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The importance of resource interaction in strategies for managing supply chain disruptions

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ABSTRACT

The turbulent business environment highlights the need for strategies for mitigating, responding to, and recovering from (that is, managing) supply chain disruptions. Resources are central in these strategies but remain unspecified in the literature. This paper shows how the resource interaction approach (RIA) can help understanding resources in this setting by acknowledging their interactive and networked nature. Based on a conceptual discussion that compares key assumptions within the supply chain risk management (SCRM) and supply chain risk resilience (SCRes) literatures with the RIA, we propose an alternative approach to strategies for managing supply chain disruptions. We challenge the SCRM and SCRes literatures by emphasizing interdependence (as opposed to independence) and pointing to relationships as key resources in strategies for managing supply chain disruptions. Collaboration relying on an interplay between temporary and permanent organizing is suggested as a starting point instead of being just one of several alternative strategies.

1. Introduction

Recent developments in today's business environment, including the war in Ukraine and the COVID-19 pandemic, have caused big disruptions in most sectors (Donthu & Gustafsson, 2020), and revealed the vulnerability of supply chains and society at large (Craighead, Ketchen, & Darby, 2020; Ivanov, 2020; Sodhi & Tang, 2021). The uncertain and complex business environment reflects the new (ab)normal in which companies face disruptions to their supply chains (Sheffi, 2020), and managing these disruptions has been put on the strategic agenda (Ahlqvist, Norrman, & Jahre, 2020). As a response, many organizations have turned their attention to supply chain risk management (SCRM), which implies "supply chain solutions that ensure supply continues to meet the demand in case of a [small and large, expected as well as expected] disruption or soon after the occurrence of such a disruption" (Sodhi & Tang, 2012, p. 304). Furthermore, the recent developments have accentuated the need to improve supply chain resilience (SCRes), which refers to the ability of a supply chain to prepare for, respond to, and efficiently and effectively recover from a disruption (Tukamuhabwa, Stevenson, Busby, & Zorzini, 2015). For example, the European Union's updated industrial strategy for 2020 has strengthened its focus on resilience (IMF, 2022).

Resources are key building blocks in SCRM (e.g. Norrman & Jansson, 2004) and SCRes (e.g. Ambulkar, Blackhurst, & Grawe, 2015). For example, previous SCRM research has found that resource mobility and flexibility help companies mitigate and respond to risks (Kleindorfer & Saad, 2005), and resource redundancy in terms of safety stock of critical resources is considered a key risk mitigation strategy (Tang, 2006a, 2006b), and also emphasized as key in SCRes (Al Naimi, Faisal, Sobh, & Bin Sabir, 2021; Tukamuhabwa et al., 2015). Furthermore, recent SCRes literature has emphasized how firms' orchestration of strategic resources (Craighead et al., 2020; Ketchen & Craighead, 2020) and reconfiguration of their resource base (Ambulkar et al., 2015) is central for SCRes. Much of this research focuses on the internal aspects of such resource bundling, even if it is recognized that companies depend on access to resources from external partners (Ambulkar et al., 2015). However, little attention has been given to the nature and role of resources and how companies relate to others to gain access to external resources, even if collaborative strategies are increasingly acknowledged as important in the SCRM (Friday, Ryan, Sridharan, & Collins, 2018) and SCRes literatures (Azadegan & Dooley, 2021).

In the present paper, we argue that understanding the nature of resources and how they interact across organizational boundaries is critical for enhancing our understanding of effective strategies for managing

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(that is, mitigating, responding to, and recovering from) supply chain disruptions. Disruptions take many forms and include normal fluctuations that companies experience, as well as major, unexpected disruptions, such as the COVID-19 pandemic. While (Tang, 2006b) identified nine robust strategies (see Table 2) that are arguably suitable for all types of disruptions, the recent pandemic led Sodhi and Tang (2021, p. 12) to acknowledge that “we need more than what the existing literature provides when it comes to extreme conditions.” For example, while SCRM traditionally assumes supply chain operations over an extended period of time, the authors argued that the supply chain’s permanent nature is now questioned (Sodhi & Tang, 2021).

A perspective that seems useful in view of these challenges is the Resource Interaction Approach (RIA) (for an updated overview, see Bocconcelli et al., 2020), which is derived from studies of change and development in business networks within the Industrial Marketing and Purchasing (IMP) group (e.g. Baraldi, Gressetvold, & Harrison, 2012; Huemer & Wang, 2021; Håkansson & Waluszewski, 2002; Jahre, Gadde, Håkansson, Harrison, & Persson, 2006; Prenekert, Hasche, & Linton, 2019; Wedin, 2001). These studies demonstrate the interactive and networked nature of resources and how they can enable change and create value (or not) because of their heterogenous nature (Baraldi et al., 2012). Even if the RIA has been applied to a variety of empirical settings, including logistics and SCM (Jahre et al., 2006), there have been recent calls for studies that use and further develop this approach in the current business and organizational contexts (Bocconcelli et al., 2020).

