Organizing for supply chain resilience: a high reliability network perspective

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Abstract

Purpose – Both high reliability theory (HRT) and "new school" supply chain resilience (SCR) promote a multi-layered, adaptable, transformational, and holistic perspective on organizing and managing. The authors explore whether, and if so how, HRT offer fresh perspectives on the SCR challenges experienced during COVID-19 and on organizing for future resilience.

Design/methodology/approach – Addressing SCR at the interorganizational network level, and blending theory synthesis and case study research, the authors assess if and how HRN constructs and practices can guide analysis of SCR in dynamic, complex networks, and help shape development pathways towards organizing for resilience. Findings draw on thick description and iterative coding of data (58 interviews and 200+ documents) on the buyer network responsible for managing the supply of critical medical products in the Netherlands.

Findings – HRT highlights the interconnectedness of challenges encountered during COVID-19 and helps design future resilience through three lessons. Organizing for SCR requires (1) both anticipation and containment strategies, (2) stable working relationships characterized by trust, and (3) a clear basis of command underpinned by experience-based legitimacy.

Originality/value – Distinctive from SCR, which views crises as "black swans", HRT organizes around everyday consideration of the risk of failure. Taking a buyer network perspective, the authors move beyond the buyer-supplier network focus in SCR. The authors contend that emphasis on measures such as supplier base management, stockpiling, and domestic production are essential but not sufficient. Rather, HRT implies that deep structural and social ties within the buyer network should also be emphasized.

Keywords Reliability, Resilience, Network, Procurement, Supply chain

Paper type Research paper

1. Introduction

The consequences of supply chain failures during the COVID-19 pandemic have been widely reported by for example: the BBC on the UK's failure to stockpile (BBC, 2020), the Guardian on hijacked supplies (the Guardian, 2020), and The New York Times on price gouging (The New York Times, 2020). Supply challenges encountered during the pandemic fueled

unprecedented policy attention on supply chain resilience (SCR) and triggered re-evaluation and continuous learning on SCR in order to deal with future crises:

> The United States needs *resilient*, diverse, and secure supply chains to ensure our economic prosperity and national security. (The White House, 2021).

> Our dependencies in areas like energy and raw materials weaken us economically and politically. But we also need to rethink our supply chains from an environmental and social point of view... We need secure and sustainable supply chains. (European Commission, 2022)

Recent SCR studies based on COVID-19 experiences have paid attention to the complexity and dynamic nature of supply chains (Wieland and Durach, 2021). Single entity focused definitions of resilience have been replaced with multi-layered definitions, in which supply chains are seen as intertwined and complex networks (Ivanov and Dolgui, 2020). The static equilibrium-based view of resilience – which refers to the ability of a supply chain to "bounce back" or "forward" after a disruptive event – has been replaced with a dynamic view in which the supply network continuously evolves (Novak *et al.*, 2021). Following on from these new insights on *what* is SCR, the next step is understanding *how* to organize for resilience.

This new dynamic complexity perspective on SCR and the focus on organizing for resilience calls for novel approaches in practice and research. Traditionally, supply chain management (SCM) literature has been operationally focused, and firm centered. Controllability, rationality, optimality, and objectivity have been the leading determinants (Wieland, 2021). Experiences in the pandemic reveal the limitations of this view. For instance, with a shared objective of health continuity during the pandemic, the importance of network (including buyer-to-buyer) coordination has been emphasized. Taking a dynamic, holistic perspective means that we must seek deeper layers of interconnectedness between operational activities and (emerging) strategies, and address the role of the interorganizational network. We endeavor to understand the governance of the network and its influences on building resilience. In doing so, this study responds to Craighead *et al.* (2020) advocating that "pandemics require scholars to take a fresh look at what lenses offer understanding of supply chain phenomena in order to help supply chain managers better prepare for the next pandemic" (p. 838).

Relating to research process, shifting from a firm-focused to a multi-layered view of SCR represents a shift in the unit of analysis from organizations to networks. Here, we focus on the network of buyers within the healthcare system. Second, traditional case study approaches following qualitative positivism and centered on theory replication through multiple cases are of limited use in efforts to understand organizing for supply resilience in complex supply systems. The complexity of the multifaced supply challenges in a dynamic supply network during the pandemic points to the benefits of problematizing (Jaakkola, 2020) and *understanding* supply resilience, investigating low *n* or single case studies with an interpretivist perspective (Bonache, 2021).

In the interpretivist paradigm, "theories do not express the underlying engines of generalized empirical patterns. Rather, they are instruments that provide illumination, insight, and understanding." (Alvesson and Kärreman, 2007, p. 1267). High reliability theory (Weick *et al.*, 2008) is such an instrument. Translated to the context of networks, it enables understanding of the ways in which a network can become reliable. In a high reliability network (HRN), reliability refers to the ability to maintain effectiveness in times of crisis and peak demand (Berthod *et al.*, 2017). In the light of the above, this paper addresses two research questions, specifically in the context of supply chain management:

RQ1. How can HRT deepen understanding of SCR and shed light on specific challenges encountered during the COVID-19 pandemic?

RQ2. How can HRT help in the design of future, dynamic and adaptive modes of SCR?

Based on a single, in-depth case study of a Dutch medical supply network during the COVID-19 pandemic (see Peters *et al.*, 2021), we found that the HRN perspective is relevant and valuable for SCR research. The HRN perspective sheds light on the interconnectedness of the challenges encountered during the pandemic by providing a deeper layer of understanding. Instead of viewing crises as outliers (as in SCR literature), it takes a "permacrisis" perspective (Zuleeg *et al.*, 2022), in which one crisis follows the other. Additionally, SCR literature often focuses on buyer-supplier interactions, not taking into account buyer networks. Combining the buyer network and high reliability perspective creates new opportunities for organizing for SCR in both research and practice. We argue that the current SCR focus on isolated measures such as supplier base management, stockpiling, and national production, are necessary but not sufficient. Without familiarity and coordination between actors in the network, these measures are bound to be suboptimal.

Rooted in the HRN perspective, new policy and practice ideas on how to organize for SCR are proposed. First, organizing for SCR requires both anticipation and containment strategies at the interorganizational level. Second, organizing for SCR requires stable (and potentially dormant) working relationships characterized by trust among actors in the supply chain. This includes buyer-to-buyer relationships. Third, organizing for SCR requires a clear basis of command, building on experience-based legitimacy, which allows for layering and switching of governance modes to achieve effective forms of network governance both in times of (relative) stability and crisis.

