not honoring the contract agreements, because we understand why pricing is beyond their control". Director, interviewee 3*
	Multilingualism		*"We usually have used some planners who luckily speak Japanese or Chinese with our suppliers on the phone located in Asia to better understand each other in times of rush". Manager, interviewee 29*
	Non-verbal/kinesics communication		*"I don't care what people say about TEAMS and all that stuff, you have to build that relationship face-to-face. So, I think the ones that I did not have that face-to-face camaraderie with, that was a big hindrance. It's hard for me to gauge people's honesty when I don't see them. On the phone, you can't read any of the facial expressions, the body language, and you're just going by someone's tone and you have no idea what they're working with". Director, interviewee 24*

Dimension	Sub-dimension		Illustrative quote
Shared Narratives	Shared prior disruption experiences		*"We've had other situations in the past where we've had to deal with port lock downs and extended factory closures for other reasons, and so we had a little bit of experience dealing with supply chain disruption. So, I think just all those elements put together and our experience in dealing with situations like that in the past have helped out". Senior Buyer, interviewee 25*
	National culture	Multicultural experiences	*"In Japan, they thank you. They thank you for sending emails, they thank you for replying...My German vendor and my vendor in Italy are very strict. They are very much about the contract. They abide by everything that has to do with the contract. It is very hard to get them to adjust an invoice for instance. The European vendors, they point everything out to you. They want to make sure everything is out in the open, and everything is communicated". Senior Planner, interviewee 27*
			"With our domestic vendors, it's more of an informal conversation with them. If they need something quickly, they shoot me a text or give me a quick phone call. So, having a conversation with them is much easier". Senior Manager, interviewee 25
			"Overall, we are all in different places, but have the same goals in lowering inventory for example, getting things shipped out, decreasing our metrics or increasing depending on what metric you're looking at. We're all on the same page but we react and project things differently. So, it doesn't matter what the culture is, we all have the same goals and comply with our procedures and requirements". Senior Manager, interviewee 30
	Shared values	Commitment or integrity	*"I think these kinds of difficult, challenging times really show what companies actually follow through when things get tough. When suppliers don't respect their commitments, I will always remember that when I run my next request for pricing". Director, interviewee 3*
		Empathy	*"I learned how to be patient a little bit because they all have problem like us, and when you understand them, they want to return the favor". "Being a little more conscious about how they are doing like saying: I hope you and your family are well, helped calm us down and get things done". Senior Planner, interviewee 23*
		Honesty & Fairness	*"We've always treated people outside our company with the same honesty and fairness as we do inside the company. Consequently, most of our suppliers have dealt with us honestly and fairly. They don't have the same models, creed, basic principles and culture as us, but being fair with each other definitely helped our relationship". Manager, interviewee 22*
		Team mentality	*"If you don't have the team mentality, if each partner doesn't do its part, you're going to fail". Senior Manager, interviewee 37*
		Customer-focus	*"those friendly suppliers that had strong customer-centric cultures were able to respond a lot faster and were more supportive than those who had just more kind of profit-based revenue business sense goals in mind for the relationship. So, I found that our collaborative partners and suppliers who had like-minded customer mindset were far simpler to deal with and could relate to our requests in a much more rapid pace than those suppliers of ours that were more transactional cost-based". Vice President, interviewee 18*
	Shared philosophies	Lean versus higher inventory	*"I do not think I have ever worked anywhere that was so lean before, but this company's general philosophy is no safety stock. So, I think one of the lessons is to have a little bit additional in our warehouses, or with our channel partners". Senior Manager, interviewee 4*

Dimension	Sub-dimension		Illustrative quote
Shared Narratives	Shared business approaches	Remote working	*"I think both the suppliers and our organization were really quick to adapt to the technology to adapt to the working from home culture. We were used to it before the pandemic. That is one thing that I noticed helped us collaborate". Manager, interviewee 35*
		Virtual communication	*"Luckily my work can be performed with just a laptop, of course with the internet. The only thing was that I had to wait longer for responses because our suppliers were inundated with emails. So, I called them instead sometimes". Senior Planner, interviewee 13*
		Virtual negotiation	*"It's better to get everybody in a room to have a meeting. You know you can do it on TEAMS, but it's really not the same because you don't know who's rolling their eyes, and most people don't like to put their camera on. But, you know, we negotiate for a living. And, it's a lot harder to negotiate via the web when I can't see somebody because I can't read how they're absorbing my information, or I can't perform body language to tell them one thing while my mouth is saying another. And, not to be deceitful, but as a negotiation tactic, I have to kind of play that. So, you've had to try to learn some alternate negotiation strategies or talking strategies when it comes to that approach. I am learning a bit more of how to do this virtually, and how to get responses and speak better. And, with the body language missing, I am learning how to interpret information and how to ask for clarity sometimes when I don't get it". Senior Manager, interviewee 6*
	Shared capabilities	Size	*"The bigger the organization is the better it can survive because it can take a financial hit like inventory increase or revenue loss. So, we helped our smaller suppliers hold their stocks". Manager, interviewee 28*
		Number of departments	*"Because we have so many departments, they also sometimes experience delays due to some of the red tape that we would have here". Senior Manager, interviewee 4*
		Processes	*"When suppliers deal with us, they have issues because some of our manual processes are not something they can handle because they're more automated, but we put in place reports like the backlog report to follow-up ". Manager, interviewee 1*
		Information sharing speed	*"Suppliers sent their rates automatically. I will then need to reach out to different departments and get approval, and then come back to the suppliers to tell them okay this is approved. All this takes time. And then by the time you finally got approved, the rate might not be valid anymore because the market rate changes daily". Senior Manager, interviewee 2*

Table 3-5 Illustrative quotes

The thematic analysis, patterns, and interview transcriptions were recorded in a database. Multiple sources of information consisting of interviews, follow-ups when needed, executive conversations, documents, and databases enabled data triangulation, which increased the reliability and validity of the results (Yin, 2018). All interview transcriptions were sent to respondents for verification.

3.4. Findings

3.4.1 SCRES preparation

3.4.1.1 Shared codes and language

Pre-COVID, ELECTRO Co's past face-to-face interactions with suppliers enriched shared information, not only enabling better grasp and conveyance of information, but also strengthening relationships, trust, and same-page attitude. This relational closeness, eased by past face-to-face communication, helped prepare and facilitate virtual interactions during the pandemic, notably in negotiations.

Also, prior to COVID, ELECTRO Co relied on a few multilingual workers to communicate with (e.g., Vietnamese) suppliers having issues with English. Identification of multilingual team players prepared ELECTRO Co for future disruptions requiring language skills.

3.4.1.2 Shared narratives

ELECTRO Co relied on pre-prepared solutions mapped out from past supply disruptions such as tsunamis hitting Japanese suppliers or positive demand shocks (i.e., sudden demand increases) in the US. These prior disruption experiences developed shared survival goals, and buyer-supplier familiarity needed to improve joint threat recognition and built preparation plans avoiding time wasted in goal recalibration.

A pre-COVID shared collaborative team spirit had long existed between ELECTRO Co and most of its suppliers, which eased collaborative efforts during the crisis. However, while some agreed-upon collaboration on lean and just-in-time inventory philosophies previously helped minimize ELECTRO Co's stock before the crisis, they became disastrous after COVID hit, particularly for products sourced from Japan with sudden demands. Still, with an already built shared value system consisting of empathy, honesty, and fairness, ELECTRO Co and its suppliers were mentally prepared for the pandemic shock. Indeed, empathetic anteriorly formed relationships were beneficial during the crisis as they helped prepare ELECTRO Co to facilitate conversations with suppliers.

Differences between ELECTRO Co and its suppliers in terms of size and processes influenced the velocity of shared information before the pandemic started. In fact,

ELECTRO Co noticed that its high number of employees and departments involved in decision-making processes retarded internal information circulation and risk sensing, which ultimately hampered external communication with suppliers. For example, most 3PL suppliers in the US shared information automatically, whereas ELECTRO Co had to manually share data. This difference in information-sharing speed and automation desynchronized effective decision-making in the past. Although not being highlighted as a major problem before the crisis, this information delay became far more significant during COVID, preventing the propagation of risk recognition needed in swift decision-making, rendering the buyer unprepared to effectively recognize internal and share externally information. Nevertheless, with solid cash flow and a diverse product portfolio, ELECTRO Co was more financially prepared than its smaller suppliers to hold inventory and lose revenue.

ELECTRO Co made some cultural observations about the way suppliers from different national cultures responded, shared information, and communicated before the crisis. In Asia, Japanese suppliers seemed to be highly responsive, and often anxious to answer and quickly execute requests. They also constantly expressed gratitude in emails or by phone and considered respect to be very important. Consequently, ELECTRO Co learned through the years to reciprocate that gratefulness to align shared values. As to American suppliers, they tended to be direct and informal, sharing information via phone calls and text messages, while Italian and German suppliers were more formal, yet open in their interactions. Although these national culture disparities were not noticeably performance disruptive before COVID, ELECTRO Co's experience with these differences proved to be helpful to anticipate suppliers' behaviors and prepare for the crisis, and it was a source of comment from the respondents.

3.4.2 SCRES response

3.4.2.1 Shared codes and language

Shared goals emerged as the most cited cognitive capital element in SCRES response. Overall, the pandemic created a common goal to survive, regardless of demand increases or decreases. Rapid goal synchronization with suppliers prioritizing high-revenue shipments, became fundamental in improving response time. On the other hand,

unmatched goals created response delays. Specifically, when suppliers tried to minimize costs by delivering poor quality, ELECTRO Co had to recalibrate quality expectations, which delayed effective response plan implementations.

Shared assumptions during daily operations, across all product and service categories, facilitated joint problem-solving, planning, and decision-making needed to evaluate and respond to risks. The more ELECTRO Co understood how suppliers were grappling with their environments, the smoother and quicker responses were implemented collaboratively. For example, any supply disruptions or transportation price fluctuations were handled immediately with suppliers through virtual meetings to respond effectively.

Before COVID-19 hit, some difficulties in understanding each other in English existed between ELECTRO Co and Asian suppliers in Vietnam and China, but the handicap was manageable as the information shared via emails was simple and not frequent. Nevertheless, as soon as COVID-19 appeared, the level of information-sharing increased, triggering this linguistic difference to become more prominent. Fortunately, ELECTRO Co had some multilingual employees assisting in conveying complex ideas to Asian suppliers when needed. Multilingualism enabled quick situation assessments and responses.

3.4.2.2 Shared narratives

ELECTRO Co considered integrity, team mentality or collaborative mindset, customer focus, empathy, and honesty helpful in improving alertness and reaction time needed to recover. Indeed, intra-COVID, ELECTRO Co went as far as reconsidering engagements with suppliers not expressing these traits, especially with transportation carriers that kept pushing multiple times their acknowledged shipment dates or were slow to answer ELECTRO's inquiries. Constantly looking for a trusted, aligned, partner, ELECTRO Co highly weighted suppliers' integrity and commitment. In fact, to avoid replacement back-ups, time to transition, and long response times, some employees infected by COVID-19 at ELECTRO Co kept working remotely with their suppliers to quickly respond to the crisis. Regular virtual communication strengthened relationships and enabled the implementation of response plans. Shared values of empathy and honesty, while sharing

information, promoted transparency, which helped to assess risk. Essential shared high-inventory philosophies, notably in the aftermarket repair business, allowed ELECTRO Co to respond quickly to demand variability.

Shared experiences, such as tsunamis or abrupt demand increases, created relational bonds and joint reflexes like information sharing, stress containment, and shared planning, making ELECTRO Co and its suppliers more responsive to threats. Also, ELECTRO Co noticed that past multicultural experiences became instrumental to respond to disruptions from Asia.

In terms of shared capabilities, some suppliers had faster and more automated information-sharing capabilities than ELECTRO Co. For example, fluctuations in transportation and personal protective equipment (PPE) prices were disseminated by suppliers real-time and needed approval almost immediately. Disrupting response time, the approval process was manual and time-consuming at ELECTRO Co, with individuals working remotely at different levels and departments. Often using the Procurement team to negotiate these rates, ELECTRO Co delayed rates approval, but made intensified virtual negotiations a new key relational component with 3PL and PPE suppliers.

3.4.3 SCRES recovery

3.4.3.1 Shared codes and language

Shared goals, across product and service categories, facilitated teamwork, problem-solving, and process building. All partners wanted to survive the crisis financially. This common goal, along with a customer-satisfaction focus, increased communication, shifting mindsets towards forecast refinement to ensure sales and business continuity. Misaligned goals emphasized the utilization of tools such as supplier performance management, leveraging contracts, metric tracking and risk identification allowing for progressive recovery. Dyads with conflicting sales goals, where ELECTRO Co saw decreased sales and suppliers were stuck with inventory, had jointly to balance the inventory. Communicating frequently, partners understood the unfortunate ramifications of the global pandemic, which smoothed inventory management negotiations and process development.

Through virtual communication, by ways of emails, MS Teams calls, video chats, and messages, partners stayed in touch to enable constant shared assumptions. These helped clarify goals, create joint processes, resolve daily issues, and ensure business continuity. For instance, shared assumptions of problems such as absenteeism or lockdowns forced dyads to find helpful solutions including quick hiring, shift rescheduling, and remote working to resume logistical operations.

3.4.3.2 Shared narratives

Shared values consisting of integrity, team mentality, customer focus, empathy, and honesty helped recovery from the impact of the pandemic. ELECTRO Co relied heavily on suppliers taking ownership of their commitments to keep operations running. ELECTRO Co exchanged trust against supplier's integrity and found shared team mentality and customer-focus to be valuable assets easing communication, problem-solving, and process-building in the recovery process. Demonstrated through regular virtual communication, shared integrity, team mentality, and customer focus eased the implementation of risk mitigation processes and recovery plans. During COVID, shared values of empathy and honesty, while sharing information, supported effective negotiations needed to recover. Moreover, shared high-inventory philosophies in the repair business kept service operations running.

Shared process capability supported ELECTRO Co's recovery across product and service categories. For example, shared demand forecasting, and inventory allocation processes became indispensable to anticipate unexpected demand and prioritize high-value customers. Furthermore, shared processes around information sharing frequency, backlog management, delivery allocation, alternative transportation route planning, shift scheduling and separation, but also virtual communication and negotiations became crucial for maintaining day-to-day operations.

3.4.4 SCRES learning

3.4.4.1 Shared codes and language

During the pandemic, ELECTRO Co expressed the need to develop special training for high demand products by managing inventory shortages through increased stock and

multi-sourcing approaches for products sourced in Vietnam, Malaysia, and China. As for decreased demand products, ELECTRO Co highlighted the need for training on how to handle surplus stock by developing or using already established customer networks in other regions to sell. Finally, ELECTRO Co recognized how key multilingual actors can bridge misunderstandings between countries sharing information. In fact, ELECTRO Co is contemplating asking Asian suppliers for English speakers to be more actively involved in buyer-supplier interactions.

3.4.4.2 Shared narratives

Inevitably, with demand picking up, just-in-time methodologies handicapped ELECTRO Co's ability to fulfill customers' increased demand for some product categories. Thus, ELECTRO Co learned to rethink the lean inventory philosophy with suppliers by adding safety stocks to guard against future disruptions.

From a value perspective, ELECTRO Co learned who were the suppliers who kept their commitment and integrity. Particularly, some large third-party logistics providers will not be reconsidered for business because of their lack of communication or commitment during the pandemic, while smaller logistics providers who were more responsive and committed won business with ELECTRO Co. Using empathy, ELECTRO Co also learned that most suppliers reciprocated the empathetic behavior by trying their best to perform, which strengthened relationships, continuous improvement, and performance.

ELECTRO Co's managers remarked that established and aligned goals and processes made consensus favorable during the pandemic, regardless of suppliers' national differences. Accordingly, ELECTRO Co learned to develop relationships in virtual settings through frequent scheduled meetings. The intent was to strengthen ties with suppliers and ensure alignment of goals and processes. Finally, during COVID-19, ELECTRO Co learned how to negotiate over the internet and phone to compensate for the lack of face-to-face communication with American suppliers. With increasing buyer-supplier virtual interactions, ELECTRO Co highlighted remote working, and virtual negotiation as new key skills to promote in a socially distant environment.

3.5 Discussion

This study focuses on the SCRES temporal capabilities of preparedness, response, recovery, and learning. In light of more contemporary debates from multiple disciplines (i.e., engineering, ecology, economics, social sciences), we draw from complex adaptive systems (Day, 2014), and the concept of antifragility (Nikookar et al., 2021; Taleb, 2012) by considering the learning phase as growth in the face of turbulence enabled by post-disruption learning (Hendry et al., 2019), which is consistent with the resilience ideas of adaptation and transformability (Walker, 2020; Wieland and Durach, 2021), but also antifragility going beyond resilience as it embraces and learns from a disorder rather than avoiding it (Nikookar et al., 2021; Taleb, 2012).

The results reveal the unique role that the various elements of cognitive capital play in the SCRES temporal capabilities to prepare, respond, recover, and learn, through the lens of two contingencies: (1) product and service categories with steep demand fluctuations (i.e., increase, decrease) (Chopra and Sodhi, 2004), and (2) the supply-base complexity element of supplier geographical proximity (Choi and Krause, 2006) (Figure 3-4). Throughout the information collection and analysis process, propositions emerged from the data. The proposition development logic follows a sequential four-step process: (1) the analysis of all the interviews to classify and understand the cognitive capital elements (Table 3-5); (2) the definition of the SCRES temporal capabilities to prepare, respond, recover, and learn (Figure 3-2); (3) the statistical analysis of the top cognitive capital elements that surfaced from interviewees for every SCRES temporal capability (Table 3-4); this step cross-referenced data from the interviews with SCRES temporal capabilities and ranked top cognitive capital elements per SCRES capability; and (4) the consolidation of the main cognitive capital elements and observed contingencies that influence specific SCRES temporal capabilities (Figure 3-4).