Against this backdrop, we aim to explore the implications of the RIA to advance the understanding of managing supply chain disruptions. We conducted an integrative review of the SCRM and SCRes literatures to identify their key assumptions about resources and strategies, including how firms are assumed (or suggested) to relate to their inter-organizational context. The next sections describe the methodology and findings of the review. We then introduce the RIA perspective and its key assumptions, before we compare and discuss these with the key assumptions within the SCRM and SCRes literatures. Based on this discussion, we develop three propositions as building blocks for an alternative approach to strategies for managing supply chain disruptions. The final section concludes our analysis and outlines the key implications for future research.

This paper addresses recent calls to develop a new understanding of how to manage supply chain disruptions (Sodhi & Tang, 2021) and the role of collaborative strategies in these efforts (Friday et al., 2018). We contribute to the literature on managing supply chain disruptions through an extensive review of SCRM and SCRes literatures and their assumptions about resources and how actors are assumed to relate to each other. We offer an alternative approach based on the RIA, where resource interaction, interdependencies, and collaboration are considered fundamental in strategies for managing supply chain disruptions. We also add understanding of the inter-organizational context of resources, firstly by demonstrating the relevance of the RIA in the supply chain disruption setting (Bocconcelli et al., 2020), and secondly by highlighting the interplay between temporary and permanent inter-organizational contexts in strategies for managing supply chain disruptions (Sodhi & Tang, 2021).

2. Methodology for review of SCRM and SCRes literatures

The SCRM and SCRes literatures are expanding vastly, and a broad review of hundreds of articles is beyond the scope of this paper. Instead, we decided to conduct an integrative review (Torraco, 2005), with the purpose of assessing, critiquing, and synthesizing the literature on SCRM/SCRes. Such an approach is useful when the purpose of the review is not to cover all articles ever published on the topic, but rather to create new insights. We followed Snyder (2019) recommendations to ensure transparency in collection and analysis. Our systematic search in the Web-of-Science provided a good basis for the final selection of relevant papers to reveal and discuss the basic assumptions about

resources and inter-organizational relationships in the extant SCRM and SCRes literatures.

2.1. Designing and conducting the review

First, we conducted a pilot search based on a smaller sample of SCRM papers to identify key papers, key search terms, and inclusion/exclusion criteria (Snyder, 2019). As resilience and disruption are often used interchangeably with risk management, we found it necessary to include all three terms when searching for abstracts to identify papers with the appropriate scope and focus (Wilding & Wagner, 2014). We then combined these with three other search terms. We searched the resulting abstracts to identify papers where the review was the main contribution, thus avoiding papers for which reviews simply provided the basis for an empirical study. When published works are extensive, existing literature reviews indicate core themes and development through time (Snyder, 2019). For a more in-depth and detailed review of resources and how companies are assumed to relate to each other (inter-organizational relations), we searched broadly for papers (reviews, conceptual and empirical). We included capabilities in our search because this term is commonly used in SCRes in addition to or instead of ‘resources’. Table 1 gives an overview of the search terms applied.

2.2. Analysis and write-up

We performed a combination of quantitative and qualitative analysis of the papers to critically analyze and examine the literature and the main ideas and relationships (Snyder, 2019) of how resources (capabilities) are treated in SCRM and SCRes literatures, particularly regarding inter-organizational relations. The general search yielded 628 articles across all three groups. We identified three periods that clearly show how the field has expanded over the years:

- The beginning: 2006–2012 (74 papers over seven years).
- The expanding: 2013–2017 (195 papers over five years).
- The golden: 2018–2021 (359 papers over 3.5 years).

After removing duplicates, we ended with 350 articles. Of these, literature reviews yielded 123 results, and with a similar pattern of increasing numbers over the years (15 vs 28 vs 80 papers over the three periods). We screened titles and abstracts, and if necessary, the papers, using the following criterion: the papers had to be general, meaning that we excluded those that covered only specific risk types (such as climate risk, counterfeits, price, cyber risk), specific methods (such as SCOR, trial and evaluation laboratory (DEMATEL)), and/or specific contexts (food, for example). After screening, we ended with 37 papers (final list in Online Material) and based on citations and journal impact factors, selected two reviews on SCRM and SCRes, respectively, from each of the three periods (see Table 2). We also included the review by Friday et al. (2018) on collaborative risk management due to its high relevance for our study.