2. Literature review

2.1 Supply chain resilience

Whilst there is no universally accepted definition, there is the widely-held notion that SCR is about recovering from disruptive events (Novak *et al.*, 2021). COVID-19 led to scrutiny of many, previously widely accepted facets of resilience. First, traditional SCR, but also more generally SCM, are often explained through an individualistic perspective – in the majority of cases, one organization or the relationship between an organization and its suppliers is the unit of analysis. In the early 2000s, Choi *et al.* (2001) argued for a shift in perspective stating that "supply networks emerge rather than result from purposeful design by a singular entity" (p. 351). This need to understand phenomena through a multilayer perspective is emphasized by Carter *et al.* (2015), who argue that SCM should move to multi-level theorization: "investigations that employ single-level theorizations potentially restrict our understanding of complex SCM phenomena and systems" (p. 94). Though twenty years have passed since Choi *et al.* (2001) advanced their view, Novak *et al.* (2021) find that the resilience of a single entity continues to be taken as a proxy for SCR. In line with Carter *et al.* (2015), Wieland (2021), and Novak *et al.* (2021), we argue that this single-level view limits the scope for understanding supply chain resilience and its complexity, and that this is important in coming to understand the impact of the COVID-19 crisis.

Second, traditional SCR is often focused on controllability and optimality (Wieland, 2021). This is evident in pre-COVID-19 definitions of resilience as, for instance, with Kamalahmadi and Parast (2016, p. 121): "The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations." Phrases such as "reducing probability", "resisting the spread of disturbances", "maintaining control", "transcend the disturbance" and "restore the supply chain to a robust state" imply stability and controllability within supply chains. Rather, resilience in the post-COVID-19

period is about the ability "to maintain core functionality by continually adapting, evolving, and transforming in response to the dynamic multiscale feedbacks that occur between the multitude of interconnected organizations, institutions, and social and ecological systems that are all parts of the larger supply chain." (Novak *et al.*, 2021, p. 10). This implies that instead of trying to "maintain control [of supply chains]" and "restore supply chains to a robust state" – which was the approach underlying the "old-school" SCR concept – new SCR should center on the adaptability and continuous transformation of supply chains.

Third, the focus on firm, controllability and optimization lead to a linear, operational perspective rather than a holistic view which encompasses emergent, intertwined and strategically significant outcomes of network actors' distributed behaviors over time. Academic articles published in reaction to the pandemic underpin this. Duong and Chong (2020) focus on collaboration in relation to the pandemic, Handfield *et al.* (2020) focus on stockpiling, and Phillips *et al.* (2021) address information asymmetry in decision making in relation to the COVID-19 crisis. Sanchez-Graells (2020) concentrates on public procurement regulation, whereas Tip *et al.* (2021) take a competitive rivalry perspective to the procurement strategies utilized during the crisis. These various themes are in fact interrelated and interdependent – rivalry impacts collaboration and vice versa. Similarly, procurement regulations impact information asymmetry and stockpiling options. Therefore, we argue for a holistic approach because compartmentalizing limits the opportunity to understand SCR and its complexity.

With the (1) single layered, (2) controllable and stable, and (3) compartmentalized operational view under scrutiny in reaction to the COVID-19 pandemic, new research on SCR adopts a (1) multi-layered, (2) adaptive and transformative, and (3) holistic perspective. The first step in understanding SCR is comprehending what SCR entails. However, extant research has yet to provide guidance in how to organize for resilience. Based on this new understanding of SCR, we argue that understanding the "how to organize for resilience" question is the next step.

2.2 High reliability networks (HRN)
When writing about crises, accidents, and pandemics, organizational theorists often refer to high reliability theory (HRT) (Shrivastava *et al.*, 2009). HRT investigates how organizations operating in extremely complex settings effectively avoid accidents for lengthy stretches of time, whilst maintaining their ability to fulfill highly unpredictable and demanding production targets. In essence, researchers sought to identify organizational characteristics or procedures that significantly reduced the hazards associated with operating in a highly dynamic and closely connected environment (Shrivastava *et al.*, 2009). In other words, researchers sought to identify "how to organize in the face of the unexpected" (Weick, 2006, p. 51).

Similar to the earlier work on SCR, where the focus lay on controllability and stability, early high reliability work stressed a singular focus on safety and concentrated on the closed loop environment (Weick and Sutcliffe, 2007). Recent work, however, acknowledges environmental and intra-organizational influences. We note many similarities between the new notion of SCR and the notion of high reliability. Where resilience centers on "recovering from disruptive events", HRT focuses on "managing the unexpected", with both underscoring the importance of adaptiveness and a transformative approach. HRT literature is distinctive, however, in the sense that it focuses on the failures rather than the successes and, therefore, tries to organize for complexity (Weick *et al.*, 2008). Rather than treating organizations which operate in extremely complex settings and which try to effectively avoid accidents for lengthy stretches of time (such as space shuttles, nuclear power plants, and naval aircrafts) just as exotic outliers, HRT researchers argue they help reveal processes that are relevant and useful to all organizations because they provide unique learning opportunities for organizational effectiveness under extraordinary conditions (Weick *et al.*, 2008). Having noted that the purpose of high reliability theory and SCR seem to

be converging – albeit with a difference in approach – we developed the research questions set out above.

Similar to the single-entity-centered supply chain literature, high reliability research was predominately undertaken on an organizational level, introducing high reliability organizations (HROs) (Weick *et al.*, 2008). Schulman *et al.* (2004) later introduced the concept of reliable networks, arguing that "high reliability in providing critical services has become a process that is achieved across organizations rather than a trait of any one organization" (p. 14). The interorganizational nature of reliability is acknowledged in HRO research, but research evolving from high reliability organizations (HROs) to high reliability networks (HRNs) remains limited (Berthod *et al.*, 2017).

HRO theorists have sought to identify what qualifies an organization to be an HRO. Weick and Sutcliffe (2007) describe characteristics that are key to "organizing for high reliability": "HROs manage the unexpected through five processes: (1) preoccupation with failures rather than successes, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise as exhibited by encouragement of a fluid decision-making system. (p. 38)". Lacking however a clear understanding of how to organize for high reliability within a *network*, we sought insights from existing HRN literature.