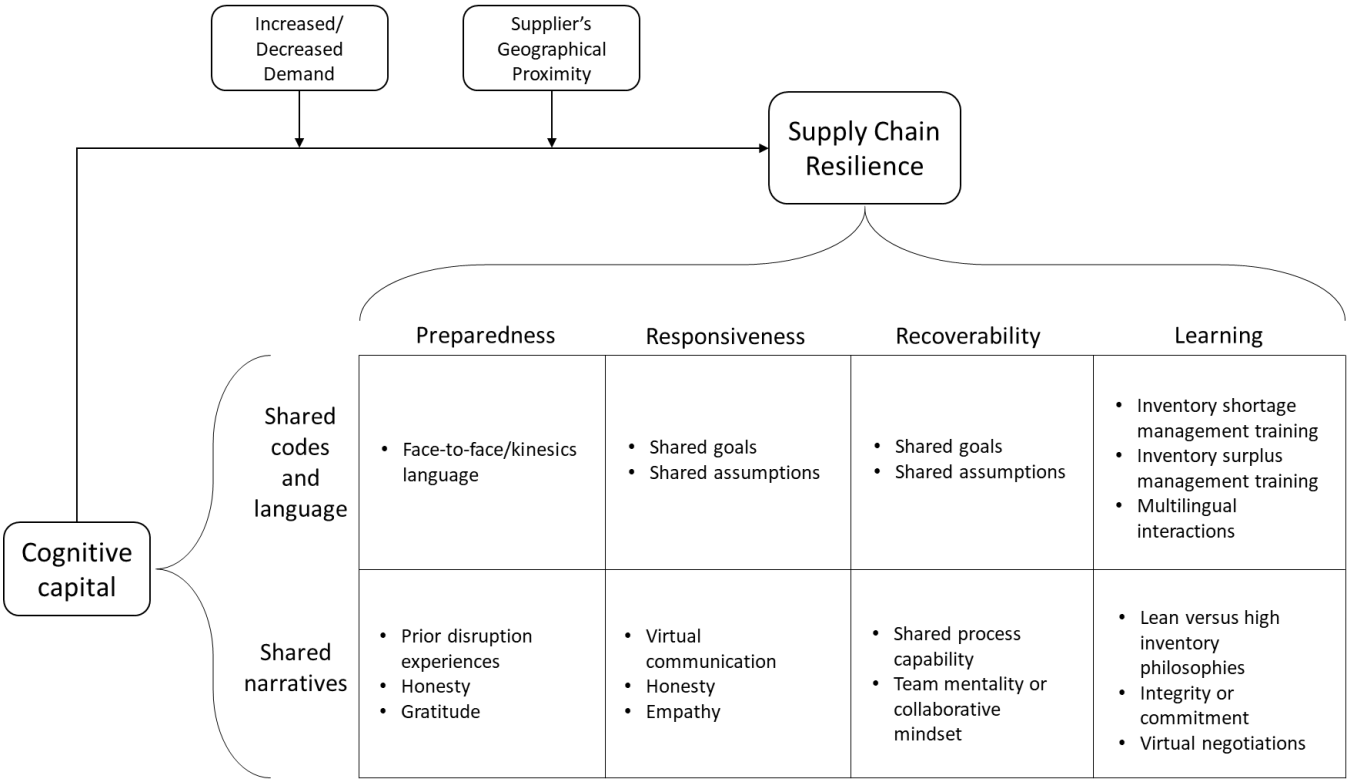

Figure 3-4 Main cognitive capital elements and contingencies influencing SCRES

3.5.1 The role of cognitive capital in SCRES preparation

Past physical buyer-supplier interactions strengthen relationships by familiarizing partners with each other, and improving communication and trust needed for crisis preparation. Employees who already developed shared kinesics language with suppliers in the past, missed face-to-face communication, particularly with geographically close suppliers because of the socially distant environment.

Buyer-supplier prior disruption experiences improved SCRES preparation. Through participative, continuous, and shared sense-making processes, cognitive capital develops shared understanding used to share information (Carey et al., 2010; Krause et al., 2006). Pre-COVID events such as tsunamis or production shutdowns helped dyads better acquaint themselves with disruptions, regardless of product categories. Also, building shared values such as honesty invigorated buyer-supplier trust, information exchange, and understanding, helping better prepare for crisis.

Looking at differences between suppliers' geographical distances from the buyer, prior disruption experiences seem to be critical across all products and services no matter where suppliers are located, while kinesics interaction appears to be important in dyads with US-based suppliers, potentially because they are located in the buyer's region. Moreover, honesty and gratitude are fairly underlined by the buyer dealing with suppliers in Japan, where these values are important. As to American suppliers, they tend to share information informally via phone calls and text messages, while Italian and German suppliers use emails formally, remaining open in their interactions.

Consequently, the following proposition is developed:

> ***Proposition 1.*** *For increased and decreased demand categories, buying firms that share kinesics language, prior disruption experience, and values with their suppliers are more likely to make their supply chain prepared for an unexpected disruption. Kinesics language is more likely shared with geographically close suppliers, while shared values are more likely adjusted to be consistent with geographically distant suppliers.*

3.5.2 The role of cognitive capital in SCRES response

During response time, aligned goals, shared assumptions, and virtual communication avoid wasted time in goal recalibration and shorten problem-solving time when demand for materials increases. Indeed, shared goals and assumptions enable better understanding (Johnson et al., 2013), facilitate quick joint decisions, and create expected norms and behaviors (Fan and Stevenson, 2018), avoiding conflict (Villena et al., 2011).

Generally, low supply dispersion means low supply risks for buyers (Lei et al., 2019), who prefer dependable, responsive, and geographically close suppliers for quick problem-solving (Ellegaard, 2008). Examining differences between suppliers' geographical distances with the buyer, virtual communication seemed essential, to keep information flowing and join efforts during the crisis, particularly with distant suppliers in Asia and Mexico.

For decreased demand products, partners had conflicting goals because the buyer did not want stock, while suppliers were trying to push inventory to the buyer. Constant communication fine-tuned buyer-supplier shared assumptions about each other's situation, while shared values of honesty and empathy alleviated tension and facilitated quick response time.

Overall, these propositions are suggested:

> ***Proposition 2A.*** *For increased and decreased demand categories, buying firms that share assumptions with their suppliers are more likely to make their supply chain responsive to an unexpected disruption.*
>
> ***Proposition 2B.*** *For increased demand categories, buying firms that share goals, and virtual communication with their suppliers are more likely to make their supply chain responsive to an unexpected disruption. Virtual communication may be particularly valuable with geographically distant suppliers.*
>
> ***Proposition 2C.*** *For decreased demand categories, buying firms that share values with their suppliers are more likely to make their supply chain responsive to an unexpected disruption.*

3.5.3 The role of cognitive capital in SCRES recovery

Cognitive capital aspects are key enablers of inter-firm collaborations (Alinaghian et al., 2020; Boschma, 2005). Shared goals can encourage information sharing and ideas, but also enhance shared understanding, which reduces disagreements and refines the sense of shared responsibility, role, and task ownership (Chowdhury et al., 2019). During the crisis, selling was the number one goal for partners faced with increased demand, which enabled shared assumptions. Shared process capabilities became essential to control backorders, share forecasts, manage delivery priorities, monitor shift scheduling and separation, find transportation alternatives, and handle steep demand increases. Crucial in enabling a progressive recovery, team mentality facilitated communication and collaboration, which helped keep operations running.

When product demand decreases, the buyer avoids replenishment, while suppliers intend to ship inventory to the buyer. In this context, team mentality and shared assumptions become critical to keep business harmony, thus making shared process capabilities such as forecast sharing and regular virtual calls essential in the recovery process.

No major differences in cognitive capital elements are found regardless of suppliers' geographical distances with the buyer.

This leads to the development of these propositions:

> ***Proposition 3A.*** *For increased and decreased demand categories, buying firms that share process capability, and team mentality with their suppliers are more likely to make their supply chain recover from an unexpected disruption.*
>
> ***Proposition 3B.*** *For increased demand categories, buying firms that share goals and assumptions with their suppliers are more likely to make their supply chain recover from an unexpected disruption.*
>
> ***Proposition 3C.*** *For decreased demand products, buying firms that share assumptions with their suppliers are more likely to make their supply chain recover from an unexpected disruption***.**

3.5.4 The role of cognitive capital in SCRES learning

Lean inventory philosophy precluded production ramp-ups for increased demand products and services. Consequently, the buyer learned to add safety stocks to plan for the worst. The lack of inventory shortage management training delayed the buyer's ability to find stock, but ultimately triggered the buyer to identify resolution plans and train teams to follow them. Facilitating a self-reinforcing process of sensemaking (Weick, 1995), shared values such as integrity or commitment became important factors for the buyer to gauge suppliers' dedication during the crisis. Integrity was difficult to evaluate for a few distant suppliers who did not consider virtual communication indispensable.

Regarding low-demand product, virtual negotiation is essential to convince suppliers to keep extra inventory in-house, particularly when suppliers are not geographically close to the buyer. Training on how to manage stock surplus for decreased demand products is

an important factor to consider for future crises. Shared language eases communication, collaboration, and understanding (Inkpen and Tsang, 2005). Accordingly, the buyer realized quickly that sharing information in suppliers‘ national languages is often helpful in problem-solving.

The following propositions are elaborated:

> ***Proposition 4A.*** *For increased demand categories, buying firms that focus on their shared lean inventory philosophies, inventory shortage management trainings, and partners' integrity levels with their suppliers are more likely to make their supply chain learn how to alleviate an unexpected disruption. Integrity is more difficult to assess with geographically distant suppliers not favoring virtual communication.*
>
> ***Proposition 4B.*** *For decreased demand categories, buyer organizations that develop their virtual negotiation and multilingual skills, and inventory surplus management trainings with their suppliers are more likely to make their supply chain learn how to alleviate an unexpected disruption. Virtual negotiation and multilingual skills are particularly valuable with geographically distant suppliers.*

3.6 Theoretical contributions, managerial implications, and future research

3.6.1 Theoretical and managerial contributions

This paper contributes to the literature on supply chain risk and resilience and buyer-supplier relationships using an empirical approach. First, this study contributes to the supply chain risk and resilience literature by establishing the importance of cognitive capital embedded in a buying firm's relationships with suppliers (e.g., Johnson et al., 2013) in its SCRES capabilities. While the existing literature is heavily geared towards the structural and relational aspects of social capital, this paper extends the understanding of the role of cognitive capital by identifying its underlying relevant elements and their interrelationship with the four SCRES capabilities of prepare, respond, recover, and learn (e.g., Hendry et al., 2019; Ponomarov and Holcomb, 2009). In particular, drawing data from a unique supply chain disruption context caused by the COVID-19 pandemic, this study extends the previous literature by unpacking the role of

cognitive capital in the temporal SCRES capabilities observed to be at play as the disruption events unfolded. Also, the study of a disruption resulting in global fluctuations in both supply and demand enabled the identification of two contingencies (the impact of disruption on category demand in terms of demand increase vs. decrease and supplier geographical proximity) that affect the relationships between different aspects of cognitive capital and SCRES capabilities. This study further adds to the buyer-supplier relationship literature by identifying new elements of cognitive capital that are embedded in buyer-supplier relationships. New cognitive capital elements include kinesics language, strengthening relationships before the disruption, and shared values such as integrity and empathy, which are helpful in avoiding tensions. Business approaches like remote working, virtual communication and virtual negotiation enable information sharing and business continuity, while multilingualism clarifies communication with suppliers more comfortable in their native language. The supply chain risk and resilience literature has been highly analytical favoring mathematical reasoning over empirical approaches obtained from data and observation. Indeed, a high proportion of simulation and modeling papers examines contract optimization minimizing supply chain risks (Daghar et al., 2021), while empirical studies based on surveys and case studies remain limited (Ali et al., 2017; Tukamuhabwa et al., 2015). Daghar et al. (2021) in their review specifically note the dearth of work looking at the role of cognitive capital in supply chain resilience and call for qualitative work to understand it more fully. This paper is a response to that call.

The results of this study offer practitioners several practical implications. First, the insights of this study can help practitioners capitalize on and/or develop various facets of cognitive capital that are embedded in their relationships with their suppliers to enhance their organization's ability to prepare for, respond to, recover, and learn from supply chain disruptions. Indeed, for example, practitioners can use this study to examine particular cognitive capital elements that influence negatively their ability to prepare, respond, recover, and learn with their suppliers. Furthermore, this study brings to the fore two contextual factors (categories with increased vs. decreased demand as well the geographical proximity of suppliers with the buying firm) that managers need to be aware of when analyzing the various facets of cognitive capital in relation to their SCRES capabilities. Analyzing these different aspects of cognitive capital episodically with the

demand pattern and suppliers' geographical proximity can help contextualize how cognitively aligned partners are for every SCRES temporal capability. This can enable professionals to make more informed decisions when considering SCRES capability opportunities such as partner selection and relationship arrangements, sourcing strategies, governance mechanisms including contracts, process development and improvement, or any collaborative activities. This study provides managers with an analytical tool to manage the potential harmful effects arising from misalignments between parties in terms of interpretations and meanings, values, and goals. Procurement and supply chain management professionals may need to reconsider or even disengage from cognitively misaligned suppliers, as unshared values, assumptions, goals, approaches, experiences, and languages can add to the complexity of supply chain relationships and reduce their effectiveness in achieving resilience in supply chains.

3.6.2 Future research agenda

Clarifying theoretical concepts in practice, this paper cannot establish statistical generalizations but is an invitation for future research on cognitive capital's operationalization, and interaction with other social capital dimensions (i.e., structural, relational) and SCRES. Theoretical lenses (e.g., social network analysis, social psychology), and different units of analysis consisting of multi-level studies (i.e., individual level, organizational level) could assist in the investigation.

First, cognitive capital's nature is difficult to decipher in context because of its richness and entanglement with other social capital dimensions (Nahapiet and Ghoshal, 1998). Indeed, shared codes and language, and shared narrative elements are part of any supply chain ecosystem, but remain diverse, contextual, and thus hard to collect. Cognitive capital has been examined with the rest of the other social capital dimensions, mostly in surveys and a few qualitative studies. Yet, cognitive capital remains misunderstood throughout the literature, rendering its full operationalization challenging. Some cognitive capital elements could require several studies to grasp the full extent of their meaning in context such as shared values (e.g., honesty, fairness, gratitude, empathy, or integrity), kinesics or face-to-face language, and training. Scarcely noted in

the literature, specific cognitive capital elements such as shared identity and management styles need assessment, especially because of their day-to-day practicality.

Second, the interaction of cognitive capital's elements on their own, but also with other social capital dimensions (i.e., structural, relational) and SCRES has been underexplored throughout the literature. Indeed, some cognitive element levels might trigger other cognitive elements to intensify or decline. For example, shared assumptions could facilitate shared goals or vice-versa, and shared values like integrity could increase empathy. This study invites the analysis of how cognitive capital develops, accumulates, cancels, decreases, or counteracts other evolving social capital dimensions. Despite research calls on cognitive capital (Daghar et al., 2021), and some of its elements such as organizational culture (Revilla and Saenz, 2017) or national cultures (Gupta and Gupta, 2019), cognitive capital elements' interaction with each other's and SCRES remain superficial in the literature. Qualitative work could delineate the relationships between cognitive capital and SCRES, while quantitative research could assess how cognitive capital accounts for the variation of the SCRES' most cited enablers (i.e., collaboration, flexibility, visibility, velocity) (Jüttner and Maklan, 2011) for every SCRES temporal capability (i.e., prepare, respond, recover, learn). Further research could also examine interrelationships between social capital, particularly cognitive capital, and the concept of antifragility or the ability to go beyond resilience by embracing and learning from disorder rather than avoiding it (Nikookar et al., 2021; Taleb, 2012).

Third, using different perspectives of analysis could enrich SCRES research, notably with the social network analysis and social psychology lenses. The extant literature largely adopting a dyadic approach, qualitative or quantitative approaches have yet to be examined in network contexts. Social network analysis using position and connectedness indicators could be a valuable tool to grasp better how cognitive capital influences SCRES for both buyers and suppliers. The social psychology literature could also open an in-depth investigation of cognitive capital in SCRES. For example, social cognition concerned with how social information is processed, stored, and applied, notably through thought or behavior patterns called schemas could be an intriguing area to study. Moreover, examining the role of attitude, but also self, and social identity could improve

the understanding of how emotions, beliefs, behaviors, and self-perceptions affect social interactions and SCRES. Finally, group behaviors, dynamics, leadership, disagreement, persuasion, peer pressure, and conformity are other interesting social psychology topics. Furthermore, despite the great volume of scholarly work on interorganizational relationships in buyer-supplier settings, existing studies have not investigated social capital and how it develops across levels of analysis (i.e., individual level, organizational level). Organizations and relationships are embedded in one another and can influence each other (Lumineau and Schilke, 2018). As such, there is a need for multi-level studies (Lumineau and Schilke, 2018) examining the ramifications of both individual and organizational levels.

Data availability statement: due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data are not available.

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APPENDIX B for Paper 2

Table B.1 Case study interview questionnaire

1. COVID-19 CONTEXT	(a) Can you tell me what happened with your suppliers since COVID 19 started? (b) How resilient do you think your (upstream) supply chain was? (c) Where do you think the vulnerabilities were and why? How did you face them? (d) Where were the successes in dealing with the crisis and why do you think were you successful in these areas?
2. SUPPLIER-BUYER RELATIONSHIPS	(a) How did your relationship with your suppliers help or hinder you in this crisis? (b) What do you think are the key lessons learned in terms of selecting and managing your supplier relationships?
3. ORGANIZATIONAL CULTURE AS A PROXY FOR COGNITIVE CAPITAL	Definition: organizational culture is a set of shared assumptions, values, narratives, beliefs, norms, mutual understandings, and behavioral expectations tying together people around an organization over time and reflecting in practices (a) What do you think about this definition? (b) How different or similar were your suppliers' organizational cultures compared to yours? (c) How did your and supplier organizational cultures influence the way you dealt with your suppliers at the time of crisis? (d) How did these organizational cultures affect the way you handled the crisis generally?
4. ADAPTATION/LEARNING	(a) Since COVID-19 started, how is your relationship with your supplier evolving, and why? (b) How did this crisis shape your practices with your suppliers? (c) How (fast) did you and your supplier adapt to the crisis? (d) What and how did you learn with your supplier during the crisis?