For the other two search groups, we screened the abstracts and, when necessary, the papers, to exclude cases where “resource/capability”

Table 1
Search terms for the integrative literature review.

| Review | Search terms |
|-------------------------------|--|
| Literature reviews | AB = (supply chain risk management OR supply chain resilience OR supply chain disruption) AND AB=(review) |
| Resources | AB = (supply chain risk management OR supply chain resilience OR supply chain disruption) AND AB=(resource* OR capabil*) |
| Interorganizational relations | AB = (supply chain risk management OR supply chain resilience OR supply chain disruption) AND AB=(collabor* OR cooper* OR relational OR partnership) |

Table 2
Selected literature reviews.

| Period | 2006–2012 | 2013–2017 | 2018–2021 |
|---|---|--|-----------------------------------|
| SCRM (Citations/ Impact factor) | Tang, 2006a (1646/8.31) | Ho et al., 2015 (861/ 8.568) | Bier et al., 2020 (58/4.147) |
| SCRes (Citations/ Impact factor) | Ponomarov & Holcomb, 2009 (1513/5.89) | Kamalahmadi & Parast, 2016 (578/ 8.31) | Al Naimi et al., 2021 (0/4.1). |

and/or “collaboration/cooperation/relational strategies” were mentioned coincidentally or used only when referring to other papers. We used the same exclusion criteria as above regarding specific risk types and methods. We also excluded papers on specific technologies (such as blockchain), pure modelling papers, and pure discussion papers.

The search for papers on resources/capability yielded 145 papers (10, 39, and 95 over the three periods), while there were 82 papers on “collaboration/cooperation/relational strategies” (five, 29, and 47 in the three periods, respectively). We see that these follow the same pattern as the papers overall, with a large increase in the “golden” period. After the screening we ended up with 30 papers on resources and 22 papers on inter-organizational relationships. Splitting between SCRM and SCRes shows that resilience papers are becoming more common than SCRM (22 vs 15 during the last period). The final 52 papers were then qualitatively analyzed. The key questions that guided the analysis were how the SCRM and SCRes literatures view resources, including capabilities, on one hand, and inter-organizational dependencies and relationships, on the other, and how these views are combined and impact each other. A list of the 52 articles, including a short presentation of the results of the analysis can be provided by the authors upon request.

2.3. Quality and limitations

To ensure the quality of the review, we drew upon [Palmatier, Houston, and Hulland \(2018\)](#), who identified key criteria for review quality. To ensure depth and rigor, we started wide and described the selection strategy, which also allows external readers to replicate the study and reach similar findings. Our purpose was to capture data and insights to offer something beyond a recitation of previous research, making the review useful for scholars and practitioners. We limited the search to only one database and selected journal articles in English published by July 6th, 2021. While this may have caused us to miss some relevant papers, we believe the methodology and results fulfill the purpose for an integrative review.

3. Analysis of the view on resources in the SCRM and SCRes literatures

3.1. Resources in the SCRM literature

While resources are key building blocks in SCRM ([Norrman & Jansson, 2004](#)), the literature primarily uses the term ‘resources’ in a general sense, such as in relation to enterprise resource planning (e.g. [Rao & Goldsby, 2009](#)), financial risk management (e.g. [Heckmann, Comes, & Nickel, 2015](#); [Wiengarten, Humphreys, Gimenez, & McIvor, 2016](#)), or capacity (e.g. [Christopher, Mena, Khan, & Yurt, 2011](#)). Most papers use the term ‘resources’ without going into details (e.g. [Kumar & Harrison, 2012](#); [Skipper & Hanna, 2009](#)); for example, referring simply to supply chain or logistics resources (e.g. [Shao, 2013](#)). However, some papers specify types of resources, including human, equipment, production, information, transportation, raw material and utilities availability (e.g. [Chiang, Kocabasoglu-Hillmer, & Suresh, 2012](#); [Ivanov,](#)

[2021](#); [Lavastre, Gunasekaran, & Spalanzani, 2014](#); [Pettit, Croxton, & Fiksel, 2013](#)), but without further conceptualization or categorization. We did not identify any literature reviews in SCRM that focused on resources as such.

The SCRM literature typically suggests investing in redundancy; that is, important resources for mitigation and response such as strategically placed excess transportation capacity and strategic stocks ([Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007](#); [Tang, 2006a](#)). For example, [Norrman and Wieland \(2020\)](#) discussed how resources can be classified based on their importance ahead of a crisis. Key decisions include deciding how much excess capacity firms should have, where it (that is, the individual resource or capacity) should be placed, and the cost of such investing in it ([Manuj and Mentzer \(2008\)](#)). This is similar to traditional logistics and supply chain management (see [Gadde, Håkansson, Jahre, & Persson, 2002](#) for a discussion of this assumption). Many SCRM scholars have identified the challenge of getting companies and organizations to invest in resources to mitigate risks that might not occur (e.g. [Jahre, 2017](#); [Lavastre et al., 2014](#); [Norrman & Jansson, 2004](#); [Tang, 2006a](#)). Investments in physical prepositioned stock are often discussed in the literature without considering other necessary resources (human, systems, etc.) ([Jahre, 2017](#)). In summary, the review shows that the SCRM literature gives priority to individual physical resources that are freely available for mobilization. Several different resources, particularly logistics resources, have been mentioned. However, no attempts have been made to categorize these resources, except from the notion of ‘criticality.’ As such, the review indicates that scholars within this literature tend to see resources as having a fixed value (that is, resource homogeneity).