Reliability is defined as "the ability of an organization or network to both anticipate and contain incidents in the course of its operations, thereby maintaining its effectiveness even during crises and times of peak demand" (Berthod *et al.*, 2017, p. 1). Whereas containment only takes place once the incident has occurred, anticipation activities ask for preparation work within the network. Therefore, according to Berthod *et al.* (2017), anticipation activities – through working together – increase awareness and confidence within the network, and mitigate concerns when a crisis erupts. At the same time, anticipation further reinforces the ability to contain incidents due to the reactivation of inactive relationships and the general state of preparedness (Berthod *et al.*, 2017). Both containment and anticipation are essential components of high reliability networks. This links directly to the process of Weick *et al.* (2008), which they defined as a "commitment to resilience", where both anticipation and the capacity to cope with the unanticipated should be present in effective HROs. This gives rise to the following proposed characteristic:

Characteristic 1. A high reliability network engages in both containment and anticipation strategies.

Increasing awareness and confidence within the network through anticipation activities highlights the importance of working relationships: "a durable basis for trust during crises is positive precrisis working relationships", and "such relationships can be deliberately cultivated" (Moynihan, 2009, p. 10). They facilitate a common language and mutual understanding of one another's mandates, duties, expertise, and interests, with a consequent improvement in mutual trust. With trust being "the willingness to accept vulnerability based on positive expectations about another's intentions or behaviors'" (McEvily *et al.*, 2003, p. 92), its importance in crises becomes evident. Again, this is consistent with the view of Weick *et al.* (2008) on the processes needed to achieve high reliability in an organization. Whilst they do not earmark a single process, the authors argue: "The fundamental processes involved in reliable performance are processes indigenous to all relationships that matter." (p. 56). Together, these points give rise to the following characteristic:

Characteristic 2. A high reliability network has stable (and potentially dormant) working relationships characterized by trust among actors in the network.

Arguably, the most important attribute of a high reliability network is an effective mode of network governance. Provan and Kenis (2008) distinguish between three modes of network governance: (1) shared governance, denoted by the absence of a central governing structure –

instead, direct cooperation in participatory decision making is used to coordinate actions; (2) lead-organization governance entails network coordination by a single organization, often enforced through either resource dependency or obligations; (3) network administrative organization (NAO) – NAO-based governance involves establishing a separate, impartial administrative organization to operate as a central broker for the entire network.

Berthod *et al.* (2017) argue that different features of these governance modes will surface, depending on whether a network is in crisis mode. The optimal combination being contingent on the situation means hybrid forms of governance. These are developed through two activities: layering and switching. Layering refers to the informal processes in which different features of governance modes are used simultaneously to move to the hybrid mode that fits the situation best. Layering is therefore reliant on trust and working relationships within the network. Layering creates stability in the network through both inclusiveness and the leveraging of network ties. Switching is a decision-based process, where networks temporarily act as a – prepared – centralized structure in times of crisis or high demand, and afterwards switch back to a layered mode of governance.

Both switching and layering require a clear – though not necessarily centralized – basis of command (Berthod *et al.*, 2017). Without one, no institution(s) can be held accountable for the governance of the network in stable times, which means that organizations are less likely to collaborate between crises (Moynihan, 2009). Without this, layering cannot occur. Thus, layering depends on a clear understanding of each other's responsibilities. Similarly, switching – as a decision-based process – is dependent on one (or more) organization(s) taking accountability for network governance. This does not suggest that one "*static*" organizational entity in the network is accountable for the governance of the network at all times. Rather, these bases of command can be dispersed: various organizations could take on this role depending on their capabilities and the situation the network is in.

The continuous activities of layering and switching result in highly diverse governance modes, which are context dependent. Berthod *et al.* (2017) differentiate between two types of governance modes, with different bases of legitimacy and control: supportive and assertive. Supportive modes are based on decision structures with rotating responsibilities, where control is informal through legitimacy, developed through organizations' experience and expertise over the long term. The supportive governance mode is used in stable times, where organizations with experienced-based legitimacy anticipate future crises through informal processes. Assertive modes are based on consulting structures with centralized responsibility that operate through formal control in operative legitimacy. Hence, in times of crisis, a network might switch to (and between) assertive governance mode(s), where one (or more) organization(s) coordinate the network governance through established operational legitimacy. In this case, operational legitimacy relates to the fact that only a few organizations are able to coordinate the operational side of that specific crisis. In conclusion, this leads to the following characteristic:

Characteristic 3. A high reliability network can switch between, and combine, different forms of network governance giving hybrid arrangements for effective performance. This requires a clear, yet dynamic (and not necessarily unitary) basis of command, achieved through either operational or experience-based legitimacy.

3. Research method
3.1 Research perspective
New approaches to SCR question several key methodological assumptions in traditional SCM research. In SCM, most case-study research is based on qualitative positivism, in which researchers focus on a single reality that can be discovered, predicted, and controlled (Welch

and Piekkari, 2017). This resonates well with the earlier view of resilience, where controllability and stability were seen as the main objectives, often from a single-entity perspective (Wieland, 2021). However, focusing on single-level solutions, theorizations and/or entities restricts our understanding of the complexity of supply chains (Carter *et al.*, 2015). Analyzing how supply chains can become resilient, in a dynamic, adaptive, and holistic way, requires an approach that considers the context of the COVID-19 pandemic and the interwovenness of cause and effect. This perspective and the research strategy align with interpretivism, where both the context and process shape the study (Bonache, 2021; Welch and Piekkari, 2017). Hence, rather than focusing on explaining and controlling, this study aims to understand the phenomenon, taking an interpretivist approach.

Our approach aligns with and draws inspiration from a range of eminent authors on research perspectives and processes. It is both about theory synthesis (Jaakkola, 2020) and case study research (Welch *et al.*, 2011). Theory synthesis "seeks to achieve conceptual integration across multiple theories or literature streams. Such papers offer a new or enhanced view of a concept or phenomenon by linking previously unconnected or incompatible pieces in a novel way" (Jaakkola, 2020, p. 21). Our case study approach is based on a single case developed as part of a research project on medical SCM commissioned by ZonMw, the Dutch national health research agency, in late 2020 when the healthcare system experienced severe shortages of products needed to care for COVID-19 sufferers. The funding agency sought to build knowledge about the practical strategies that buyers in the healthcare system could adopt to mitigate problems in this and future crises. Concerned with practical relevance, our approach reflects a practical – rather than scientific – rationality: "practical rationality. . . makes theory a derivative of practice and, thus, more reflective of the 'richness' of practice" (Weick and Sutcliffe, 2007, p. 14).