4. Resilient interorganizational culture in multi-tier supply networks: the ‘what’ and ‘how’

Abstract

Purpose: Highlighted in multiple calls, research on interorganizational culture remains limited in the supply chain resilience (SCRES) literature, particularly at the supply network-level. Drawing from an in-depth case study of a US chemical multinational and 21 multi-tier suppliers facing the COVID-19 disruption, this paper explores interorganizational culture's role in SCRES in a multi-tier supply network.

Design/methodology/approach: The case consisted of 83 in-depth interviews over nine months, collecting data from a buyer and 21 suppliers in the chemical industry. Using balance theory, the analysis examines what and how inter-organizational culture elements influence the SCRES elements of collaboration, flexibility, visibility, and velocity in a disrupted multi-tier supply network.

Findings: The case study sheds light on the various cultural elements and supply network mechanisms between organizations during a significant global disruption. These cultural elements encompass shared goals, expectations, understanding, processes, and values. The findings of this study indicate that these cultural elements, along with supply network-level mechanisms of cultural propagation and cultural transitivity in balanced and unbalanced triadic cultural relationships, affect different aspects of SCRES uniquely. The study underscores the significance of evaluating the interorganizational cultural alignments existing in supply networks to achieve SCRES.

Originality: This paper maps aligned cultural elements and explains how they characterize a resilient interorganizational culture in a multi-tier supply network through the ideas of network-level cultural propagation and cultural transitivity in balanced and unbalanced triadic cultural relationships. This case study extends the SCRES literature by exploring the application of balance theory to resilient interorganizational cultures in multi-tier supply networks.

Keywords: supply chain resilience, supply network, balance theory, interorganizational relationships, interorganizational culture, buyer-supplier relationships.

Article classification: Research paper, case study.

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4.1 Introduction

Interorganizational culture represents shared goals and objectives, business philosophies or management styles (Sáenz et al., 2014), assumptions (Chowdhury et al., 2019), norms, beliefs, and values (Hult et al., 2007) that help achieve strategic alignment between partners (Sáenz et al., 2014). Scholars have connected the idea of interorganizational culture to cultural compatibility (e.g., Sáenz et al., 2014). While interorganizational culture is what partners culturally share, cultural compatibility, also known as cultural alignment or fit (Cartwright and Cooper, 1993), identifies the degree to which two partners share a set of norms, beliefs, or values (Hult et al., 2007). The sharing of norms between partners enables the transition of intra- to interorganizational rules and vice versa (Sáenz et al., 2014). In the context of alliances and partnerships, scholars suggested that an aligned interorganizational culture is vital in nurturing trust and commitment, necessary to achieve strategic congruence (Cartwright and Cooper, 1993). Similarly, in the buyer-supplier context, existing studies have demonstrated that interorganizational culture significantly shapes supply chain performance (Cao et al., 2015), notably by influencing collaborative synergies, shared understanding, and cognitive efforts to mitigate supply risks, thereby enabling supply chain resilience (SCRES) (Chowdhury et al., 2019). Scholars have further revealed that compatible or aligned interorganizational cultures can help avoid business failure, strife, and suspicion (Rajaguru and Matanda, 2019).

The existing supply chain literature has largely focused on cultural aspects at the organizational and buyer-supplier levels (Chowdhury et al., 2019; Rajaguru and Matanda, 2019). However, culture transcends the walls of one firm or buyer-supplier relationships, since social interactions among groups of people occur without any clear boundaries (Lee et al., 2015). Supply chains go beyond the confines of buyer-supplier dyads (Kim et al., 2011), as these dyads can influence each other and be influenced by different connections within the broader supply networks. A firm's failure to address supply disruptions often stems from a limited understanding of the supply network in which it is embedded (Kim et al. 2015). Consequently, SCRES strategies must be network-wide (Christopher and Peck, 2004). Indeed, the performance of a supplier relies on the

effectiveness of its extended supply network. Therefore, it is essential for buyers to reduce supply risks by selecting and assessing suppliers not in isolation but rather in consideration of their embeddedness within larger supplier networks (Kim et al., 2011). A relevant example is Toyota, whose North American truck production stopped over a component disruption in a Japanese plant (Kim et al. 2015). As such, a network lens is necessary to develop resilience and understand how global supply chains work comprehensively. Given the increasing number of supply chain players struck by disruptions, a few studies have recently shifted their attention from dyads to broader supply networks to unveil complex and inconspicuous supply network patterns and how disruptions proliferate insidiously in multi-tier supply networks (Kim et al., 2015). Shaping how companies address issues, culture affects interfirm relationships and trust (Cao et al., 2015) and plays an instrumental role in making supply networks resilient (Ali et al., 2017; Christopher and Peck, 2004). The current supply chain literature focuses predominantly on the flow of materials and information. It needs to articulate how resilient interorganizational cultures work and what cultural mechanisms regulate them in multi-tier supply networks.

This work explores resilient interorganizational culture at the supply network-level. It adopts a network view (Kim et al., 2011) that draws on balance theory (Choi and Wu, 2009) to examine cultural balance/unbalance in triads and supply networks. Investigated in triads, balance theory stipulates that relationship balance is possible when all partners share similar views or when two relationships in the triad are adversarial (Hummon and Doreian, 2003). SCRES enables companies to persist, adapt, or transform when dealing with disruptions (Wieland and Durach, 2021) through organizational and interorganizational resources and capabilities (Kamalahmadi and Parast, 2016). This study seeks to identify precisely what and explain how interorganizational culture elements impact the four most common SCRES capability elements (i.e., collaboration, flexibility, visibility, and velocity) (Ali et al., 2017; Johnson et al., 2013; Jüttner and Maklan, 2011) in a disrupted multi-tier supply network. These SCRES capabilities will be fully defined in the next chapter. The research questions guiding this work are as follows:

(1) What interorganizational cultural elements impact SCRES elements at a supply network-level?
(2) How do these interorganizational cultural elements impact SCRES at the supply network-level?

Culture is an intricate concept, lending itself to qualitative methods seeking data depth to understand unclear underlying assumptions and meanings (Cadden et al., 2013). Hence, a qualitative approach based on an in-depth case study of the industrial lubricant supply network of a chemical multinational in the US was used to collect data from 83 interviews from 22 organizations (i.e., 21 suppliers and one lead buyer). This paper contributes theoretically to the SCRES literature by mapping aligned/misaligned cultural elements and explaining how a resilient interorganizational culture is constituted through the ideas of cultural element propagation and transitivity in a multi-tier supply network.

4.2 Theoretical background

4.2.1 SCRES

In the supply chain literature, scholars have mainly adopted an engineering view of resilience, highlighting the system's ability to bounce back to an equilibrium state (Sheffi and Rice, 2005). However, some supply chain researchers have recently started to challenge the equilibrium state and consider disruptions as opportunities to metamorphose, adapt, evolve, and transform (Wieland and Durach, 2021). Drawing on complex adaptive systems from the study of ecosystems, social systems, and the panarchy framework, scholars have introduced the notion of growth (Day, 2014), adaptation, transformability (Wieland and Durach, 2021), and antifragility, embracing turbulence rather than avoiding it (Nikookar et al., 2021). In the same vein, recent theorizations have adopted the dynamic capability lens to study transformation and growth in SCRES (Nikookar et al., 2021). This lens investigates the SCRES capabilities to (1) sense/recognize threats and opportunities (i.e., proactive capability to prepare and learn), (2) seize/respond to threats and opportunities (i.e., reactive capability to respond), and (3) transform/improve the firm's capabilities (i.e., reactive capability to recover and learn) (Nikookar et al., 2021). Accordingly, this study considers SCRES as an adaptive capability to maintain operations continuity against disruptions at the desired level of

connectedness and control over structure and function (Ponomarov and Holcomb, 2009). This adaptive capability consists of preparing for, responding to, recovering from (Ponomarov and Holcomb, 2009),and learning from disruptions (Day, 2014).

SCRES capabilities of preparation, response, recovery, and learning are enabled by elements/enablers (Ali et al., 2017; Christopher and Peck, 2004). The most common SCRES elements discussed in the literature are collaboration, flexibility, visibility, and velocity (Ali et al., 2017; Jüttner and Maklan, 2011; Johnson et al., 2013; Sá et al., 2019; Scholten and Schilder, 2015). Other than these four elements, many others stemming from these can be found in the SCRES literature such as management support, continuity teams, training, past learning (Chowdhury and Quaddus, 2016), risk awareness, efficiency, redundancy (Scholten et al., 2014), knowledge management, but also social capital (Ali et al., 2017) with personal relationships and social interactions (Nikookar and Yandori, 2022).

Firms are not self-sufficient and need each other's critical resources to operate and survive in supply networks. As such, resilience in supply networks depends on resources possessed by different supply network members (Nikookar and Yandori, 2022). These resources are called network resources (Gulati, 1999). In this study, network resources consist of the four most discussed SCRES elements in the literature (i.e., collaboration, flexibility, visibility, velocity), which the buyer and suppliers in the network can access to enable SCRES. Collaboration between members represents the level of tactical, operational, and strategic shared decision-making and joint efforts (Jüttner and Maklan, 2011). Flexibility is the aptitude of a supply chain to change the number and heterogeneity of possible solutions to respond to a market event while maintaining performance (Stevenson and Spring, 2007). This could manifest in flexible supply, demand, processes, capacity, and order fulfillment or transportation (Ali et al., 2017). Visibility is the ability of the supply chain to capture timely information about the identification, location, and status of supply chain events or entities (Johnson et al., 2013). Velocity revolves around the adaptation speed by which a supply chain responds to and recovers from a market event (Christopher and Peck, 2004).

4.2.2 SCRES and interorganizational culture

Components of interorganizational culture have been briefly examined within buyer-supplier relationships in the supply chain risk and resilience literature. Suppliers and buyers use interorganizational culture to help tacit and explicit understanding, but also cognitive effort in supply risk identification (Fan and Stevenson, 2018) and mitigation (Chowdhury et al., 2019). Studying humanitarian supply chains, Altay et al. (2018) show that control and flexibility orientation cultures positively influence SCRES and pre/post-disaster performance. SCRES and supply chain risk management cultures are specific organizational cultures that enable the concepts of resilience (Christopher and Peck, 2004).

Buyer-supplier organizational culture compatibility achieves the highest performance outcomes (Cadden et al., 2013). Indeed, interorganizational cultural compatibility in philosophies, values, social norms, professionalism, and chemistry positively impacts interorganizational information systems integration and supply chain capabilities (Rajaguru and Matanda, 2019).

4.2.3 A supply network view of SCRES

A supply network is a collection of nodes and arcs (Borgatti and Li, 2009). Nodes consist of suppliers, manufacturers, service providers, and customers linked by arcs/ties in the form of physical flows (e.g., materials) or contractual relationships (Kim et al., 2011). The literature discusses disruptions at two levels of analysis: the node/arc-level and network-level. The node/arc-level investigates nodes individually and/or arcs consisting of a dyad with two nodes, while the network-level examines the broader structure (Kim et al., 2011). This study grounds its supply network perspective on a focal node network encompassing a focal firm or the lead buyer and a set of firms or suppliers with direct or indirect ties to the focal firm (Borgatti and Li, 2009). In this study, the focal firm or lead buyer is the destination of the physical flows emanating from other nodes. Acknowledged in a few studies, SCRES at the supply network-level remains underexamined (Kim et al., 2015). This work focuses on node/arc disruptions and how they affect the SCRES elements of collaboration, flexibility, visibility, and velocity of the supply network. Conceptualizing

supply networks in the form of material and informational flows, the literature overlooks the role of cultural alignment between two nodes and how it affects supply network resilience. This study looks at the extent to which two nodes and a supply network are culturally aligned as the critical mechanism impacting SCRES.

4.2.4 Balance theory's applicability to interorganizational cultural relationships

Balance theory is a theoretical framework, first developed in behavioral psychology, to study triadic interpersonal and group relationships, where a (+) sign typically represents a cooperative relationship between two firms, while a (-) sign indicates an uncooperative relationship between two firms (Choi and Wu, 2009). This work uses balance theory to characterize the nature of cultural relationships between partners. Balance theory enables to identify and understand balanced and unbalanced cultural relationships in triads. According to the literature on balance theory (Hummon and Doreian, 2003), a balanced triadic relationship always has three (+) signs or two (-) signs and one (+) sign, and an unbalanced triadic relationship always has two (+) signs and one (-) sign or three (-) signs. Balance theory describes interorganizational relationships similarly to the buyer-supplier relationship literature with positive/cooperative relationships or negative/adversarial relationships between two nodes. It is also the only theory from the broad academic literature that addresses triads (Choi and Wu, 2009). Triads constitute the smallest supply networks. Therefore, using balance theory has sound applicability to interorganizational cultural relationships in triads and larger supply networks. Although initially this theory focuses on the individual level, management researchers have used it to understand organizations. Answering the call from Choi and Wu (2019) to use balance theory while examining relationships in triads, this paper explores cultural elements and their alignments to form SCRES in triads and larger supply networks to expand the literature. This work characterizes cultural alignments between two actors with a (+) and cultural misalignments between two actors with a (-).

4.3 Method

Underexplored in the literature, interorganizational culture, and resilient interorganizational culture are complex real-life phenomena that can amply be explored

through a single case study (Siggelkow, 2007) seeking meaning and context over causality and positivist generalization (Eisenhardt, 1989). As such, despite its limited generalizability applications and risk of subjectivity, a case study method was selected to focus on detailed descriptions, data analysis, and exploration of contextual factors (Yin, 2018). The case analyzes the supply network of the US-based industrial lubricant division of a chemical multinational consisting of a lead buyer referred to as LEAD_BUYER in this paper and 21 other organizations operating in its extended upstream supply chain (Figure 1).

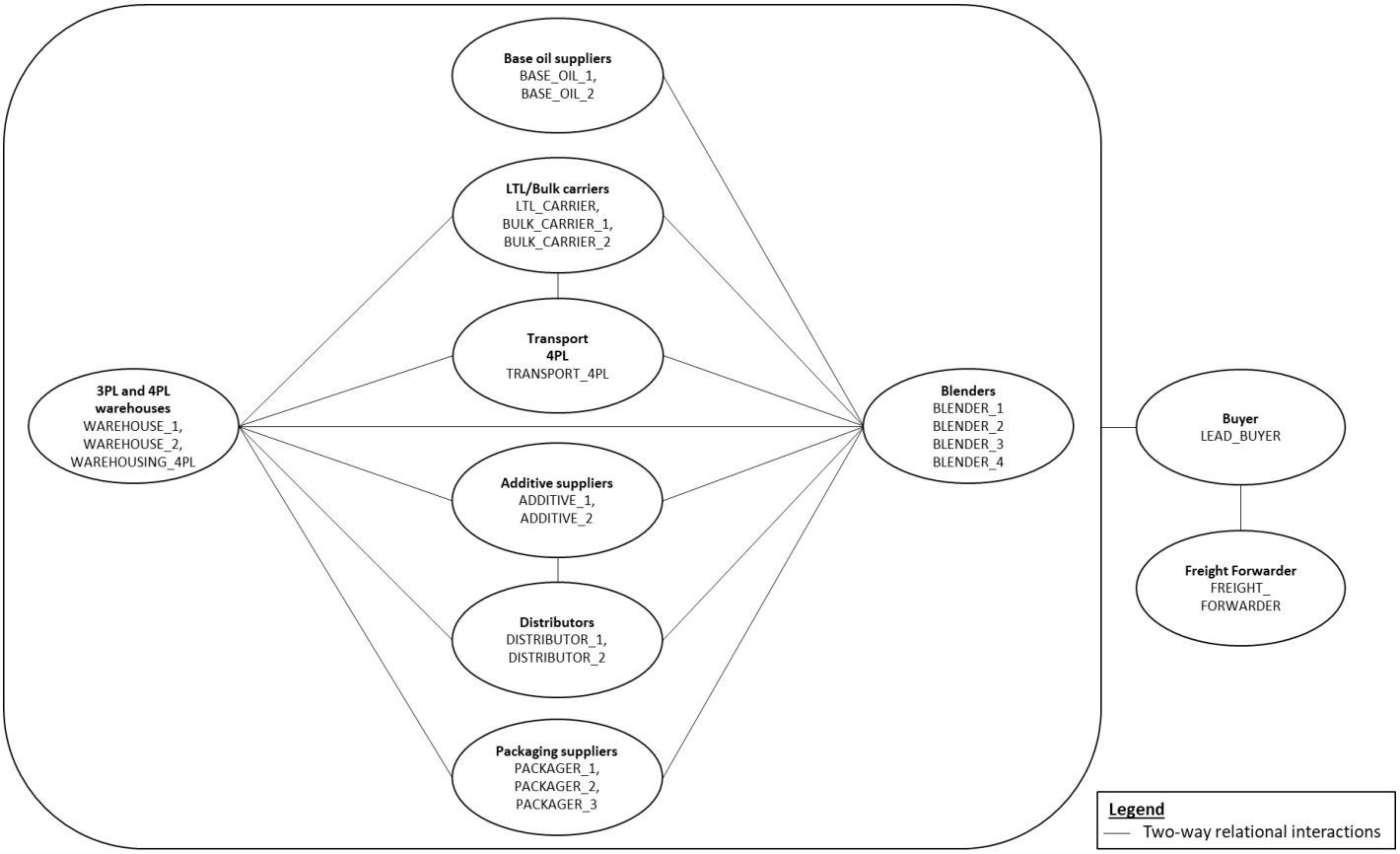

Figure 4-1 Examination of LEAD_BUYER's supply network

LEAD_BUYER was the focal buyer and purchased products and services directly from 21 suppliers. LEAD_BUYER had a FREIGHT_FORWARDER that managed ocean and land carriers for products overseas. LEAD_BUYER subcontracted the production of some special blends to BLENDER_1, BLENDER_2, BLENDER_3, and BLENDER_4 that produced oil blends shipped to LEAD_BUYER's third-party WAREHOUSE_1,

WAREHOUSE_2, and WAREHOUSING_4PL or end-customers. In the production process, LEAD_BUYER and blenders used suppliers: BASE_OIL_1, BASE_OIL_2, ADDITIVE_1, ADDITIVE_2, PACKAGER_1, PACKAGER_2, PACKAGER_3, DISTRIBUTOR_1, and DISTRIBUTOR_2. In the delivery process, blenders used LEAD_BUYER's transportation 4PL, TRANSPORT_4PL, to organize transport with LTL_CARRIER (i.e., LTL: Less-Than-Truckload), BULK_CARRIER_1, and BULK_CARRIER_2 shipping to LEAD_BUYER's third-party warehouses and customers. The warehouses worked with all LEAD_BUYER's suppliers, except the base oil suppliers, to schedule deliveries of materials that LEAD_BUYER needed. LTL and bulk carriers were exclusively managed by LEAD_BUYER's transportation 4PL. Distributors purchased products from additive suppliers. Packaging suppliers supplied the blenders and LEAD_BUYER. Suppliers were selected for their products and service diversity to enable a richer contextual analysis. The data collection process lasted nine months, between January and September 2022.