The case provides both inspiration and illustration (Siggelkow, 2007). The initial analysis of the case (see Peters *et al.*, 2021) provides a rich description of the unfolding supply crisis from the point of view of buyers and buyer-side stakeholders (e.g. the Ministry of Health) within the healthcare system (hereafter: the "buyer network"), and insights on a series of practical measures to mitigate supply shortages in future crises. Those "crisis procurement protocols", which closely reflect network actors' accounts of their learning, did not however effectively address deep structures nor systemic change needed to better organize for future crises. Our difficulties in conceptualizing and articulating these aspects led to looking outside SCM to the field of organization studies. Subsequent analysis using constructs from HRT and HRN provides the basis for illustrating their relevance to the supply chain domain.

Though the first round of data analysis was primarily inductive, our goal was not inductive theory building (Eisenhardt) nor natural experiment (Yin) (Welch *et al.*, 2011, p. 745). Our case research approach is non-linear and non-positivist (Dubois and Gadde, 2002, 2014). It is interpretive with an emphasis on understanding, but also an interest in explaining, since it is only through appreciating causal mechanisms (Welch *et al.*, 2011) that we can draw out insights for future organizing. We follow aspects of "interpretive sensemaking" and "contextual explanation", two of the four case study types delineated by Welch *et al.* (2011), both of which place a strong emphasis on contextualization.

Welch *et al.*'s (2011, p. 748) account of the "contextualized explanation" mode case study research is especially relevant to our case: "He (Bhaskar— the main advocate of contextualized explanation) ascribes causal power to human agency. . . Yet, at the same time, explanations cannot be reduced solely to human intentionality and agency, because human actors operate within already existing social structures. Social structures condition our actions, yet through our actions we (re-)produce these very social conditions . . .. while human action is inherently meaningful and purposeful, a causal explanation cannot be built solely from actors' own understandings and interpretations". In developing a network-centered and network level case narrative to consider system level issues, researchers

necessarily abstract away from the experiences of respondents, something which is subject to criticism by some proponents of inductive qualitative research (Gioia *et al.*, 2022).

3.2 Data collection and analysis

Our case is the buyer network within the Dutch medical supply network during the COVID-19 pandemic, built on 58 interviews and over 200 items of documentary data. Respondents include representatives of different types of organizations active in the supply of medical equipment during the COVID-19 emergency, on either the local, regional, or national level in the Netherlands (see Table 1). Interviewees were asked to describe their experiences and reflect on what they had learnt. Interview guides were adapted for different roles, and covered these themes: personal role and employing organization's role during the pandemic; preparedness; prior regulations and protocols; purchasing process adaptations; experiences of collaboration/competition; communication and information sharing; perceived effectiveness; learning (see page 14–19 of Peters *et al.* (2021) for full details).

In the analysis, our first aim was to obtain a better understanding of the data and the wider context. In the first round, transcripts were coded by the nature of the event. Phrases were coded as either (1) a challenge, (2) an action or (3) an evaluation/future intention. The interconnectedness of the supply challenges and activities experienced during the COVID-19 pandemic could then be visualized (see below). Future intentions and evaluations were summarized and critically compared. Interviewees identified three common objectives for future resilience, with six different measures. These objectives for future resilience and the corresponding measures (building stockpiles, increasing domestic production, enhancing purchasing capabilities, improving information systems, partially centralizing procurement in times of crisis, and building national protocols) are explained below.

Whereas the first round of coding showed patterns of interconnectedness both within the challenges and between the challenges and measures for future improvement, concepts such as trust and familiarity moved more to the background. Instead, the focus was on operational ideas for future improvement. For example, insufficient supply could be counteracted through operational resilience by increasing stockpiles and domestic production. However, these measures disregard aspects that are hiding in deeper layers of the challenges, such as trust, legitimacy, working relationships, and familiarity. These are all aspects relating to governance of the network. Hence, in the second round of coding, we analyzed whether the characteristics related to HRN can provide a deeper understanding of the challenges encountered during the COVID-19 crisis and, therefore, help in the design of future resilience beyond the traditional operational aspects.

Type of organization the interviewee worked for	Number of interviewees
Academic hospitals	4
Disabled care organizations	10
Elderly care organizations	8
General hospitals	12
Government (Ministries)	5
Mental health organizations	5
National Consortium	5
Other: Police	1
Purchasing collaborations	4
Regional coordination organizations (ROAZ/GGD/GHOR)	4
Total	58 interviewees

Table 1.
Overview of
interviewees

All previously coded actions were classified as either anticipation or containment strategies. This provided a better understanding of the relations between the Dutch supply challenges. Secondly, to assess the stability of working relationships characterized by trust, all evaluations of relationships and all activities directly and indirectly related to trust were coded. Third, we coded all phrases related to accountability and authority. In other words, this included all evaluations and comments on the question: "who is/should be in charge?" This helped us understand how a clear basis of command might be achieved in the future. Lastly, we reviewed the (very detailed) contextual description (see Peters *et al.*, 2021, pp. 20–64) which provides a coherent narrative of the case, to understand the layering and switching opportunities needed to achieve the most effective form of network governance. Hence, by coding and interpreting the data according to the characteristics of HRN, the Dutch supply network during the COVID-19 pandemic could be understood from a HRN perspective, providing insights into the previously hidden layers of the challenges and, consequently, where the future improvement opportunities may lie.

4. Contextual analysis of the case study

4.1 The Dutch healthcare system

The Dutch healthcare system has many seemingly disparate features in relation to crisis response. Its cooperation-, consensus- and negotiation-based approach focused on inclusivity of all organizations (Grit and Dolfsma, 2002), often referred to as the Polder model (Visser and Hemerijck, 1997), is unique. There are many purchasing collaboratives between providers, which enhance information sharing, bundle expertise, increase market power, and generate economies of scale (Schotanus and Telgen, 2007). This collaborative, inclusive approach exists within a government and healthcare structure whose design points to a rather individualistic and competitive approach. The Netherlands is a highly decentralized unitary state, where power is shared by the central government, the twelve provinces, twenty-five safety regions, and three hundred and forty-five municipalities (European Commission, 2014). Similarly, although general hospitals are privately owned in the Netherlands and competition between institutions is encouraged, they operate on a not-for-profit regulatory basis (Figueras *et al.*, 2005). Further, there is a strong emphasis on the procurement autonomy of each contracting authority in the Netherlands (Janssen and Stuijts, 2021). Notably, purchasing coordination is voluntary, not centrally mandated.

In 2019, the Global Health Security Index study ranked the Netherlands third (after the US and the UK) in overall preparedness for a pandemic (GHS Index, 2019). By 2021, the Netherlands' ranking had fallen to 11th. In line with the 2019 GHS index, the Minister of Health, Welfare and Sport (hereafter, the Minister of Health) did not seem unduly concerned in late January 2020, when COVID-19 surfaced in Europe: "the Netherlands is well prepared for any infections. RIVM (National Institute for Public Health and Environment), Erasmus MC (as our reference laboratory for emerging diseases), and the GGDs (Municipal Health Services) are prepared for surveillance, detection, and contact tracing. The partners in acute care, such as the National Acute Care Network, hospitals, and general practitioners, are prepared for isolation and patient care" (Bruins, 2020a).

The first action was taken at the end of February. The Ministry of Health was advised by its outbreak management team to set up regional distribution centers for personal protective equipment (PPE). The Ministry initiated eleven regional distribution centers in the (pre-COVID-19) health crisis regions, called ROAZs (van Dissel, 2020). Alongside their distribution responsibilities, the ROAZs were appointed to gain insights into regional shortages, demand, and stockpiles. On March 2nd, a national coordination center was added: the Ministry of Health appointed the GGD (with no established national structure) to nationally oversee the distribution of products to the regions through the ROAZs. The GGD was also charged with

collecting data from the regional ROAZs to monitor stocks, demand, supply, and shortages on a national level (Bruins, 2020b). Prompted by the purchasing collaboratives, government organizations, suppliers, hospital purchasers, and the ROAZs came together to consult for the first time on March 4th (Policy maker, Ministry of Health, interview). Two days later, a directorate of the Ministry of Health started purchasing PPE on behalf of the government: "A group of policymakers, who had never bought anything before, were collecting and buying things" (Policy maker, Ministry of Health, interview).

On March 17th, a new organization – LCH – was officially launched as the centralized national buying agency for PPE and other COVID-19 critical materials, taking over from the Ministry of Health (Rijksoverheid, 2020). Whereas formal responsibility and funding remained with the Ministry of Health, operational processes were executed by a combination of healthcare purchasers, purchasing collaboration employees, Dutch logistics companies, Dutch PPE suppliers, and pro-bono consultancy experts (van der Kolk, 2020). LCH's main role was purchasing medical equipment for the healthcare sector. However, as a central organization, it was also a common point of contact for the government, regional-, and healthcare organizations. This meant that care (such as nursing homes) and cure institutions (such as hospitals) remained individually responsible for the acquisition of medical supplies, but they could apply to LCH if stocks threatened to be insufficient. Hence, different types of organizations together organized the supply of COVID-19 related medical equipment: the Ministry of Health, LCH, ROAZ, GGD, purchasing collaborations, and care and cure institutions.

4.2 Challenges and proposed next steps
Interviewees indicated that there were no "off the shelf" national structures or protocols for coping with increased demand in crisis situations: "Everything that you hoped was there was actually not there. So that was the world we were in." (Coordinator, GGD, interview). This also included no national production facilities or national stockpile. Consequently, the Ministry of Health appointed existing organizations (GGD and ROAZ) as national and regional medical equipment coordinators. Under normal circumstances, this task falls outside the scope of these organizations' responsibilities. Lacking the necessary organizational structures, protocols, and experience, they had to improvise. Though they did have purchasing and logistics experience, those establishing LCH faced similar problems, exacerbated by healthcare institutions' lack of familiarity with LCH's role and strategy. For example, some interviewees expressed uncertainty about the purpose of the LCH – was its role to serve primarily as a safety net, or as a new supplier for individual healthcare providers?

The decision to centralize supply meant collecting up-to-date data on demand and stock levels among care and cure providers, and resulted in the Ministry of Health, national and regional coordinators (GGD &ROAZ), and individual healthcare professionals all building information systems. Unfamiliarity with the nationally appointed organizations led to a local institutions' reluctance to share information. Organizations such as nursing homes did not want to reveal their actual stock levels, afraid that it would mean that they had to provide stock to other organizations, and then running out themselves. Consequently, there was a lack of confidence in the quality of the data, with many then questioning whether there was in fact a scarcity of PPE in the Netherlands as a whole, or whether local shortages in fact reflected distribution problems.

Prior to the pandemic, routine medical products were frequently procured through standardized processes from East Asia through wholesalers, with an emphasis on price and efficiency. When wholesalers failed early in the pandemic, hospital buyers found themselves engaging in direct sourcing from manufacturers. Their lack of experience in dealing directly with East Asian suppliers was a major hurdle. It was difficult to rapidly find new (alternative) suppliers, notably in terms of supply reliability, including quality control and distribution

guarantees. Supplier fraud became an increasingly important new challenge, due to buyers' limited understanding of testing and certification. The task of filtering a great many (un) solicited proposals also challenged buyers within the medical supply network. Furthermore, there were at least two distribution challenges: non-delivery or delayed supplies by unreliable and less dependable vendors, and new and rapidly changing export regulations.

Internationally, actions by national governments presented many challenges and a few opportunities. The export of medical products from Europe was outlawed on March 15, 2020 (European Commission, 2020a). However, some EU countries (e.g. France and Germany) also closed their borders for export within the EU. In the depths of the crisis, the EU tried and failed to organize a unified tender (European Commission, 2020b). As buyers competed in the same overloaded international market, inter-continental, international and inter-healthcare provider rivalry escalated.

The challenges identified by interviewees are interconnected – the (perceived) shortages of medical equipment during the COVID-19 pandemic have led to multiple (sub)challenges, incidents, and actions. Figure 1 provides a model of the incidents and actions mentioned in the interviews.