4.3.1 Case study selection and context

The choice of the case study was based on the supply network complexity (i.e., number of suppliers, geographies, interactions), multisectoral and functional supplier diversity, and data accessibility. Heavily affected by diverse COVID-driven disruptions, LEAD_BUYER is a chemical multinational that has a vast supply network embedded in various industries. Open to provide access to their data in this case study, LEAD_BUYER's biggest suppliers in volume are also major players deeply anchored in the chemical, transportation, and logistics industries. With numerous suppliers scattered in the United States, LEAD_BUYER sources from and delivers to multi-industrial actors. The case study focuses on the industrial lubricant division and the suppliers of the US multinational. Extreme contexts enable compelling portrayals of phenomenon characteristics (Scholten et al., 2014). As an extreme case, the COVID-19 pandemic context was chosen as an opportunity to delve into the concept of resilient interorganizational culture at the supply network-level. Multiple COVID-driven incidents were identified throughout the case, enabling the utilization of critical incident analysis (Flanagan, 1954) to understand how people perceived unfolding events. The case

predominantly revolves around LEAD_BUYER and tier-1 and tier-2 suppliers but also incorporates tier-3 and tier-4 suppliers. A network approach was selected to explore qualitatively how interorganizational cultural elements align to form supply network resilience.

4.3.2 Data collection

The study uses mainly 83 semi-structured interviews of individuals from 22 companies in the chemical industry, plus other data (Table 4-1: respondent profiles list). Representing all product categories needed to produce industrial lubricants, top tier-1 suppliers in volume selling to LEAD_BUYER were selected for interviews. All selected tier-1 suppliers working in Sales agreed to participate in the study. Then, based on a chain sampling process, these Sales participants referred the research team to other participants from their Supply Chain departments and top suppliers. These suppliers were tier-2 suppliers to LEAD_BUYER, which provided access to their suppliers, as well. Chain sampling continued until data saturation was reached, sometimes up to tier-3 and tier-4 suppliers.

To allow data-rich collection, individuals with different title levels and decision-making influence in Sales and Operations were selected and interviewed. Twelve company types were interviewed: an industrial lubricant manufacturer/lead buyer, two base oil suppliers, four blenders, two additive suppliers, three packaging suppliers, two distributors, one 4PL warehouse provider, two warehouses, one 4PL transportation provider, one LTL carrier, two bulk carriers, and one freight forwarder. On the buyer side, 20 individuals in Operations were interviewed from Production, Maintenance, Quality, Engineering, Planning, Purchasing, Procurement, Transportation, and Logistics at different levels (i.e., Analyst, Manager, Director). On the supplier side, 63 individuals were interviewed. Three people were interviewed per supplier from the Sales and Supply Chain departments at different levels (i.e., Analyst, Manager, Director, VP, President/GM/CEO). Additionally, information available in supplier-buyer project presentations, meetings, emails, and phone calls allowed for data triangulation, increasing the reliability and validity of the results (Yin, 2018). Data were collected and analyzed from participatory observations (i.e., 29 hours of 36 virtual and face-to-face meetings) and non-participatory observations

(i.e., 12 hours of 15 virtual and face-to-face meetings). Interviews were recorded using Microsoft Teams and were transcribed.

Interviewee number	Gender	Age	Title	Company years of experience	Interview time in minutes	Anonymous company name	Core business
1	Male	44	Purchasing Manager	5	40	LEAD_BUYER	Buyer
2	Female	38	Distribution and Logistics Supervisor	3	55		
3	Male	41	Transportation and Logistics Analyst	7	40		
4	Female	43	Buyer	4	41		
5	Male	45	Transportation and Logistics Analyst	6	54		
6	Male	63	Warehouse Manager	43	43		
7	Male	42	Customer Service and Distribution Manager	5	51		
8	Male	60	Supply Chain Manager	31	67		
9	Male	49	Buyer	2	46		
10	Female	41	Production Planner	3	42		
11	Male	59	Warehouse and Transportation manager	37	41		
12	Male	46	Production Manager	4	41		
13	Male	74	Senior Business Consultant	3	77		
14	Male	61	Technical Director	9	45		
15	Male	31	Planner	4	41		
16	Male	52	Sourcing Project Director	11	50		
17	Female	32	Buyer	2	47		
18	Male	38	Maintenance Manager	15	40		
19	Female	44	Buyer	2	41		
20	Male	61	Health, Safety, Environment, and Quality Manager	43	42		
21	Female	26	Account Manager	4	43	BASE_OIL_1	Base oil supplier
22	Male	54	Senior Sales Executive	20	43		
23	Male	44	Senior Supply Chain Analyst	5	44		
24	Male	55	Account Manager	15	40	BASE_OIL_2	
25	Female	38	Director of Supply Chain Planning	3	39		
26	Male	44	Director of Customer Accounts	4	34		
27	Male	54	General Manager	31	39	ADDITIVE_1	Additive supplier
28	Male	61	Vice President of Sales	11	39		
29	Female	62	Sourcing and Procurement Manager	12	46		
30	Male	51	Director of Sales	15	40	ADDITIVE_2	
31	Female	59	Transportation Manager	36	36		
32	Male	46	Transportation, Logistics, and Packaging Category Manager	10	36		
33	Female	38	Business Development Manager	3	43	BLENDER_1	Blender
34	Female	59	Purchasing Manager	27	42		
35	Male	44	President	17	43		
36	Male	58	Vice President of Manufacturing and Supply	17	44	BLENDER_2	
37	Male	64	Chief Operating Officer and General Manager	39	46		
38	Female	58	Director of Customer Relations	30	40		
39	Male	62	Vice President of Sales	34	42	BLENDER_3	
40	Male	54	Senior Operations Manager	22	35		
41	Male	45	Senior Customer Service Manager	11	42		
42	Male	44	Director of Business Account	17	40	BLENDER_4	
43	Male	42	Production Manager	9	41		
44	Female	44	Purchasing and Procurement Manager	8	52		

Interviewee number	Gender	Age	Title	Company years of experience	Interview time in minutes	Anonymous company name	Core business
45	Female	44	Senior Sales Account Manager	4	52	DISTRIBUTOR_1	Distributor
46	Male	52	Vice President of Supplier Development	24	68		
47	Male	44	Director of Supplier Relationships	6	45		
48	Female	44	Vice President of Corporate Accounts East	22	50	DISTRIBUTOR_2	
49	Male	56	Vice President of Corporate Accounts West	25	42		
50	Male	55	Senior President of Commercial Operations and Supply	20	43		
51	Male	46	President	20	53	PACKAGER_1	Packaging supplier
52	Male	70	Director of Sales	6	57		
53	Female	45	Procurement Manager	20	44		
54	Male	58	Account Manager	31	48	PACKAGER_2	
55	Female	48	Procurement Manager	18	39		
56	Male	62	Corporate Logistics Manager East Region	36	34		
57	Male	40	Production Manager	7	54	PACKAGER_3	
58	Male	36	Supply Chain Manager	6	44		
59	Female	42	Sales Manager	17	41		
60	Female	41	National Account Manager	3	73	FREIGHT_FORWARDER	Freight Forwarder
61	Male	43	Sales Manager	2	42		
62	Male	58	Vice President of Sales and Customer Accounts	4	62		
63	Male	56	Director of Accounts	29	64	TRANSPORT_4PL	Transportation 4PL
64	Female	47	Purchasing and Support Services Director	22	42		
65	Male	43	Director of Business Development	12	52		
66	Male	57	Senior Vice President of Strategic Planning	27	34	LTL_CARRIER	LTL carrier
67	Male	62	Senior Vice Presdient of Sales	31	38		
68	Male	62	Vice President of Maintenance	33	48		
69	Male	63	Chief Operating Officer and General Manager	38	46	BULK_CARRIER_1	Bulk carrier
70	Male	32	Senior Dispatch Analyst	8	36		
71	Female	58	General Manager	38	41		
72	Male	38	Business Development Manager	16	49	BULK_CARRIER_2	
73	Male	50	Chief Operating Officer and President	30	84		
74	Male	66	Chief Financial Officer	42	43		
75	Female	35	Director of Customer Success	3	54	WAREHOUSING_4PL	Warehousing 4PL
76	Female	44	Head of Supply Chain Experience	3	36		
77	Female	38	Procurement Manager	3	42		
78	Male	46	Warehouse Manager	7	56	WAREHOUSE_1	Warehouse
79	Male	46	Vice President of Marketing and Strategy/General Manager	12	38		
80	Male	54	Vice President of Business Development	6	43		
81	Male	62	General Manager	27	41	WAREHOUSE_2	
82	Male	46	Warehouse Manager	4	43		
83	Female	62	Sales Manager	8	36		

Table 4-1 Respondent profiles

An in-depth interview protocol was built using open-ended questions with broad and known themes to enable understanding, exploration, and follow-up questions. The same interview questions were used for buyers and suppliers. Questions probed buyers and suppliers about their respective relationships. Interorganizational cultures and networks were investigated using words such as corporate culture similarities/differences, suppliers, and customers. SCRES was examined using words such as risk coping mechanisms/resilience, and the SCRES elements of collaboration, flexibility, visibility, and velocity. 95% of the interviewees had three or more years of experience in their respective organizations. Approximately 30% of respondents were female and 70% male. The interview average time was 46 minutes. No pattern emerged from the employees' time in their organizations, titles, or core business functions.

Interviewees discussed certain disruption events that involved their organizations with others, explaining how one or more cultural alignment(s) helped them cope with disruptions and create resilience. These disruption events constituted narratives with respondents, organizations, cultural alignments/misalignments, and impacted SCRES elements. Every collected narrative was modeled by connecting the organizations of the disruption-driven story in a diagram/supply network where nodes represent the organizations and links/arcs characterize cultural alignments/misalignment embedded in material, informational, and financial flows. Respondents highlighted relevant cultural elements that impacted SCRES in their respective supply networks and narratives. Supply networks were only modeled and created when actors of the network discussed a specific disruption, respective cultural alignments/misalignments, and impacted SCRES elements with actors they were connected to in the modeled network. This enabled the identification of shared/interorganizational cultural elements running through the supply network between organizations during a specific disruption. Some disruptions were discussed in narratives where actors and cultural elements were different but embedded in supply networks of similar structure (i.e., same number of actors and links/arcs configuration). Thus, each diagram/supply network can represent multiple narratives or disruption stories between different actors discussing different cultural and SCRES elements.

4.3.3 Data analysis

The thematic and data analysis of the transcribed interviews was processed in NVivo, helping to systematize substantial textual data (Johnson et al., 2013).

Interorganizational culture represents common goals, objectives, business philosophies, or management styles (Sáenz et al., 2014), assumptions (Chowdhury et al., 2019), norms, beliefs, and values (Hult et al., 2007). Using this definition, the data analysis unveiled (1) what specific interorganizational cultural elements impact SCRES and (2) how these interorganizational cultural elements impact SCRES at the supply network-level. Table 4-2 shows the thematic analysis of interorganizational cultural elements surfacing from the data in a supply network context with a total of 101 codes. Staying faithful to the terms used by informants and the definition of interorganizational culture, the Gioia methodology (Gioia et al., 2013) was used to determine the interorganizational cultural elements aligning between partners to help enable SCRES in the supply network. Interorganizational cultural elements consisted of shared goals and expectations (i.e., 17 codes), understanding (i.e., 23 codes), processes (i.e., 24 codes), and values (i.e., 37 codes). Shared goals were comprised of shared delivery performance, business continuity, and safety goals emerging as shared principles guiding all strategic and operational processes. Shared understanding entailed shared assumptions and narratives. Shared assumptions were beliefs assumed by partners to be true, such as logistical capabilities, while shared narratives were shared stories. Shared processes were agreed-upon norms consisting of forecast sharing, shared delivery scheduling processes, and shared invoice management processes. Shared values revolved around shared communication, empathy, and respect.

FIRST-ORDER CONCEPTS	SECOND-ORDER THEMES/ELEMENTS	AGGREGATE ELEMENTS
• Suppliers need to deliver results on-time as initially agreed upon with their customers • On-time delivery expectations from customers are rippling back to the lead buyer and its suppliers • The goal of any actor is to deliver high-quality products on-time to avoid supply chain disruption	**Shared on-time delivery performance goals**	**Shared goals and expectations**
• Failure to keep the business operating affects negatively customers • If work stops, there will be supply chain resource inefficiencies, downtime and costs associated • Operational non-performance prevents collaboration, profit and survival	**Shared business continuity goals**	
• Safety is crucial to avoid fatalities • All operations are supervised using safety protocols and procedures • Suppliers are selected based on how safe they run	**Shared safety goals**	
• Understanding partners logistical capability helps coordinate deliveries with carriers • Misunderstandings between partners (e.g., delivery time, PPE needs,) create conflict and waste time • Partners prioritize high revenue generating customers • Suppliers want to increase their business volumes with customers	**Shared assumptions**	**Shared understanding**
• The lack of supply, increased demand, resource shortages and inflation created a shared narrative • Shared COVID-driven contexts and problems helped resolving situations collaboratively • Lack of resources due to the pandemic delayed operations. This was understood by most people	**Shared narratives**	
• Customers became alert about their backlog growing, and scheduled more meetings to follow up and prioritize shipments • Scheduling deliveries became critical, with the lack of logistics and production resources across the supply chain network • Managing suppliers and their performance is necessary to identify weaknesses in the supply network and coordinate deliveries	**Shared delivery scheduling process**	**Shared processes**
• The focus of the buyer was on customers sharing their forecasts to increase demand predictability • Partners shared forecasts to manage supply allocation and prioritize backlogs • Forecasts were shared between the lead buyer and suppliers to anticipate supply needs	**Shared forecasts process**	
• Customers not paying invoices were on the red list. Deliveries to these customers stopped • Suppliers scheduled frequent meetings with customers to discuss unpaid invoices • A few small to medim size unpaid suppliers suffered financially and were on the brink of collapsing	**Shared invoice management process**	
• Communication is the number one tool to resolve any problem • A few communicative actors are key at determining substitutable materials, and finding alternatives • Working from home made emails, phone calls and virtual meetings essential to communicate • There is a need for absolute transparency and honestly to help understand and fix problems	**Shared communication**	**Shared values**
• Adaptability to customers' requests and suppliers' contexts sustained collaborative relationships • Sometimes mistakes are made and being apologetic can alleviate the situation • No one wants to work with aggressive drivers or customers with an attitude • Suppliers who are responsive and supportive are easy to work with and take precedence over others • Commitments are taken very seriously, and are a sign of professionalism • Creative suppliers accommodating customers, for example by stationing trucks overnight at the customer site are very helpful • Lots of questions are asked, out of curiosity. Answers to these questions help resolve problems • Suppliers lying or overpromising are pushed to the side. Integrity is essential for business • Partners who understand each other's pain tend to be patient and help each other more • Compatibility of personalities between partners can make or break relationships • Respectful, trustworthy, and professional relationships improve collaboration • Friendly partners with a team spirit help reach solutions quicker	**Shared respect and empathy**	

Table 4-2 Interorganizational cultural elements emerging from the Gioia method

Ponomarov and Holcomb (2009) define SCRES as a supply chain adaptive capability to maintain operations continuity against disruptions at the desired level of connectedness and control over structure and function. Underexamined in the previous SCRES literature, the concept of connectedness over structure and function is explored in this work through the lens of cultural alignments enabling cultural connectedness between partners. All actors in the supply network interacted through material, financial, and informational flows. The paper examines interorganizational cultural alignments embedded in these flows. Quotes were selected and split into two categories: those describing aligned cultural elements and those depicting misaligned cultural elements.

To understand what and how interorganizational cultural elements influence SCRES elements, quotes including aligned/misaligned interorganizational cultural elements were sorted and connected to the SCRES elements of collaboration, flexibility, visibility, and velocity. Table 4-3 provides illustrative case study quotes and their links with SCRES Ali et al., 2017; Johnson et al., 2013; Jüttner and Maklan, 2011). A total of 7,933 quotes (i.e., 164,083 words) discussing interorganizational cultural elements in SCRES emerged and were selected for an in-depth analysis. These cultural elements were ranked (Table 4-4) by the percentage of companies and people discussing them per SCRES elements. Table 4-4 is only descriptive and is not a claim or generalization of how important cultural elements are for every SCRES element.