Based on interviewees' reflections on their experience and their suggested improvements before being better prepared for future extraordinary events, we identified six different measures for future preparedness, addressing three objectives: increasing supply redundancy, increasing supply capabilities, and increasing coordination of supply. First, interviewees argued that supply redundancy should be increased through both individual stockpiles and national stockpiles, as well as through increasing domestic production capacity. Both measures would decrease dependency on other nations. Second, interviewees argued that healthcare buyers' capabilities should be improved. A shift from routine purchasing to strategic purchasing, with the corresponding (advanced) capabilities, is needed, as is a central information system for data sharing. Lastly, interviewees argued that the coordination of supply should be improved. This should be achieved principally through introducing national crisis protocols and procedures for the supply of medical equipment in times of crisis, and partly through the option of centralizing the procurement of medical equipment for increased purchasing power.
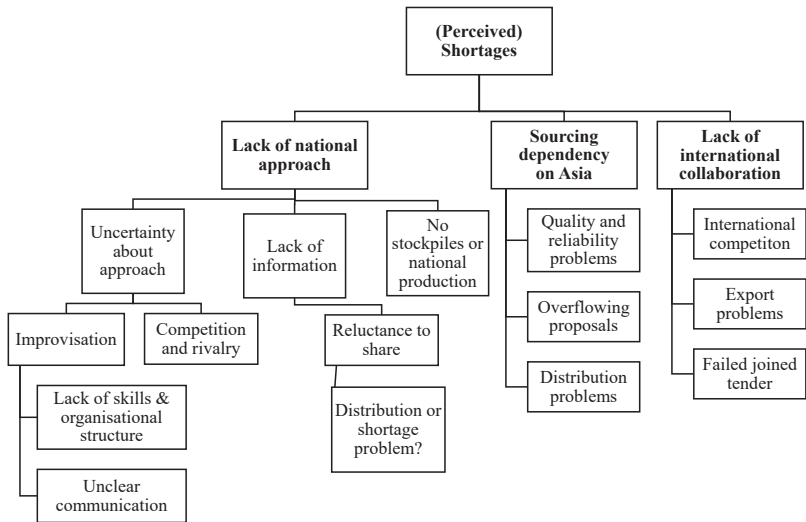
Figure 1.
Dutch supply network challenges encountered during COVID

5. Findings

5.1 Anticipation and containment strategies

Some Dutch institutions had adopted some anticipatory measures. Most often these concerned stockpiling selected products; several hospitals benefited from stockpiles built up ahead of Brexit. Others had local crisis plans in place: "Normally a hospital already has a crisis team. So, we have said we are not going to set up a crisis team specifically for COVID-19, but we are going to use the existing structures" (Head of purchasing department, hospital, interview). These measures are however at the level of the individual healthcare provider, and are centered on maintaining local care provision, not dealing with supply shortages across the nation. And yet, as shown by Harland *et al.* (2021) and within this case, rivalry between buyers can readily become the default mode of working, and this should be addressed ahead of any crisis.

In relation to HRN, collaborative anticipation activities raise network awareness and build network confidence, alleviating concerns during a crisis. Anticipating strengthens the ability to limit the impact of accidents by maintaining otherwise dormant relationships and improving overall preparedness (Berthod *et al.*, 2017). Our interviews showed little evidence of anticipation strategies *at the level of the national network*. Interviewees working at regional or national institutions attributed the lack of network level preparation to the lack of a national structure. National and regional crisis planning covered healthcare delivery but not the management of critical supplies. Established channels for cooperative purchasing were all about consolidating spend and purchasing power, not cooperative management of critical national shortages.

In the absence of network anticipation strategies, containment strategies were developed "on the run". National measures took time to yield benefits. Establishing the regional distribution centers for PPE was one containment strategy. However, the lack of familiarity with the organization (due to absence of anticipation) made execution difficult: "Even the LCH said: I don't even know the people from the ROAZ, so I would not know what information to get" (Head of purchasing department, hospital, interview). Many localized initiatives within the network were led by care and cure providers who shared supplies and information informally. "We as [hospital] procurement managers of the [region name] also very quickly had ourselves actually just sort of conference call . . . And then we agreed that we would just call each other every week on Thursday at three o'clock." Bottom up and top-down containment strategies were very much ad-hoc, and there is no reason to expect these structures will endure or inform future anticipation activities.

The examples above illustrate the connectiveness between containment and anticipation strategies and, consequently, how the effectiveness of containment strategies is dependent on anticipation strategies. In our case, we notice a mismatch in scale: whereas containment activities are on the network level, anticipation strategies are only on the organizational or department level. For effective containment on the network level, anticipation strategies on the network level are needed.

5.2 Trust and working relationships

Anticipation activities normally build trust (Berthod *et al.*, 2017), but with limited network collaboration prior to the pandemic, network members did not understand and had no experience of each other's expertise, commitment, and responsibilities. Working relationships and trust had to be built during a crisis – referred to as swift trust (Meyerson *et al.*, 1996). In the interviews, we noticed major differences on whether trust and working relationships could still be established or not. We observed that, depending on the level of mutual cooperation – rather than one-way communication – and the frequency of meetings, trust and working relationships could either be built during the crisis or destroyed.

A regional coordinator who had almost daily meetings with healthcare institutions noticed that it took him 6 weeks at the beginning of the crisis to build trust and working relationships: "The first conference calls with the hospitals were tough. And rightly so, because they also thought, 'Who is this man?' You have to trust each other. You notice this

when we have a team meeting now, it is very relaxed and smooth. But in the beginning, it was hard work, because you have to create trust. That is a very important aspect in a crisis." (Head of procurement department and regional coordinator, hospital and ROAZ, interview). His recipe for success was cooperation and frequent meetings. Conversely, a purchaser employed at a care institution had a different experience with another newly established regional distribution center. With infrequent meetings and one-way communication, she did not trust that the regional distribution center would act in her interests: "Moral of the story, we just did not trust the ROAZ at all and we just did our own thing. At some point, it became an obligation to pass on your stocks to the ROAZ. I know everyone did that. I also know that everyone cheated. Because nobody wanted to reveal their actual position." (purchaser, care institution, interview).

Both examples illustrate how trust, achieved through working relationships, is a pre-requisite for effective coordination in a pandemic. In asking interviewees about improved arrangements for future crises, trust building exercises were not directly addressed. Rather, interviewees advocated improving coordination by establishing protocols and procedures, and possibly (partly) centralizing the procurement of medical equipment. Notably, the evidence above suggests these structural arrangements would fail unless underpinned by trust embedded in established working relationships.

5.3 Switching and layering

Effective network governance depends on being able to switch and layer between different modes of governance (Berthod *et al.*, 2017), leading to two hybrid forms of governance: supportive governance in stable times and assertive governance in times of crisis (Berthod *et al.*, 2017). Supportive governance is achieved through rotating responsibilities, a participative decision structure, and experience-based legitimacy. However, in analyzing the opportunities to achieve supportive governance in the Dutch case study, one obstacle is prominent: among the six institutions active in the Dutch medical supply network, four organizations (GGD, ROAZ, LCH, Ministry of Health) either do not exist or do not have an active role with regard to supply management in stable times. This would hinder layering (informal processes to switch mode of governance) because layering is reliant on trust and working relationships within the network, which creates inclusiveness and stability (Berthod *et al.*, 2017). This also implicates the participative decision structure, rotating responsibilities, and experienced-based legitimacy, which characterize the supportive governance mode, because it is impossible to engage in the network when organizations are inactive. Within the Dutch system in its current form, responsibilities cannot be rotated, and neither experience-based legitimacy nor participative structures can be developed by inactive organizations. The competition-centered logic of the Dutch health system structure accentuates the problem, hindering participative decision structures, and rotating responsibilities.