Aggregate element	Element	Illustrative quote
Shared goals and expectations	Shared on-time delivery performance goals	Alignment quote: "The goals are we're trying to get as much product to customers that they need to fill their needs, and then we're working with the customers on what their priorities for each order is to make that efficient. So, it's much more dialogue and it's driven by communication so that you can meet goals on a weekly basis until we get out of this time of turmoil" (Interviewee 35, President at BLENDER_1). Misalignment quote: "I've got one supplier that pisses me off all the time, because we placed orders, I give plenty of lead time, in this case for six weeks. And then they're late in delivery or they don't have the products available, but you know, I've learned to deal with it. And, also have learned that if they say they're going to ship on this date that I better plan on something else because it isn't coming on that date" (Interviewee 40, Senior Operrations Manager at BLENDER_3).
	Shared business continuity goals	Alignment quote: "I think the overarching cultural benefit that we all faced was that the pandemic seemed like a huge unknown, and we didn't know how bad it was going to be. There was this overarching, you know, culture that we don't know the details, but we're going to try to make you move forward with what we can do to maintain operations, regardless. So, a little bit of we're going to try until we can't, and luckily, we found out that we could move forward. And so, our leadership was pushing us to continue to supply as long as we can get material from our suppliers. We sought alternatives. And, in the conversations with our suppliers, it was very plain that they wanted to supply us, as well. So, I think the overarching culture was let's try to move forward regardless of the restrictions from COVID" (Interviewee 46, Vice President of Supplier Development at DISTRIBUTOR_1). Misalignment quote: none.
	Shared safety goals	Alignment quote: "So, I'm not saying money is irrelevant because it is business. However, generally it doesn't work when the first bits of conversation with a customer are directed at money, and not directed at the quality of your work and the safety of your fleet and the quality of the people doing the work, whether it's our back office staff or their back office staff. So, I think on the customer side, we're definitely looking at that fit of culture with a focus on safety and getting it done right" (Interviewee 72, Business Development Manager at BULK_CARRIER_02). Misaligmnent quote: "Showing up at a plant without PPE is a dry run. For that, does my customer pay for the driver I dispatched the truck? Do I have to eat that? Was it my fault? No, it's the culture. I had an SOP for that particular chemical plant that when drivers come they have to do pre vehicle inspection. They have to fill out the form for the pre vehicle inspection. They have to check to make sure they've got hard hat safety glasses, reflective vest, hearing protection, steel toe boots, long sleeve shirts, fire retardant, the whole nine yards. This guy shows. He didn't show up in like shorts and flip flops, but I mean, he didn't have his stuff. Dry run. Yeah, so anyway, that's an example of what can cause cost and cause me problems. Because now guess what? I'm supposed to pick up the container. I've been having that truck booked out for a week to pick up that container for a week. Now what? Now the customers container doesn't ship because I can't find another truck for another three days. So, it's not just that a driver showed up without PPE . There's a knock on effect for the cost of my customers, sitting on another container then for another three days before I can pull it" (Interviewee 62, Vice President of Sales and Customer Accounts at FREIGHT_FORWARDER). Misalignment quote: none.

Aggregate element	Element	Illustrative quote
Shared understanding	Shared assumptions	Alignment quote: "We know what Scott's capabilities are. I know he's got six trucks. I know he's got five drivers. I know he's got some other customers that he has to deal with. So, I understand that about him and he knows we can't unload two trucks at the same time. So he'll send one and then he'll send another one two hours later because he knows that's how long it takes. His understanding of our business and our operations makes it easy for him to do business with us" (Interviewee 20, Health, Safety, Environment, and Quality Manager at LEAD_BUYER). Misalignment quote: none.
	Shared narratives	Alignment quote: "I think the idea that everybody was in the same boat was sort of, I don't want to say helpful. It's not really the right word, but it sort of helped everybody understand the stakes. So, everybody was suffering the same way and everybody was basically trying to make sure that they were doing the right thing by their customers and their suppliers. I think that really was a big one" (Interviewee 1, Purchasing and Procurement Manager at LEAD_BUYER). Misalignment quote: none.
Shared processes	Shared delivery scheduling process	Alignment quote: "You need to keep a tight schedule if you do not want to lose customers. So, we were working with customers and carriers to make sure they communicated with freight forwarders to make sure everything was on schedule and met the schedules. So, I guess, if I can say anything over the pandemic, it actually created better communication between us and the customers" (Interviewee 30, Director of Sales at ADDITIVE_2). Misalignment quote: "The only thing is that they'll do a pop up. They'll just bring on a delivery without us knowing. That supplier just comes and does whatever they want. They shouldn't have come without letting us know. And, this was a PO that was pending from July. And, it was under my name. So, when I saw it, I couldn't believe it and so Rob called me Friday morning at six in the morning. He goes we have two trucks here. And I'm like what truck is that. I'm like send me a picture of the PO. That PO was from July of last year that the supplier came with. Unbelievable. You just don't want to work with these reckless suppliers" (Interviewee 38, Director of Customer Relations at BLENDER_2).
	Shared forecasts process	Alignment quote: " There was something we did mutually with the suppliers and with our customers. We executed more often operational and forecast meetings where we discussed more about forecasting. So, we discussed long term forecasts and long term goals to understand their long term aspirations and requirements to prepare our production. During the pandemic, we had these forecast meetings more often to align and help us now go back to our suppliers to be able to meet the customers demand" (Interviewee 57, Production Manager at PACKAGER_3). Misalignment quote: "Some of the customers thought their name was on a drum reserved in our warehouse. We had to really go back to the customers and have these conversations about we need you to forecast what you need because other people need your products and materials are very, very tight right now. So, I think we had difficult conversations trying to get them to understand forecasting" (Interviewee 50, Senior President of Commercial Operations and Supply at DISTRIBUTOR_2).
	Shared invoice management process	Alignment quote: "When we call some customers and we have a problem, they put us to the top of the list. So, I know when those invoices come in, they also go to the top of the list. We have, I guess, a stronger relationship with vendors who pay us on time. I avoid those who don't" (Interviewee 71, General Manager at BULK_CARRIER_1). Misalignment quote: "There is definitely an issue in the sense of payments and the dragging out of the company being so corporate minded and dragged over a lot of stuff on getting some answers on issues. For us, that's the only frustrating thing. We don't want to deal with delinquent payers" (Interviewee 22, Senior Sales Executive at BASE_OIL_1).

Aggregate element	Element	Illustrative quote
Shared values	Shared communication	Alignment quote: "The customer enjoys talking to the supplier base and vice versa. That is when those core cultural values align. We're always involved in the conversation like a three way conversation. We're always willing to all get into a room and say, okay, here's the issue or the barrier that we face. How do we work together to get through it? Because success means success for all three of us. Yeah, so it's not one person trying to win. It's like how do we the three of us work together to succeed at the end? That has always existed. For the most part, our core suppliers appreciated that so much that they were like, Hey, let's just get together and we'll go talk and we'll figure a solution out" (Interviewee 64, Director of Accounts at TRANSPORT_4PL). Misalignment quote: "I think what's missing with this supplier is more of a proactive communication. The person is not as effective I feel and lacks timely response and effective communication. So, maybe they need to have a more effective person to make sure order processing isn't disrupted. We cannot delay a business because of one person not answering. So, I feel that culturally they need to be on the same page and be able to communicate and process order on time to keep the business flowing. Otherwise, without communication on orders, nothing ships and we lose our business. At the end, my emails are not being answered and that means I need to find another supplier" (Interviewee 5, Transportation and Logistics Analyst at LEAD_BUYER).
	Shared respect and empathy	Alignment quote: "This vendor or supplier is more empathetic in his communication, because I mean, we're all in the same boat going through the same thing. So, small things like that can really go a long way and makes me want to work with the guy even more. A lot of them are great in that sense. They're very understanding about our needs, and then how we can achieve those goals and maybe things we can't do and what our constraints are. So, speaking with them, it's been great. There does seem to be a light at the end of the tunnel because it does seem like everyone's working to improve and build upon what we have now. This positive energy gets us going even when everything is falling apart" (Interviewee 15, Supply Chain Planner at LEAD_BUYER). Misalignment quote: "We have some drivers that come in here that got attitude problems. They want to get out of here right away. There was one guy that just a couple of months back was down here. He's yelling at Phil and I went out there and all of a sudden there were three or four of us gathered around this guy. He said: where's my paperwork? How come I'm still here? And, he was screaming at the top of his lungs. I told him go wait in your truck and he did. We finally got rid of him. I called his dispatcher and said I don't want this driver any longer" (Interviewee 11, Warehouse and Transportation Manager at LEAD_BUYER).

Table 4-3 Illustrative case study quotes and their links with SCRES

SCRES COLLABORATION				
Cultural aggregate element	**Rank**	**Cultural element**	**% of companies**	**% of people**
Shared goals and expectations	1	Shared safety goals	100%	43%
	2	Shared on-time delivery performance goals	45%	30%
	3	Shared business continuity goals	32%	20%
Shared understanding	1	Shared narratives	59%	33%
	2	Shared assumptions	40%	29%
Shared processes	1	Shared invoice management process	55%	24%
	2	Shared forecasts process	41%	17%
	3	Shared delivery scheduling process	41%	15%
Shared values	1	Shared communication	100%	64%
	2	Shared respect and empathy	45%	16%

SCRES VISIBILITY				
Cultural aggregate element	**Rank**	**Cultural element**	**% of companies**	**% of people**
Shared processes	1	Shared forecasts process	38%	20%
	2	Shared delivery scheduling process	35%	14%
Shared values	1	Shared communication	100%	41%

SCRES FLEXIBILITY				
Cultural aggregate element	**Rank**	**Cultural element**	**% of companies**	**% of people**
Shared goals and expectations	1	Shared business continuity goals	27%	18%
Shared understanding	1	Shared assumptions	50%	31%
	2	Shared narratives	38%	24%
Shared values	1	Shared communication	87%	60%
	2	Shared respect and empathy	36%	12%

SCRES VELOCITY				
Cultural aggregate element	**Rank**	**Cultural element**	**% of companies**	**% of people**
Shared understanding	1	Shared assumptions	52%	29%
	2	Shared narratives	21%	17%
Shared values	1	Shared communication	78%	54%

Table 4-4 Distribution % and ranking of interorganizational cultural elements per SCRES element

Drawing from critical incident analysis (Flanagan, 1954), supply chain disruption events emanating from the case were scrutinized for connections between specific cultural elements and SCRES elements. Grounded in the data, a total of 22 critical types of supply chain incidents appeared: demand variability, demand visibility, production stoppage, warehouse space shortage, production staff shortage, selection of unsafe materials, supply shortage, supplier staff shortage, lack of training, supply price increases, unpaid suppliers, relationship tension, deception, driver and truck shortage, excessively high delivery performance goals, disrespectful and aggressive drivers, early deliveries, late deliveries, unpaid carriers, drivers not wearing PPE (i.e., Personal Protective Equipment),

reckless drivers, and unsafe transportation operations. Nine supply structures surfaced from these critical incidents: six triads with three actors each (3), two tetrads with four actors each (4), one pentad (5), one hexad (6), one heptad (7), one octad (8), one nonad (9), one decad (10), and a 22-actor network representing all 22 organizations interviewed in this study. Bounded by their stories, the structures were always composed of the lead buyer and other suppliers. Throughout this study, networks with more than three actors will be called higher-order supply networks (Figure 2).

Building diagrams helped model, visualize, and grasp the nature of interorganizational cultural elements embedded in these flows between actors. The nature of the cultural relationship between actors for every cultural element was characterized in these diagrams using balance theory with a (+) for cultural alignment when partners in a dyad shared the same cultural element and a (-) for cultural misalignment when partners in a dyad did not share that cultural element (Figure 2).

Analyzing the disruptions, cultural alignments/misalignment, and impacted SCRES elements in different supply networks, two cultural mechanisms impacting SCRES surfaced from the data. These mechanisms were proliferative processes describing the movement or reproduction of cultural elements influencing SCRES throughout the supply network. They consisted of (1) cultural propagation and (2) cultural transitivity. Cultural propagation occurred in triads and higher-order supply networks where cultural alignments/misalignment shared in a dyad propagated to other dyads located downstream or upstream. Cultural transitivity exclusively occurred in triads where cultural alignments/misalignments between actors A and B, as well as actors B and C, replicated/propagated or became transitive between actors A and C. The study used two levels of analysis composed of a node or arc/dyadic level and a network-level (Kim et al., 2011, 2015) to determine how individual nodes and/or dyads influenced the resiliency of the entire supply network.

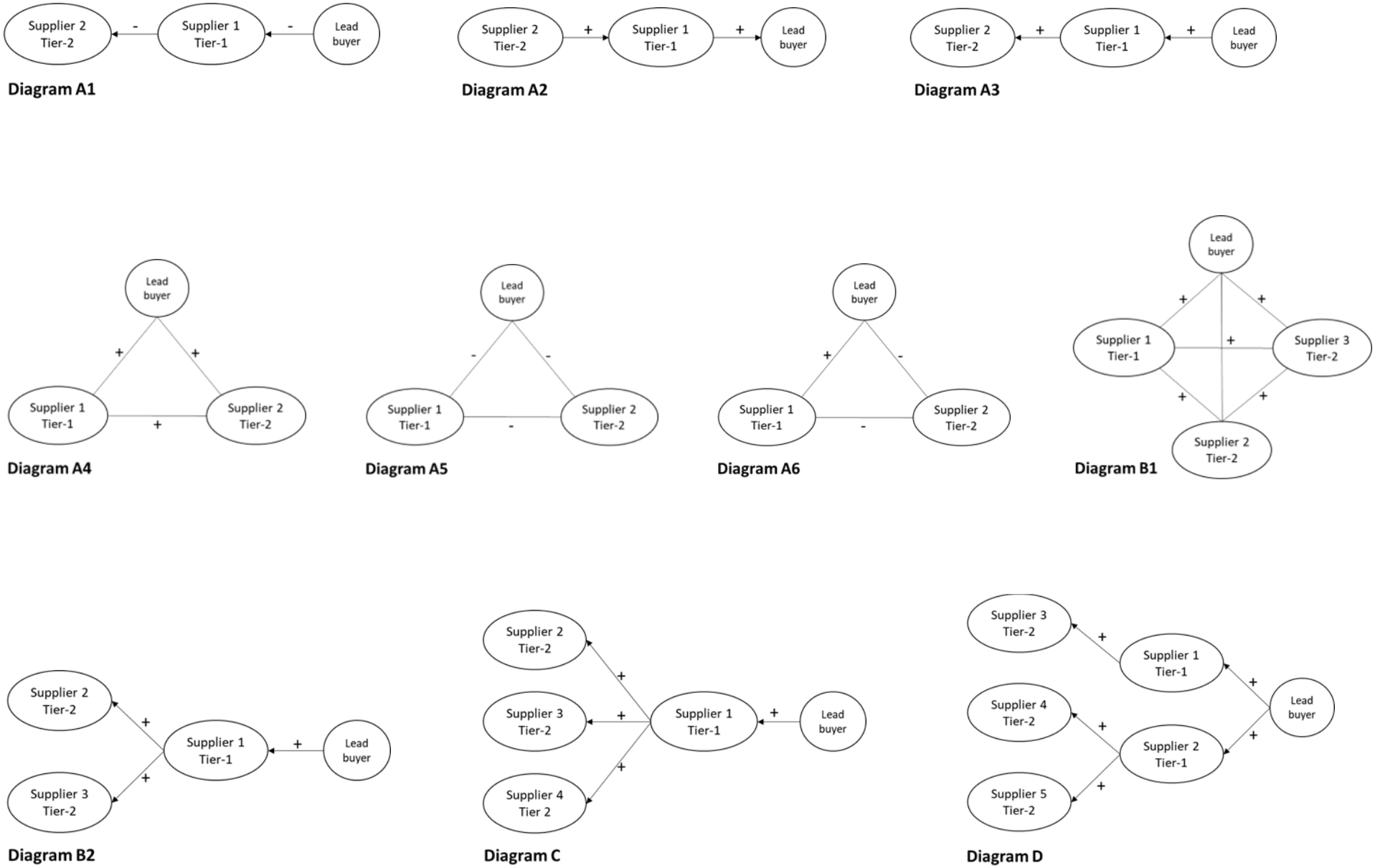

Figure 4-2 Supply network diagrams examining cultural alignments/misalignments in the data (Diagrams A1 to D)