Assertive governance relies on consulting structures, with centralized command and decision structures, that operate through formal control in operative legitimacy (Berthod *et al.*, 2017). Centralized command and decision structures do not necessarily mean centralizing the process but, rather, informally taking the leadership role through operational legitimacy (legitimacy based on being one of the few actors capable of handling the operational response) in order to speed up the decision process. Moving toward assertive governance in a crisis is executed abruptly through switching. As switching is decision-based, it requires a mutual understanding and agreement on the goals and combined resources. It requires an organization or multiple organizations to be accountable for managing the network. Again, this does not mean centralizing the process but, rather, managing the network through operational legitimacy. For several reasons, a "clear basis of command" would be difficult to achieve in the Dutch case: "The question is 'who is in charge?' That is just not clear, not even in the legislation. So, there is no clear legal framework as to who is responsible for these kinds of issues." (coordinator, GGD, interview).

It is important to consider trust and expertise alongside the issue of the basis of command. The buyer quoted in the previous section, who "just did not trust the ROAZ", arguing they "just did [their] own thing" illustrates this perfectly: the ROAZ could not achieve a clear basis of command within their assigned operations because they did not establish trust. As Moynihan (2009) argued, trust is a critical component of authority.

Expertise is also a critical component. In the Netherlands, it was the Ministry of Health which first started the purchasing of medical equipment on a national level and, later on, had the mandate as national purchasing organization. However, as they themselves conceded: they were "a group of policymakers, who had never bought anything before [. . .] We have never been in contact with suppliers about the purchase of medical devices [before]" (policy maker, Ministry of Health, interview). Other interviewees questioned whether the Ministry of Health was the right organization to take the lead as the central purchasing organization: "One thing I really criticize about the LCH is that it was ultimately a plaything of the Ministry of Health in combination with academic hospitals. If you look at their purchasing behavior, you can see that academic hospitals are used to tendering, contracting and going through procedures properly. However, we were in the Wild West at the time, and in the Wild West you just have to act and throw all procedures overboard. I think that the Ministry of Health and academic hospitals are not very good at this, it is not in their DNA. [. . .] The Ministry of Health should have decided much earlier to let the Ministry of Defense take on a kind of directing role." (purchaser, purchasing collaboration, interview). The lack of expertise and experience, led to a lack of trust, and undermined the formal command structures. We conclude that a clear basis of command cannot be achieved without trust, expertise, and experience, which is defined by Berthod et al. (2017) as experience-based legitimacy.

Lack of trust and expertise not only affect the basis of command, but also capacity for assertive governance, which relies on formal control by one (or more) organizations (Berthod et al., 2017). Yet this formal control cannot be established without trust, expertise and experience within the network. The lack of consulting structures within the network seem to hinder the development of experience-based legitimacy further, as interviewees did not always feel appreciated and included: "We did try to provide input [to the Ministry of Health], but our services were not appreciated" (purchaser, purchasing collaboration, interview).

6. Discussion and conclusion

6.1 Theoretical implications for SCR

The current body of supply resilience literature tends to be operational and rather atomistic—focusing on isolated measures such as, for example, stockpiling (Handfield et al., 2020). Consequently, it is highly focused on "finding solutions" rather than seizing the opportunity to unpack the problem. We contend that understanding how supply networks can become resilient in a dynamic, adaptable, and comprehensive way necessitates an approach that takes the COVID-19 pandemic's context and the interconnectedness of cause and effect into account. For example, in our effort to understand the challenges, the HRN perspective illustrated the mismatch between the challenges identified by interviewees (which were about coordination and at a network level) and the proposed ideas for future improvements identified by interviewees (which were often operational and more individualistic in nature). As such, the HRN perspective showcases the need for a holistic understanding suited to comprehending the complexity of the COVID-19 crisis and SCR in general, in several ways.

Black swan or permacrisis? Recent work on high reliability theory and on supply chain resilience both focus on "managing the unexpected", but there is an important, traditional distinction. Whereas SCR has been premised as preparing for disruptions as the exception, high reliability organizations are organized around the risk of failure (Weick et al., 2008).

Phillips *et al.* (2021) for example, build on the notion of a black swan event to explore responding to information asymmetry in a crisis. And yet, "pandemics such as the COVID-19 outbreak have been described as "black swans", even if they are not in fact once in a lifetime events. It is high time to consider high-impact disruptors in the supply chain" (Kovács and Falagara Sigala, 2021, p. 46). "We are living in an age of permacrisis, with one challenge seamlessly followed by the next", some being familiar and others new (Zuleeg *et al.*, 2022). Our analysis of the Dutch case suggests that the reliability perspective is valuable as SCM scholars reframe SCR.

SCR or supply resilience, in complex network environments? Kähkönen and Patrucco's (2022) review of SCR literature pre- and since-COVID-19 shows the very rapid rise in SCR publications. Perhaps more surprisingly, it also shows just how few are specifically linked to resilience in the purchasing context. Those that do most often attend to buyer–supplier networks (e.g. Durach *et al.*, 2020; Feizabadi *et al.*, 2021; Taghizadeh *et al.*, 2021), restrict the field of consideration along the product distribution channels related to a focal buying organization. Wiedmer *et al.* (2021) unpack supply resilience complexity into three categories – supply, logistics and product complexity — but miss out the fourth category that is clearly so important in the Dutch case, namely buyer(s') complexity. In incorporating buyer-networks in SCR, we align with, and yet complement, new work on meso-level network resilience (Azadegan and Dooley, 2021). Combining the buyer network and high reliability perspectives opens up new spaces for action and analysis on organizing for resilience.

Holistic and systemic. Both "new" SCR and HRT/HRN advocate a multi-layered, adaptive, and transformative approach (Novak *et al.*, 2021; Weick, 2006; Weick *et al.*, 2008; Wieland, 2021). Analysis in the light of HRN theory, and taking a more hermeneutic approach (Mees-Buss, Piekkari, and Welch in Gioia *et al.*, 2022), indicates however the risk of our understanding of the situation being based on an overly simplified view of causalities within the system (Stake, 1995). In our study, attention is drawn to social relations and deep structures within the network of buyers. Dealing with novel circumstances "suffused with dynamic complexity" needs "a fusion of sufficient complexity of thought with necessary simplicity of action" (Colville *et al.*, 2012, p. 5). HRT/HRN facilitates this. Rather than attempting to resolve the problems encountered just through a program of operational interventions, a process or structuration perspective of change is needed (Heracleous and Bartunek, 2021).