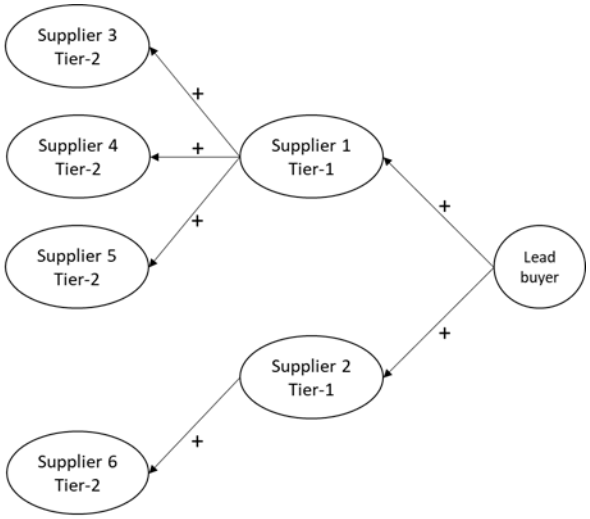

Diagram E

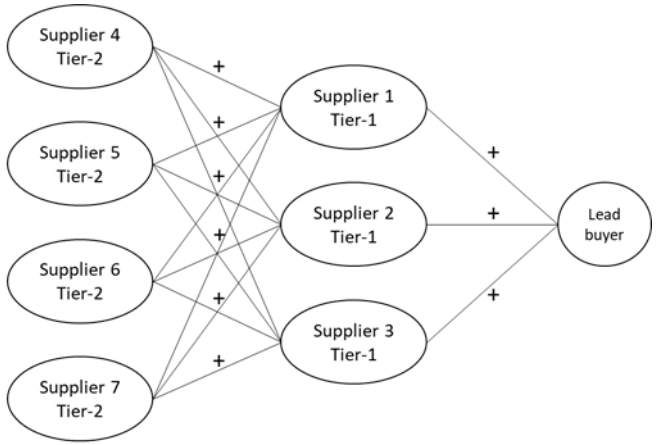

Diagram F

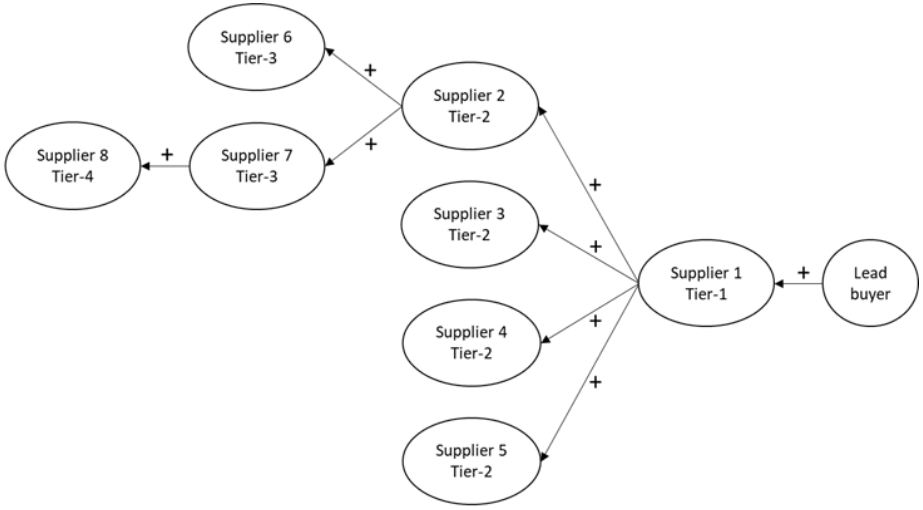

Diagram G

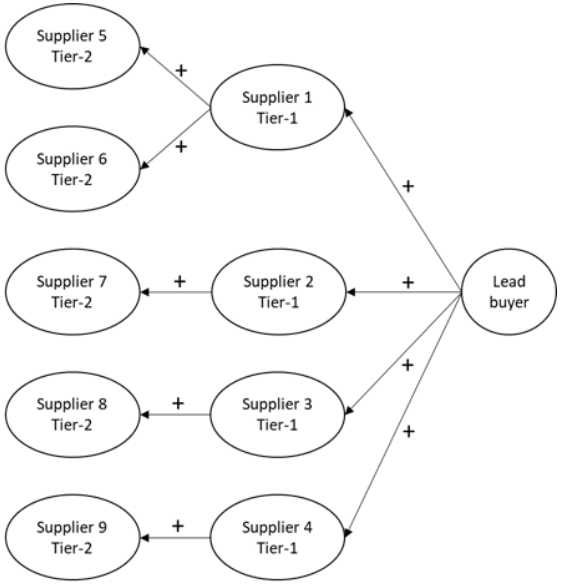

Diagram H

Figure 4-2 Supply network diagrams examining cultural alignments/misalignments in the data (Diagrams E to H)

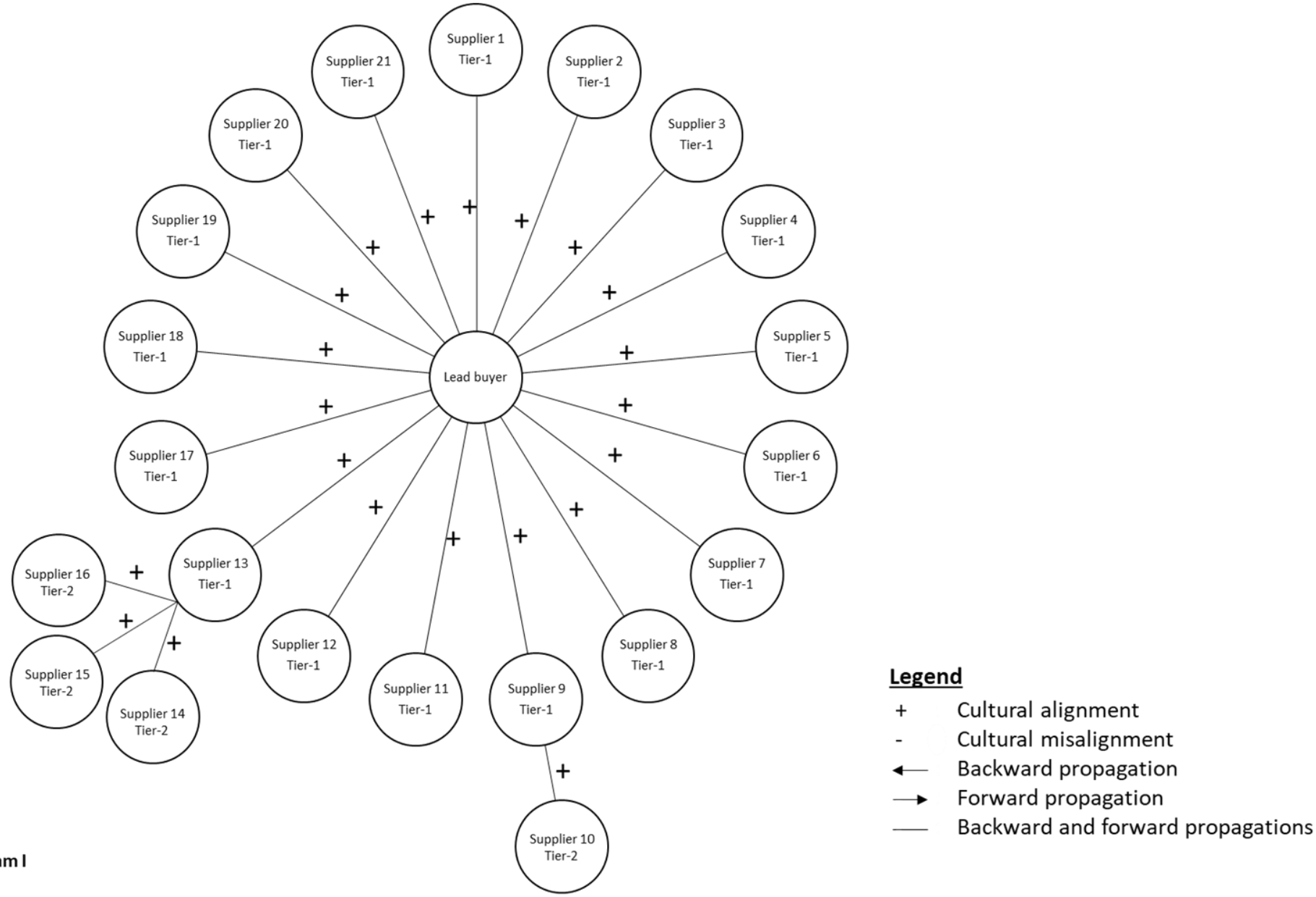

Figure 4-2 Supply network diagrams examining cultural alignments/misalignments in the data (Diagram I)

4.4 Findings

All supply networks are built around the orchestrating lead buyer node. Results revealed two mechanisms: cultural propagation and cultural transitivity. Cultural propagation transpired in open networks where actors are more disconnected and spread out, whereas transitivity appeared in closed triads where all actors were interconnected. To clarify how cultural elements and mechanisms came to be, a table was built to connect them with their respective impacted SCRES elements, managerial means such as joint meetings and communication enabling the mechanisms, network configurations (i.e., structure, number of tiers), diagrams, disruption types, and disruption tier origins (Table 4-5).

Mecanism	Sub-mecanism	Cultural aggregate element	Cultural element	SCRES element impacted	Managerial mean	Disruption type	Disruption tier origin	Network configuration and number of tiers	Diagram
Propagation	Backward propagation of cultural alignments	Shared goals and expectations	Shared on-time performance	Collaboration	Joint meetings to communicate, track and schedule deliveries; non-performance root cause identification and problem resolution	Driver shortage	Tier-2	Triad (two tiers)	A2
						Supply shortage, transportation disruption, demand variability	Tier-1, tier-2	Tetrad (two tiers)	B2
			Shared business continuity	Collaboration, flexibility	Joint brainstorming to share product knowledge, and material and supplier alternatives	Driver shortage	Tier-2	Triad (two tiers)	A2
						Supply shortage, transportation disruption, demand variability	Tier-1, tier-2	Hexad (two tiers)	D
			Shared safety	Collaboration	Audits, daily safety evaluations, product specifications, supplier selection	Selection of unsafe materials, drivers not wearing PPE, reckless drivers	Tier-1, tier-2	Triad (two tiers)	A2
							Tier-1, tier-2	Heptad, decad, 22-actor network (two tiers)	E, H, I
		Shared processes	Shared forecasts	Collaboration, visibility	Virtual communication	Demand visibility, delivery coordination, supply shortage	Tier-1, tier-2, tier-3, tier-4	Nonad (four tiers), 22-actor network (two tiers)	G, I
	Backward and forward propagation of cultural alignments	Shared goals and expectations	Shared business continuity	Collaboration, flexibility	Joint brainstorming to share product knowledge, and material and supplier alternatives	Supply shortage, production stoppage	Lead buyer, tier-1, tier-2	Triad (two tiers)	A2, A3
		Shared understanding	Shared assumptions	Collaboration, flexibility, velocity	Virtual communication; joint brainstorming to share flexible transportation and warehousing solutions				
						Warehouse space shortage, transportation disruption	Tier-2	Tetrad, pentad (two tiers)	B1, C
			Shared narratives	Collaboration, flexibility, velocity	Virtual communication	Supply shortage, transportation disruption, demand variability, price increases, staff shortage	Tier-1, tier-2	22-actor supply network (two tiers)	I
		Shared values	Shared communication	Collaboration, visibility, flexibility, velocity		Supply shortage, transportation disruption, demand variability	Lead buyer, tier-1, tier-2	Triad (two tiers)	A2, A3
						Supply shortage, transportation disruption, demand variability, staff shortage	Tier-1, tier-2	Octad, 22-actor network (two tiers)	F, I
	Backward propagation of cultural misalignments	Shared goals and expectations	Shared on-time performance	Collaboration	Joint meetings to communicate, track and schedule deliveries; non-performance root cause identification and problem resolution	Excessive high delivery performance goals, relationship tension	Lead-buyer	Triad (two tiers)	A1
Transitivity	Transitivity of cultural alignments	Shared goals and expectations	Shared on-time performance	Collaboration	Joint meetings to communicate, track and schedule deliveries; non-performance root cause identification and problem resolution	Late deliveries	Tier-1, tier-2	Triad (two tiers)	A4
			Shared business continuity	Collaboration, flexibility		Late deliveries, unsafe material and operations			
			Shared safety	Collaboration					
		Shared values	Shared respect and empathy	Collaboration, flexibility		Supply shortage, transportation disruption, demand variability	Lead buyer, tier-1, tier-2		
	Transitivity of full cultural misalignments	Shared goals and expectations	Shared on-time performance	Collaboration	Joint meetings to communicate, track and schedule deliveries; non-performance root cause identification and problem resolution	Excessive high delivery performance goals, relationship tension	Lead-buyer	Triad (two tiers)	A5
	Transitivity of partial cultural misalignments	Shared goals and expectations	Shared on-time performance	Collaboration	Joint meetings to communicate, track and schedule deliveries; non-performance root cause identification and problem resolution	Excessive high delivery performance goals, relationship tension	Lead-buyer	Triad (two tiers)	A6
			Shared safety	Collaboration	Daily operations management	Selection of unsafe materials, drivers not wearing PPE, reckless drivers	Tier-2		
		Shared processes	Shared delivery scheduling	Collaboration, visibility	Joint meetings to communicate, track and schedule deliveries	Early and/or late shipments			
			Shared forecasts	Collaboration, visibility	Virtual communication	Demand visibility, delivery coordination, supply shortage			
			Shared invoice management process	Collaboration	Supplier management	Staff shortage, lack of training, unpaid carriers	Lead-buyer		
		Shared values	Shared communication	Collaboration, visibility, flexibility, velocity	Virtual communication	Deception	Tier-2		
			Shared respect and empathy	Collaboration, flexibility	Daily operations management	Disrespectful and aggressive drivers			

Table 4-5 Cultural mechanisms in supply networks and SCRES

4.4.1 Backward and forward cultural propagation

Findings are first presented through the triadic lens as the smallest unit of network found in the case. A broader view is then taken with higher-order supply networks.

Modeling the disruption stories with supply networks, a (+) sign is assigned between two actors in a buyer-supplier dyad when both actors are aligned on a cultural element (i.e.,(+) in Figure-2|Diagrams). Cultural alignment propagation occurs when one actor in a dyad is aligned on a cultural element with the other actor and is forced by this actor to align the same element with an external actor who agrees. Repeating with other actors/dyads, this propagation process spreads the cultural element alignment to other dyads and cascades throughout the supply network, positively impacting SCRES. For example, a large steel manufacturer relied on LEAD_BUYER to deliver punctually industrial lubricants to various steel plants. To meet this demand, LEAD_BUYER implemented a business continuity plan with TRANSPORT_4PL, which sourced carriers like BULK_CARRIER_1 and BULK_CARRIER_2. These carriers had backup measures to ensure on-time deliveries in case trucks/drivers were unavailable. Thus, delivery performance and business continuity goals can align between two actors in a dyad and propagate to others in the supply network.

A (-) sign is assigned between two actors in a buyer-supplier dyad when both actors are misaligned on a cultural element (i.e.,(-) in Figure-2|Diagrams). When one actor in a dyad is misaligned on a cultural element with the other actor and is forced by this actor to align the same element with an external actor who disagrees, cultural misalignment propagates. Repeating with other actors, this propagation process spreads the cultural misalignment to other dyads and cascades throughout the supply network, negatively influencing SCRES.

Backward propagation is when the cultural alignment or misalignment propagates from a buyer to a supplier, then from this supplier to one or more of this supplier's suppliers. Forward propagation occurs when the cultural alignment or misalignment propagates from a supplier to a buyer, then from this buyer to one or more of this buyer's buyers. Throughout the case, cultural alignments were noticed to propagate both backward

(Figure-2|Diagram-B2) and forward (Figure-2|Diagram-A3), while cultural misalignments were only propagating backward (Figure-2|Diagram-A1).

4.4.1.1 Cultural propagation in triads and SCRES

Spreading from LEAD_BUYER to TRANSPORT_4PL and then its suppliers/carriers, the propagation of delivery performance and business continuity goals flowed backward. Invited by TRANSPORT_4PL to joint weekly meetings, carriers helped track deliveries, identify non-performance root causes, and resolve problems. Triadic in nature, these weekly performance meetings improved joint collaborative approaches, developing dedicated driver and backhauling models and enhancing LEAD_BUYER's customer order fulfillment (Figure-2|Diagram-A2). Safety goals also propagated backward from LEAD_BUYER to upstream suppliers. For instance, LEAD_BUYER selected blenders following specific safety and material specifications, and these blenders selected additive suppliers following the same specifications, which avoided safety-driven supply disruptions (Figure-2|Diagram-A2).

Through joint brainstorming, business continuity goals and shared assumptions propagated backward from LEAD_BUYER to its suppliers but also forward from suppliers to LEAD_BUYER to allow partners to understand and adapt to each other's contexts. In backward propagation, LEAD_BUYER expressed supply needs to distributors, which cascaded these needs to blenders. These needs were collaboratively discussed in triadic joint brainstorming sessions to identify material and supplier alternatives, enabling flexibility during supply disruptions (Figure-2|Diagram-A2). In forward propagation, for example, PACKAGER_3 conveyed production line hiccups or chemical shortfalls to BLENDER_1. Learning these shared assumptions from PACKAGER_3, BLENDER_1 shared these issues with LEAD_BUYER to develop rapid and flexible plans sustaining deliveries to LEAD_BUYER's customers (Figure-2|Diagram-A3).

The shared value of communication in triads propagated both backward and forward between LEAD_BUYER and its suppliers, empowering information and mutual understanding to proliferate and support joint decisions. Shared communication allowed partners to find speedy and flexible solutions during supply shortages (Figure-

2|Diagrams-A2/A3). For example, LEAD_BUYER communicated extensively with blenders to ensure base oil availability to produce blends. Thus, blenders had to communicate their needs to base oil suppliers constantly. Any supply delays/allocations from base oil suppliers were communicated to blenders who worked with LEAD_BUYER to find other base oil sources.

Sometimes, LEAD_BUYER had excessively high delivery performance goals with its suppliers. Overwhelmed, some suppliers disagreed with the expectations, as did their suppliers, making the delivery performance goal misalignment propagate backward throughout the supply network (Figure-2|Diagram-A1). For example, LEAD_BUYER expected a delivery performance level from BLENDER_1. However, BLENDER_1 did not meet these delivery standards due to resource constraints. Frustrated, BLENDER_1 then demanded the same performance from PACKAGER_3 who threatened to stop shipping materials, causing potential supply and collaboration disruptions.

4.4.1.2 Cultural propagation in higher-order supply networks and SCRES

Delivery performance and business continuity goals propagated backward from LEAD_BUYER to suppliers. For example, tetradic joint weekly meetings helped LEAD_BUYER, the transportation 4PL, and carriers to manage delivery performance goals and develop flexible solutions like dedicated driver and backhauling systems (Figure-2|Diagram-B2). To maintain business continuity, LEAD_BUYER was constantly in touch with its blenders in need of raw material alternatives from distributors. Through brainstorming sessions, blenders and distributors exchanged their technical product knowledge in periods of shortfalls. For instance, in a hexad, DISTRIBUTOR_2 frequently recommended alternative suppliers or materials that BLENDER_4 used in blends for LEAD_BUYER (Figure-2|Diagram-D) to enable flexible sourcing, avoiding supply disruptions. Noticed in a decad, base oil suppliers, blenders, additive suppliers, and distributors only purchased materials under LEAD_BUYER's safety specifications to ensure collaboration and product quality (Figure-2|Diagram-H).