Network capabilities underpinning operational "solutions". Analysis using an HRT perspective highlights the interrelatedness of strategies and activities and the value of a holistic approach in rethinking the design of SCR. This contrasts with, and yet complements, recent research findings and policy developments in SCR literature, which advocate that supply networks prepare for future crises through developing SCM capabilities (e.g. Harland *et al.*, 2021; Silva and Ruel, 2022) and through mitigation measures such as supply base management, stockpiling and domestic manufacturing capacity (e.g. Dube *et al.*, 2022; Handfield *et al.*, 2020; Kahiluoto *et al.*, 2020). These measures are of course important and relevant for future preparedness. They are necessary but not sufficient. Independent of whether the operational solution constitutes introducing national crisis protocols or (partly) centralizing the procurement of medical equipment, these solutions are bound to be suboptimal without familiarity with the network. HRT provides a useful extension to the recent body of supply resilience literature.

6.2 Policy and practice implications for SCR
Our evidence suggests that, while many practitioners are aware of the possibly disastrous consequences of supply disruptions especially in the medical sector, they give little attention to the effects of "deep structures" and social relations that frame behaviors such as rivalry and cooperation among buyers in the network. Our analysis reveals a critical mismatch between the network-level perceived challenges and the often organization-centered

proposed solutions. By introducing three lessons learned from applying HRT/HRN theory to the Dutch case, we present a starting point in organizing for supply network resilience.

First, HRT highlights the interrelatedness of strategies and activities during COVID-19—emphasizing the value of a holistic approach in rethinking the design of SCR. Our case study showed the negative effects of the interrelatedness: the lack of collaborative anticipation activities made the execution of containment strategies more difficult. As Berthod *et al.* (2017) argue, one strategy (or the absence thereof) reinforces the other. Through collaborative anticipation strategies, awareness and confidence in the network are increased, which improves relationships and the general state of preparedness. Without anticipation strategies, organizing for resilience through containment strategies is less effective. As such, in applying HRT we learn that:

> *Lesson 1.* Organizing for supply chain resilience requires both anticipation and containment strategies at the network level.

Second, the Dutch case study shows that, to understand resilience failures and opportunities to develop resilience, it is necessary to look beyond specific product supply chains and atomized buying organizations to buyer networks. In a pandemic, different institutions act in the same market – in our case, with the same goal – to supply medical equipment to ensure healthcare continuity. Operating in the same market makes buyers either Allies or competitors. Interviewees often experienced the latter: "I did not feel that LCH was a resolving party at all. On the contrary, we are all out and about in that market." (head of purchasing department, hospital, interview). Whereas LCH was solely established to support healthcare institutions, the lack of trust and misunderstanding of each other's roles and expertise hindered effective collaboration—trust and understanding that can be built through pre-crisis working relationships. Therefore, in applying HRT we learn that:

> *Lesson 2.* Organizing for supply chain resilience requires stable (and potentially dormant) working relationships characterized by trust between all key actors in the supply network. This includes the buyer network.

Third, organizing for supply chain resilience requires effective network governance. Different governance approaches are needed in stable times than in times of crisis. Through layering and switching, the most effective form of governance can be achieved – either supportive governance in stable times, or assertive governance in times of crisis. Supportive network governance means rotating responsibilities, a participative decision structure, and experience-based legitimacy, whereas assertive network governance requires consulting arrangements, with clear command and decision structures (Berthod *et al.*, 2017), with one or more organization(s) coordinating the network in times of crisis.

The data shows that, pre-COVID-19, the Dutch case could not realize supportive governance because in stable times buying organizations (if established) tended to be individually focused organizations, with voluntary cooperation and no central hubs or mandates. This is in line with lesson two. Implicit in this is the requirement for organizations to be active in stable times, building a web of enduring, if only intermittently activated relations. Similarly, our case study illustrated that assertive network governance cannot be effectively developed given that a clear basis of command is lacking because of underdeveloped experienced-based legitimacy. Therefore, we learn from HRT that:

> *Lesson 3.* Organizing for supply chain resilience requires a clear – though not necessarily unitary and hierarchical – basis of command underpinned by experience-based legitimacy, which allows for layering and switching of governance modes to achieve effective forms of network governance, both in times of stability and crisis.

6.3 Future research opportunities

Aligning with Craighead *et al.'s* (2020) call to deploy new theoretical lenses in SCM research, we argue that SCM research can benefit from using HRT, originating from organizational theory. Future research opportunities follow three interconnected paths: deepening connections with HRN/HRT to develop SCR theoretically; supporting the critical review and development of policy and practice; and developing our research practice to better perform the research in these two paths.

Having demonstrated the value of HRN/HRT framing for analyzing organizing for SCR, further research can delve deeper into past organizational studies research on high reliability, and related fields, such as sensemaking. There are three priorities: first, to assess the relevance and value of design principles derived for high reliability organizations (Gillingham and Applehans, 2022; Roberts and Bea, 2001; Weick and Sutcliffe, 2007) to supply chain and network settings; second to evaluate related research in other network-oriented organizations (for example, Grabowski and Roberts (2019) that write about reliability seeking "virtual" organizations, some of which (pp. 513–514) have significant supply chain connections); third, to investigate key network processes (for example, improvisation as a containment strategy (Frykmer *et al.*, 2018; Roud, 2021)), swift-trust (Meyerson *et al.*, 1996) or the dynamics of power (Boersma *et al.*, 2021). We anticipate such research will yield theoretically rich findings. More importantly, it should be relevant to and valuable in practice, informing analyses and recommendations in government-led reviews and bottom-up initiatives to learn from the pandemic, as they unfold in the coming years.

Such future research will present several specific process challenges, if it is to be consistent with the key premises of "new" SCR thinking – challenges which are familiar to researchers who undertake non-linear, non-positivist case research, and/or who undertake network level research (see for example, Dubois and Gadde (2002) or Welch *et al.* (2011)). And in the context of organizing for resilience, the temporal dimension compounds the empirical challenge of network research—how to identify and bound networks experiencing crises and demonstrating resilience, and evaluate the influence of organizational measures? (Knight and Pye, 2007). Clearly, rethinking resilience in today's complex, interconnected world will rely not only on openness to theories from other disciplines – such as HRT from organization studies and safety science – but also openness to novel research perspectives and methods.

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