Reducing the spread of COVID and potential supply disruptions, safety goals and expectations propagated backward from LEAD_BUYER to upstream suppliers through

audits, daily receipt evaluations, product specifications, supplier selection, and production protocols. Requesting to transport hazardous chemicals and people safely, LEAD_BUYER mandated suppliers to use PPE on all suppliers. LEAD_BUYER audited annually and monitored daily how safely products were handled by all tier-1 suppliers. LEAD_BUYER's tier-1 suppliers did the same with their suppliers, disseminating safety rules throughout the supply network to maintain safe and resilient joint operations (Figure-2|Diagram-I). In a heptad, TRANSPORT_4PL and all carriers only selected drivers wearing PPE and respecting road regulations. Similarly, WAREHOUSING_4PL abided by LEAD_BUYER's expectations and contracted warehouses trained to deal with chemicals (Figure-2|Diagram-E).

Shared understanding traveled backward and forward through communication between LEAD_BUYER, WAREHOUSE_1, WAREHOUSE_2, WAREHOUSING_4PL, TRANSPORT_4PL, BULK_CARRIER_1, BULK_CARRIER_2, and LTL_CARRIER. Seen in tetrads and pentads, shared assumptions such as warehousing space and resource shortages eased joint brainstorming on agile and flexible solutions, including load rescheduling and transportation mode diversity (Figure-2|Diagrams-B1/C). COVID brought supply, pricing, demand, and resource challenges. This shared narrative ran through the entire supply network, creating a collaborative survival mode and increasing problem resolution velocity. Staying connected virtually, partners coordinated activities around the clock through the entire supply network (Figure-2|Diagram-I).

From a shared process perspective, LEAD_BUYER shared forecasts and backlog reports with tier-1 suppliers early in the pandemic to enable visibility and joint workload predictions. Shared forecasts allowed suppliers to schedule production, purchasing, and transportation ahead of time with their suppliers, warehouses, carriers, and LEAD_BUYER. Propagating backward from LEAD_BUYER to upstream suppliers, forecast sharing improved network visibility in a nonad and the entire supply network, enabling distant actors to resiliently synchronize their supply chains with LEAD_BUYER (Figure-2|Diagrams-G/I).

The shared value of communication enabled information to cascade backward and forward between LEAD_BUYER and all suppliers, enabling rapid responses, supply

flexibility, and collaboration. Indeed, to respond to or preemptively alert LEAD_BUYER, most tier-1 suppliers reciprocated the communication with LEAD_BUYER, but also with their suppliers in the supply network to tackle product unavailability, delays, and allocations (Figure-2|Diagram-I). For example, as observed in an octad, blenders were often low on additive supplies coming from ADDITIVE_2. Constant communication of this shortage from blenders enabled LEAD_BUYER to switch blenders quickly but also use distributors to help find substitute additive sources for these disrupted blenders (Figure-2|Diagram-F).

4.4.2 Cultural transitivity

Cultural transitivity manifested when cultural alignments/misalignments between actors A and B, as well as actors B and C, propagated transitively between actors A and C. In this case study, cultural transitivity occurred exclusively in closed triads where LEAD_BUYER and two suppliers were all connected. The results are presented below using balance theory (Choi and Wu, 2009; Hummon and Doreian, 2003). Balanced triadic cultural relationships occurred when all three relationships in a triad were culturally aligned through transitivity of cultural alignments (i.e.,(+,+,+)|Figure-2|Diagram-A4) or when two relationships were misaligned and one relationship was aligned through transitivity of partial cultural misalignments (i.e.,(+,-,-)|Figure-2|Diagram-A6). Unbalanced triadic cultural relationships manifested when all three relationships in a triad were culturally misaligned through transitivity of cultural misalignments (i.e.,(-,-,-)|Figure-2|Diagram-A5).

4.4.2.1 Transitivity in balanced triadic cultural relationships and SCRES

Transitivity of cultural alignments in balanced triads (i.e.,(+,+,+)|Figure-2|Diagram-A4) influenced SCRES positively. It occurred for the cultural elements of shared goals and shared respect and empathy. These cultural elements existed between LEAD_BUYER and a tier-1 supplier, but also between the tier-1 and tier-2 suppliers, making both LEAD_BUYER and the tier-2 supplier transitively aligned culturally on goals, respect, and empathy. On-time delivery performance, business continuity, and safety goals were aligned between LEAD_BUYER and TRANSPORT_4PL (Figure-2|Diagram-A4). LEAD_BUYER had clear on-time expectations with TRANSPORT_4PL, requiring

transportation operations continuity and safety in handling materials. Strengthening SCRES, these goals were disseminated by TRANSPORT_4PL to BULK_CARRIER_1, BULK_CARRIER_2, and LTL_CARRIER, deciding to comply, which created transitively a cultural alignment on shared goals with LEAD_BUYER. Respect and empathy humanized relationships, inclining parties to be more receptive and flexible with each other. For example, LEAD_BUYER had a respectful and empathetic relationship with TRANSPORT_4PL, which actively sought flexible bulk tier-2 carriers for LEAD_BUYER. Relationships between TRANSPORT_4PL, BULK_CARRIER_1, and BULK_CARRIER_2 were also respectful and empathetic, and bulk carriers were performant and attentive to LEAD_BUYER's needs by proposing flexible delivery times and leaving trailers on LEAD_BUYER's site to accommodate loading schedules. Making exceptional efforts to retain their relationship with TRANSPORT_4PL, bulk carriers often covered stressful same-day shipments with multiple drivers from base oil suppliers to LEAD_BUYER, subsequently developing a two-way empathetic relationship transitively with LEAD_BUYER (Figure-2|Diagram-A4).

Transitivity of partial cultural misalignments in balanced triads (i.e.,(+,-,-)|Figure-2|Diagram-A6) influenced SCRES negatively. It materialized when the cultural alignments of delivery performance goal, delivery scheduling process, forecast sharing process, respect and empathy, and communication existed between LEAD_BUYER and a tier-1 supplier but not between the tier-1 supplier and a tier-2 supplier, making LEAD_BUYER and the tier-2 supplier culturally misaligned transitively (Figure-2|Diagram-A6). LEAD_BUYER agreed on specific delivery schedules with WAREHOUSE_2. However, PACKAGER_2 frequently shipped too early to WAREHOUSE_2, creating order non-visibility for LEAD_BUYER and WAREHOUSE_2. This created delivery schedule contentions between PACKAGER_2 and WAREHOUSE_2, but also between LEAD_BUYER and PACKAGER_2. Neglecting LEAD_BUYER's shared forecasts, a few tier-2 suppliers created shortages for LEAD_BUYER. For example, BLENDER_2 translated LEAD_BUYER's blend forecasts into drum requirements and continuously shared drum needs with PACKAGER_2. Personnel rotation and lack of training accruing, PACKAGER_2 continuously struggled to incorporate drum forecasts and failed to supply drums to BLENDER_2 on time. Most distributors formulate products with additive

suppliers for LEAD_BUYER, and when products are developed, distributors usually manage new product inventories and sell them to LEAD_BUYER. Aligned respectful, empathetic, and communicative relationships existed between LEAD_BUYER and DISTRIBUTOR_2. During the pandemic, ADDITIVE_2 decided not to notify DISTRIBUTOR_2 of a decision to work directly with LEAD_BUYER on new product development. Frustrated with this deceiving behavior, DISTRIBUTOR_2 started to work with other additive suppliers to develop new products for LEAD_BUYER and convinced LEAD_BUYER not to work with ADDITIVE_2.

Transitivity of partial cultural misalignments also occurred when the cultural alignments of the invoice management process, safety goals, and respect and empathy existed between LEAD_BUYER and a tier-1 supplier but not between LEAD_BUYER and a tier-2 supplier, making transitively both the tier-1 and tier-2 supplier culturally misaligned (Figure-2|Diagram-A6). For instance, throughout the pandemic, LEAD_BUYER lost resources and encountered issues training personnel to process invoice payments to carriers. Unpaid carriers stopped working for LEAD_BUYER and automatically disengaged from TRANSPORT_4PL. Some of TRANSPORT_4PL's contracted drivers showed up at LEAD_BUYER's doors without PPE, becoming aggressive and disrespectful to LEAD_BUYER's personnel, who followed strict PPE procedures. Discontent with these disrespectful drivers causing transport disruption, LEAD_BUYER decided with TRANSPORT_4PL not to use carriers with misbehaved drivers.

4.4.2.2 Transitivity in unbalanced triadic cultural relationships and SCRES

Transitivity of cultural misalignments in unbalanced triads (i.e.,(-,-,-)|Figure-2|Diagram-A5) influenced SCRES negatively. It happened when on-time delivery performance goals became excessive and were not shared between LEAD_BUYER and a tier-1 supplier but also between the tier-1 supplier and a tier-2 supplier, making both LEAD_BUYER and the tier-2 supplier transitively misaligned culturally on delivery performance goals. For example, LEAD_BUYER had on-time delivery performance issues with tier-1 WAREHOUSING_4PL, which contracted a tier-2 3PL warehouse that could not keep up with LEAD_BUYER's excessive expectations. The cultural misalignment in delivery goals between LEAD_BUYER and WAREHOUSING_4PL became similar between

WAREHOUSING_4PL and the pressured 3PL warehouse. This created transitively a misalignment between the 3PL warehouse and LEAD_BUYER and engendered a triadic separation between all parties, interrupting shipments to LEAD_BUYER's customers (Figure-2|Diagram-A5).

4.5 Theoretical contributions and discussion

Going beyond a dyadic view, this case study extends the SCRES literature by exploring the application of balance theory to resilient interorganizational cultures in supply networks. It offers a theoretical articulation of how interorganizational cultures influence multi-tier supply network resilience through the notions of cultural alignment/misalignment, propagation, and transitivity in balanced and unbalanced triadic cultural relationships. Supply networks are vulnerable to disruptions propagating backward and forward from a node to neighboring nodes (Świerczek, 2014). This propagation process is called the ripple effect and can be caused, for example, by financial risk or supply and demand variability (Serrano et al., 2018). The study broadens this idea of propagation from disruption propagation to the propagation of cultural alignments enabling SCRES and examines cultural transitivity in culturally balanced and unbalanced triads. Overall, the case describes what a resilient supply network culture is and explains how it works. Table 4-5 summarizes the findings and guides the proposition development offered in this paper. A resilient supply network culture is characterized by aligned interorganizational cultural elements consisting of shared goals, expectations, understanding, processes, and values, running through the supply network through cultural propagation and transitivity. Surfacing from the case study data, managerial means in Table 4-6 enable the SCRES elements of collaboration, flexibility, visibility, and velocity.

SCRES element	Managerial mean/SCRES enbaler emerging from the case
Collaboration: Represents the level of tactical, operational, and strategic shared decision-making and joint efforts (Jüttner & Maklan, 2011).	Joint meetings to communicate, joint branstorming, track and schedule deliveries; non-performance root cause identification and problem resolution, daily operations management, supplier selection, supplier management, audits, daily safety evaluations, product specifications assessment, virtual communication
Flexibility: Aptitude of a supply chain to change the number and heterogeneity of possible solutions to respond to a market event while maintaining performance (Stevenson and Spring, 2007). This could manifest in flexible supply, demand, processes, capacity, and order fulfilment or transportation (Ali et al., 2017).	Virtual communication, joint brainstorming to share product knowledge and material and supplier alternatives, joint brainstorming to share flexible transportation and warehousing solutions
Visibility: Ability for the supply chain to capture timely information about identification, location, and status of supply chain events or entities (Johnson et al., 2013).	Joint meetings to communicate, virtual communication, delivery tracking
Velocity: Revolves around the adaptation speed by which a supply chain responds to and recovers from a market event (Christopher & Peck, 2004).	Virtual communication, joint meetings to communicate, joint brainstorming

Table 4-6. Managerial means enabling SCRES elements

4.5.1 Cultural propagation in supply networks and SCRES

Shared goals enable mutual understanding between partners (Johnson et al., 2013), facilitate decision-making, and create behavioral expectations (Fan and Stevenson, 2018), avoiding conflict (Villena et al., 2011). Spreading from LEAD_BUYER to upstream suppliers, shared goals propagated backward through buyer-led joint meetings, brainstorming, audits, and protocols. Shared on-time delivery and business continuity goals helped track deliveries, non-performance, and unsafe behaviors. Facilitating collaboration and flexibility, these goals enabled the development of solutions such as dedicated drivers, backhauling, product knowledge transfer, and alternative suppliers/materials. Requesting to handle hazardous chemicals and follow material specifications safely, LEAD_BUYER ensured processes and materials followed specifications through methodical supplier selection, audits, and daily operational evaluations. This buyer-led safety behavior triggered suppliers to behave similarly to their suppliers.

As such, this proposition is suggested:

P1. Shared goals and expectations propagate backward in a supply network from the lead buyer to tier-1 suppliers and from tier-1 to tier-2 suppliers, enabling collaboration and flexibility during supply chain disruptions.

Shared processes are key for collaboration (Daghar et al., 2023). Throughout the pandemic, LEAD_BUYER shared forecasts and backlog reports with suppliers, which scheduled production and purchasing ahead of time with their suppliers. Propagating from LEAD_BUYER to upstream suppliers, forecast sharing improved visibility, enabling multi-tier actors to synchronize their supply chains.

Thus, this proposition emerges:

P2. Shared processes propagate backward in a supply network. The lead buyer shares processes with tier-1 suppliers. These processes are passed on from tier-1 to tier-2 suppliers, then from tier-2 to tier-3 suppliers, and finally from tier-3 to tier-4 suppliers, enabling collaboration and visibility during supply chain disruptions.

Instrumental in supply risk mitigation (Chowdhury et al., 2019), shared business continuity goals propagated backward and forward between LEAD_BUYER and suppliers. LEAD_BUYER discussed business continuity risks regularly with suppliers. This resulted in conversations between tier-1 and tier-2 suppliers looking collaboratively for flexible sourcing. Similarly, tier-2 suppliers often proposed to tier-1 suppliers contingency plans to sustain activities. Tier-1 suppliers communicated these plans to LEAD_BUYER for approval. Shared understanding enables rapid supply risk identification and alleviation (Fan and Stevenson, 2018; Johnson et al., 2013). Shared understanding flowed from downstream to upstream actors and vice versa, creating a collaborative survival mode. Organizational cultures supporting communication enhance value creation, strategic alliances, and collaboration outcomes (Prasanna and Haavisto, 2018). Throughout the case study, shared communication empowered information to circulate quickly between LEAD_BUYER and suppliers, improving problem-solving, rapid responses, flexibility, and collaboration.

Overall, this proposition is put forward:

P3. Shared goals, expectations, understanding, and values propagate back-and-forth in a supply network between the lead buyer, tier-1, and tier-2 suppliers, enabling collaboration, flexibility, visibility, and velocity during supply chain disruptions.

Shared goals clarify responsibility and reduce disagreements, while misaligned goals can create conflict (Villena et al., 2011). The only misaligned cultural element that propagated backward was the delivery performance goal. Tier-1 suppliers sometimes disagreed with LEAD_BUYER's high delivery performance expectations. To abide by these excessive expectations, these tier-1 suppliers often tried to pressure their tier-2 suppliers, who became overwhelmed, making the misalignment propagate backward throughout the supply network, and sometimes causing supply network fractures.

Therefore, the following proposition surfaced:

P4. Misaligned and excessive expectations from the lead buyer towards tier-1 suppliers can propagate and be imposed by tier-1 to tier-2 suppliers. This can cause tier-2 suppliers to refrain from collaborating with culturally misaligned tier-1 suppliers and the lead buyer. Tier-1 suppliers can also decide to refrain from collaborating with the culturally misaligned lead buyer, causing supply network collaboration disintegration during supply chain disruptions.

4.5.2 Cultural transitivity in supply networks and SCRES

In balance theory, a triad is balanced when firms A and B are transitively allies because they both have a positive relationship with firm C (i.e.,+,+,+) or a negative relationship with firm C (i.e.,+,-,-). Balance theory also defines unbalanced triadic relationships when triads have two positive relationships and one negative (i.e.,+,+,-), and when triads have three negative relationships (i.e.,-, -, -) (Choi and Wu, 2009).

Culturally balanced triads with positive cultural relationships (i.e.,+,+,+) formed in the case. LEAD_BUYER shared goals with tier-1 suppliers, who communicated expectations to tier-2 suppliers. Tier-2 suppliers fulfilling expectations aligned transitively and culturally on shared goals with LEAD_BUYER, promoting supply network collaboration, flexibility, and contingency planning needed to prevent disruptions. Buyer empathy can increase

supplier performance (Daghar et al., 2023). LEAD_BUYER and tier-1 suppliers developed respectful and empathetic values. These tier-1 suppliers used respect and empathy to seek flexible solutions from tier-2 suppliers. LEAD_BUYER recognized tier-2 suppliers' will to adjust to expectations by proposing flexible deliveries or supply. This developed respectful and empathetic transitive values between LEAD_BUYER and these tier-2 suppliers.

Hence, the following proposition is derived:

> *P5. The lead buyer sharing goals, expectations, and values with tier-1 suppliers can influence these suppliers to propagate these cultural elements to their tier-2 suppliers, generating the same shared cultural elements between the lead buyer and tier-2 suppliers and overall collaborative, flexible, and culturally balanced triads during supply chain disruptions.*

Culturally balanced triads also surfaced when two firms had a positive cultural relationship in the triad (i.e.,+,-,-). Cultural alignments of delivery performance goals, delivery scheduling and forecast sharing processes, respect, empathy, and communication existed between LEAD_BUYER and a tier-1 supplier, but sometimes not between this tier-1 supplier and a tier-2 supplier. This transitively made LEAD_BUYER culturally misaligned with the tier-2 supplier, affecting SCRES negatively. Sometimes, tier-2 suppliers can become competitors of tier-1 suppliers by directly working with the buyer (Rossetti and Choi, 2005). Aligned respectful, empathetic, and communicative values existed between LEAD_BUYER and tier-1 suppliers. However, during the pandemic, a few tier-2 suppliers decided deceivingly to cut tier-1 suppliers and work with the LEAD_BUYER directly. Culturally aligned on values, LEAD_BUYER and the tier-1 suppliers decided to avoid working with these opportunistic tier-2 suppliers.

Subsequently, this proposition is formed:

> *P6. Misaligned goals, expectations, processes, and values between tier-1 and tier-2 suppliers can propagate from tier-2 suppliers to the lead buyer. This can encourage the culturally aligned lead buyer and tier-1 suppliers to refrain from collaborating with the culturally misaligned tier-2 suppliers, thus negatively*

impacting collaboration, flexibility, visibility, and velocity in triads during supply chain disruptions.

Cultural alignments of invoice management processes, safety goals, and respect and empathy existed between LEAD_BUYER and a tier-1 supplier, but sometimes not between LEAD_BUYER and a tier-2 supplier This transitively made the tier-1 and tier-2 suppliers culturally misaligned, influencing SCRES negatively. In this scenario (i.e.,+,-,-), triads became culturally balanced when LEAD_BUYER and the culturally aligned tier-1 supplier refrained from working with the culturally misaligned tier-2 supplier. However, triads became culturally unbalanced when all actors became culturally misaligned (i.e.,-,-,-).

Accordingly, the following proposition is considered:

P7. Misaligned goals, expectations, processes, and values between the lead buyer and tier-2 suppliers can propagate from tier-2 to tier-1 suppliers. This can lead the culturally aligned lead buyer and tier-1 suppliers to refrain from collaborating with the culturally misaligned tier-2 suppliers, creating culturally misaligned triads and dysfunctional collaboration during supply chain disruptions.

4.6 Managerial implications and future research agenda

4.6.1 Managerial implications

First, this study invites practitioners to recognize the importance of interorganizational cultural alignments/misalignments, learn what and how interorganizational cultural elements impact SCRES through propagation and transitivity, and use this new lens to assess and adjust their cultural match with partners in their supply networks. Second, understanding the essential role of interorganizational culture in SCRES can help decision-makers make more informed choices regarding network risk assessments, joint practices, partner selection, relationship arrangements, supplier evaluation, contracts, sourcing practices, processes, and network configurations. Indeed, supply chain professionals may need to reconsider or disconnect from culturally misaligned suppliers to improve SCRES.

4.6.2 Future research agenda

Firstly, the connections between interorganizational cultural elements could be explored through large-scale survey data. Shared goals, understanding, processes, and values might trigger, mediate, and/or moderate each other to enable SCRES. Also, misaligned cultural elements emerged as potential risks to examine because they can destabilize SCRES. Additionally, understanding what triggers a supply network to transition from culturally aligned to misaligned or vice versa and why is essential to understanding SCRES levers and disruptors. Secondly, investigating how the embeddedness of cultural elements in social capital can influence SCRES is appealing. Indeed, cultural elements are part of cognitive capital (i.e., shared codes, language, narratives) (Daghar et al., 2021) and can influence structural (i.e., shared routinized processes, network configuration structure) and relational capitals (i.e., closeness, reciprocity, trust) needed in SCRES (Daghar et al., 2023; Johnson et al., 2013). Thirdly, aside from the SCRES lens used in this work, other SCRES lenses are worth exploring, including the framework of SCRES temporal capabilities to prepare, respond, recover, and learn (Ali et al., 2017; Christopher and Peck, 2004; Daghar et al., 2023) and the framework of transformability or anti-fragility, based on embracing and learning from disorder to achieve growth (Nikookar et al., 2021; Wieland and Durach, 2021). Furthermore, this study targets buyer-led networks, but supplier-led networks are also worth probing.

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APPENDIX C for Paper 3

Table C.1 Case study interview questionnaire

1. How has the pandemic affected the continuity of your operations with your suppliers and customers?
2. What actions, jointly with your suppliers and customers, did you take to respond to your affected operations?
3. What cultural alignments with your suppliers and customers did facilitate your ability to cope with the disruption before and during the pandemic?
4. How and why did these alignments help you to cope with the disruption with your suppliers and customers before and during the pandemic?
5. What alignments with your suppliers and customers did negatively influence your supply chain before and during the pandemic?
6. How and why did these alignments hamper your ability to cope with the disruption with your suppliers and customers before and during the pandemic? How did you fix this?
7. What cultural misalignments or complementarity elements with your suppliers and customers did facilitate your ability to cope with the disruption before and during the pandemic?
8. How and why did these misalignments or complementarity elements support your ability to cope with the disruption with your suppliers and customers before and during the pandemic?
9. What cultural misalignments with your suppliers and customers did negatively influence your supply chain before and during the pandemic?
10. How and why did these misalignments hurt your ability to cope with the disruption with your suppliers and customers before and during the pandemic? How did you fix this?

5. Conclusion

The goal of this thesis was to investigate the role of cognitive capital in supply chain resilience and focus on the cognitive element of interorganizational culture at the supply network-level. The thesis has three objectives that were created to answer the research questions and reach this goal.

Paper 1 in Chapter 2 addresses the first research objective through a systematic literature review, which is the foundation and frame for this thesis. This paper synthesizes systematically the current research on the role of collaborative interorganizational relationships in supply chain risks. Adopting a systematic approach, the paper examines 126 articles from 27 peer-reviewed journals between 1995 and 2020 and grounds the investigation of supply chain collaborative interorganizational relationships in social capital theory. The review reveals that structural, relational, and cognitive capital dimensions can positively and negatively impact supply chain risks, but also that perceived supply chain risks can influence structural and relational capital dimensions. Articulating theoretically how different collaborative interorganizational relationships affect supply chain risks, this study uses a social capital lens to synthesize dominant findings in the literature and provides a future research agenda. The study highlights a lack of research in the cognitive capital dimension of social capital despite the dimension's embeddedness and importance in other social capital dimensions. Rooted in this call to learn more about cognitive capital, Paper 2 seeks to explore the role of cognitive capital in SCRES.

Paper 2 in Chapter 3 focuses on the second research objective through a case study exploring the role of cognitive capital elements in SCRES. Drawing from a single case study of a major consumer electronics multinational, this paper clarifies cognitive capital's elements and contextualizes how they interact with SCRES temporal capabilities to prepare, respond, recover, and learn during a major disruption (i.e., COVID-19). This single case study is based on 40 interviews and revolves around the buyer's view across 36 multiregional buyer-supplier dyads, spanning 17 product and service categories disrupted by the pandemic. Findings discuss crisis events under contingencies of increased and decreased demands and suppliers' geographical proximity to the buyer.

The case unveils different elements of cognitive capital (e.g., shared goals, assumptions, values, kinesics language, multilingualism, virtual negotiation, prior disruption experience, shared process capabilities) during a major global disruption, and formulates propositions suggesting that different cognitive capital elements influence positively and differently SCRES' temporal capabilities. Extending the understanding of cognitive capital in buyer-supplier relationships, Paper 2 calls to research the superficially examined concept of culture and its role in SCRES. Paper 3 seeks to answer this call.

Paper 3 in Chapter 4 targets the third research objective with a case study that investigates the role of interorganizational culture in SCRES in a multi-tier supply chain network. This paper is based on 83 interviews conducted in a single case study of a US chemical multinational and 21 multi-tier suppliers facing the COVID-19 disruption. Using balance theory, the analysis examines what and how interorganizational culture elements influence the SCRES elements of collaboration, flexibility, visibility, and velocity in a disrupted multi-tier supply chain network. The case study brings forth various cultural elements influencing SCRES at the network-level. These cultural elements consist of shared goals and expectations, understanding, processes, and values. The study indicates that these cultural elements, along with the supply chain network-level mechanisms of cultural propagation, and cultural transitivity in balanced and unbalanced triads, affect different aspects of SCRES. This case study extends the SCRES literature by exploring the application of balance theory to resilient interorganizational cultures in multi-tier supply chain networks.

Paper 2 investigates thoroughly the concept of cognitive capital and its impacts on SCRES temporal capabilities in a dyadic context, while Paper 3 zooms in on one specific aspect of cognitive capital: interorganizational culture in a supply network setting. Exploring cognitive capital dyadically, Paper 2 sets the background for Paper 3 to extend the examination and awareness of one critical cognitive capital element (i.e., interorganizational culture) at the network-level. Most cognitive capital elements found in Paper 2 such as shared goals, assumptions, values, and processes were observed and confirmed in Paper 3, as well, while exploring interorganizational culture. Specific

practices enabling cognitive capital such as joint brainstorming and virtual communication are highlighted in Paper 3 confirming Paper 2's unearthed results.

Paper 2's data were collected at the beginning of COVID, when respondents were focused on practices that were put in place to prepare, respond, recover, and learn, which are the temporal whys of SCRES. In Paper 3, data was collected towards the end of COVID, and respondents were more concentrated on practices helping collaboration, flexibility, visibility, and velocity, which are the hows of SCRES. Both SCRES operationalizations investigated in the empirical papers complement each other, showing how essential cognitive capital is to SCRES.

The network lens of Paper 3 complements what was found dyadically in Paper 2. All developed dyadic propositions from Paper 2 were not tested or investigated in Paper 3 at the network-level because the scope of Paper 3 was to better understand the role of one cognitive capital element in SCRES elements. However, using balance theory, Paper 3 still supports the idea that cognitive capital is instrumental in SCRES through the ideas of cultural element propagation and transitivity in supply networks.

5.1 Theoretical implications

From a theoretical perspective, this work first examines the role of CIRs in SCRs, systematizing and theoretically elevating the research discourse on this topic through a systematic literature review. The SLR analyzes current research findings from a social capital viewpoint. From this review, theoretical gaps were identified: the underexamined cognitive capital dimension was probed to identify its sub-components and their interactions with SCRES, and the unexplored concept of resilient interorganizational culture in a supply network was investigated.

To date, the multiplexity of CIRs and their interactions with SCRs remain scattered and unconsolidated. Much needed, the SLR, or Paper 1 in this thesis, uses a social capital lens to fill this gap by consolidating and structuring the state of research on CIRs and SCRs. As such, this review contributes theoretically to the research in CIRs, SCRs, and social capital in three parts. First, the literature review extends the supply chain and social capital literature by connecting CIRs to SCRs through the social capital perspective.

Indeed, the classification and operationalization of CIRs through the lens of social capital could be useful for future research to determine the role and complexity of CIRs in SCRs. Second, the SLR provides an up-to-date synthesis of the interrelationships between CIRs and different SCRs. It reveals that the three social capital dimensions uniquely and both positively and negatively affect different SCRs. The findings further suggest that the perceived supply chain risks can influence the structural and relational capital. Third, this review suggests future research avenues. Indeed, while the existing literature tends to focus mainly on the structural and relational aspects of social capital, the SLR highlights a lack of understanding of the cognitive capital aspect of social capital in SCRs and resilience.

The first empirical paper, or Paper 2 in this thesis, is a case study that answers this call by exploring the role of cognitive capital in SCRES. This case contributes theoretically to the buyer-supplier, supply chain risk, resilience, and social capital literature in three ways. First, it extends the understanding of the role of cognitive capital by identifying its underlying relevant elements and their interrelationship with the four SCRES temporal capabilities to prepare, respond, recover, and learn as disruption events unfold. New cognitive capital elements are uncovered, such as kinesics language, multilingualism, virtual communication, and empathy. Embedded in buyer-supplier relationships, these cognitive capital elements positively influence the SCRES capabilities to prepare, respond, recover, and learn. Second, this case study identifies two contingencies that affect the relationships between different cognitive capital elements and the SCRES temporal capabilities: the impact of disruption on category demand in terms of (a) demand increase versus decrease and (b) supplier geographical proximity. Third, this empirical paper develops propositions inductively to contribute to theory. It also suggests a research agenda that points to the dearth of research in culture, which is a key cognitive element that greatly shapes SCRES at the organizational and interorganizational levels.

The second empirical paper, or Paper 3 in this thesis, is a case study that answers this call by using balance theory to study resilient interorganizational cultures in multi-tier supply networks. This case contributes theoretically to the research in interorganizational relationships, SCRES, supply networks, and balance theory in three different ways. First,

this study goes beyond the dyadic view and broadens the SCRES literature by describing what a resilient supply network culture is and how it works to sustain the SCRES elements of collaboration, flexibility, visibility, and velocity in multi-tier supply chains. Second, the case explores the application of balance theory to interorganizational cultures in supply network resiliency. It offers a theoretical understanding of what and how interorganizational cultural elements such as shared goals align and misalign to shape the SCRES of a multi-tier supply network through the ideas of network-level cultural alignment, propagation, and cultural transitivity. Third, this paper builds theoretical propositions induced by the case and develops a research agenda.

5.2 Practical implications

In Chapter 2 (i.e., Paper 1: SLR), four main ideas transpired from the literature review. First, the structural capital of CIRs appears to affect positively and negatively SCRs. For instance, the buyer-led practice of multi-sourcing seems to have a positive (Chopra and Sodhi, 2004), but also a negative effect on buyers' SCRs (Rudolf and Spinler, 2018). Second, the relational capital of CIRs appears to influence positively and negatively SCRs. For instance, relationship closeness (Chowdhury and Quaddus, 2015) can help mitigate SCRs but can also exacerbate them (Fan and Stevenson, 2019). Third, cognitive capital influences positively and negatively SCRs. For example, shared narratives, codes, and languages can help mitigate SCRs (Johnson *et al*., 2013) but can also develop collective blinding preventing partners' out-of-the-box thinking (Fan and Stevenson, 2018). Fourth, SCRs can influence structural capital such as supplier development or joint decision-making (Jajja *et al*., 2018), but also relational capital like trust (Sambasivan et al., 2013). These practical insights can become tools for managers to better understand the relational environment existing between their organizations and suppliers, leading ultimately to making better risk-averse decisions in areas such as supplier management, number of suppliers, contractual terms, joint risk management, joint planning, joint problem-solving, information, and knowledge sharing, joint decision-making, overall network structure, trust levels, shared goals, shared key performance indicators, standardization, training, and shared business approaches and capabilities.

In Chapter 3 (i.e., Paper 2), findings revealed that various elements of cognitive capital influence the SCRES temporal capabilities to prepare, respond, recover, and learn, through the lens of two contingencies: (1) product and service categories with steep demand fluctuations (i.e., increase, decrease) (Chopra and Sodhi, 2004), and (2) the supply-base complexity element of supplier geographical proximity (Choi and Krause, 2006). From the case study analysis process, propositions emerged. The insights of this study can help practitioners examine cognitive capital elements that negatively influence their ability to prepare, respond, recover, and learn with their suppliers while considering the contextual factors of increased vs. decreased demand and the geographical proximity of suppliers. This study provides managers with an analytical tool to identify potential harmful effects driven by cognitive capital misalignments between parties in terms of interpretations and meanings, values, and goals. Indeed, analyzing the different cognitive capital elements episodically with these contextual factors can help professionals assess how cognitively aligned partners are for every SCRES temporal capability and enable them to make informed decisions when considering partners, sourcing strategies, governance mechanisms, process development, or any collaborative activities. Supply chain management professionals may need to adjust to or even cut ties with cognitively misaligned suppliers because unshared values, assumptions, goals, approaches, experiences, and languages can add to the complexity of supply chain relationships and damage SCRES.

In Chapter 4 (i.e., Paper 3), the case study uncovered aligned interorganizational cultural elements positively influencing SCRES, and misaligned interorganizational cultural elements negatively influencing SCRES. Throughout the study, cultural mechanisms impacting SCRES differently surfaced: backward and forward propagation and transitivity of cultural elements. This case study goes beyond a dyadic view and extends the SCRES literature by exploring the application of balance theory to resilient interorganizational cultures from a supply network perspective. This study offers a theoretical articulation of what and how interorganizational cultural elements influence the SCRES of a multi-tier supply network through the notion of network-level cultural propagation, and cultural transitivity in balanced and unbalanced triadic cultural relationships. This study invites practitioners, seeking SCRES in their supply network, to recognize the importance of

interorganizational culture from the perspective of cultural alignments and misalignments, learn what and how interorganizational cultural elements impact SCRES, and use this new lens to assess and adjust their cultural match with supply network partners. The insights of this study can help professionals make better decisions for their organizations by assessing the level of cultural alignments in their supply network. Understanding the essential role of interorganizational culture in SCRES can help decision-makers make more informed choices regarding joint practices with suppliers, sourcing practices, and network configurations.

5.3 Limitations and directions for future research

The nature of cognitive capital is difficult to decipher because of its depth and entanglement with other social capital dimensions (Nahapiet and Ghoshal, 1998), rendering its full operationalization and sub-elements' potential interactions challenging to grasp. As such, this thesis explored cognitive capital qualitatively to dive into its intricacy and cannot establish statistical generalizations.

Future qualitative research could focus on specific areas of cognitive capital such as shared language, body language, or attitude through ethnomethodology or symbolic interactionism at the individual and organizational levels to enable multi-level studies (Lumineau and Schilke, 2018). Quantitative research could assess how cognitive capital accounts for the variation of SCRES. Qualitative and/or quantitative social network analysis is a helpful perspective that could help study how cognitive capital embedded in collaborative activities influences SCRES at the network-level.

This thesis zooms into interorganizational culture, which is a particular element of cognitive capital. However, the idea of interorganizational culture in SCRES is only nascent. Indeed, interactions between interorganizational cultural elements are underexamined and should be explored. For example, shared goals and values could trigger, mediate and/or moderate each other. Also, understanding what triggers a supply network to transition from culturally aligned to misaligned or vice-versa, and why, is essential to understanding how to improve SCRES. Furthermore, this work studies

interorganizational culture in a buyer-led network, but supplier-led networks need examination, as well.

The SCRES lenses used in this thesis are preponderantly discussed in the literature. They revolve around the main SCRES temporal capabilities of preparedness, responsiveness, recovery, and learning (Ali et al., 2017; Hendry et al., 2019; Jüttner and Maklan, 2011; Scholten and Schilder, 2015), and the SCRES elements of collaboration, flexibility, visibility, and velocity (Ali et al., 2017; Jüttner and Maklan, 2011). However, other more current SCRES lenses are worth investigating such as the framework of SCRES transformability or anti-fragility, based on embracing and learning opportunistically from disorder to achieve growth and positive transformation (Nikookar et al., 2021; Wieland and Durach, 2021).

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