3.2. Resources in the SCRes literature

Compared to the SCRM literature, the focus in the SCRes literature is on capabilities – that is, intangible resources – even if physical (that is, tangible) resources are also mentioned frequently ([Abeysekara, Wang, & Kuruppuarachchi, 2019](#); [Ivanov, 2021](#); [Pettit et al., 2013](#)). Much of the SCRes literature argues that resources are essential in terms of adaptive capabilities for managing disruptions. For example, [Al Naimi et al. \(2021\)](#) stated that the ability to manage and reconfigure resources according to a volatile environment is critical. In their seminal paper, [Ponomarov and Holcomb \(2009\)](#) defined SCRes as “The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function” (p. 131). While some SCRM research has addressed redundancy in physical resources, [Al Naimi et al. \(2021\)](#) defined redundancy in terms of “having organisational resources that can be used during disturbances to replace lost resources or capital” (p. 18). Similarly, [Brusset and Teller \(2017\)](#) found that companies can enhance their resilience through human capital resources, organizational and inter-organizational capital resources, and physical capital resources. An interesting notion related to this discussion is that of [Gabler, Richey, and Stewart \(2017\)](#), who distinguished operand resources (for example, a bridge) from operant resources (for example, the skill of operating industrial equipment), where the latter are dynamic and intangible and “valuable on their own” (p. 132).

Much of the SCRes literature emphasizes the need to combine resources. As [Ponomarov and Holcomb \(2009\)](#) highlighted, “logistics capabilities should be considered in appropriate combination rather than stand-alone abilities” (p. 134) in adapting, integrating, and reconfiguring resources, organizational skills, and functional competencies. Similarly, [Ambulkar et al. \(2015\)](#) argued that firms that are able to reconfigure their resources quickly are more resilient than those that are not. They concluded that a firm must be able to evaluate its current resource base and add new resources, shed existing resources, or recombine/reorganize existing resources. Finally, [Tukamuhabwa et al. \(2015\)](#) defined SCRes as a supply chain’s adaptive capability and

concluded that the resource-based view (RBV) and dynamic capabilities (DC) models are commonly used to explain how resources and capabilities are antecedents of resilience and should be adapted to match changes in the environment. However, they criticized the main theories (RBV, DC, and contingency theory) for their assumption that “the future value of resources is determinable” (p. 20). Furthermore, the authors concluded that these theories are not sufficient for explaining SCRes because of their emphasis on internal resources.

In summary, our literature review shows that the SCRes literature emphasizes intangible resources, particularly capabilities, and that much of this literature acknowledges the importance of combining resources, including physical. Thus, the SCRes literature differs from the SCRM literature in this respect. However, there is little explicit discussion on how capabilities are linked to specific types of resources or combinations. Furthermore, much of this literature draws upon the RBV and DC theories, and as such acknowledges that the value of a resource, such as a capability, depends on how it is used (that is, resource heterogeneity). Nevertheless, as [Tukamuhabwa et al. \(2015\)](#) noted, it is common to believe that this value can be determined beforehand. This aligns with the notion in the SCRM literature that the classification of resources and which ones are ‘critical’ can be done upfront ([Norrman & Wieland, 2020](#)).

4. Strategies suggested in the SCRM and SCRes literatures

4.1. A firm perspective on strategies for managing supply chain disruptions

Mitigating, responding to, and recovering from risks are fundamental in SCRM (e.g. [Sodhi & Tang, 2012](#)) and SCRes ([Ponomarov & Holcomb, 2009](#)). Much of the literature builds on the seminal work by [Chopra and Sodhi \(2004\)](#) and ([Tang, 2006b](#)) on robust logistics strategies, as outlined in [Table 3](#).

In their review of collaborative risk management (CRM) in the SCRM

literature, [Friday et al. \(2018\)](#) argued that conventional techniques such as postponement, hedging, and avoidance focus on implementation at the firm level: “Although collaboration and coordination are included in SCRM definitions, conventional SCRM techniques are not especially effective in advancing interfirm arrangements to address risk spill-over effects within firms and across supply chains” ([Friday et al., 2018, p. 232](#)). A common feature of SCRM and SCRes scholars is that they focus on a firm’s internal resources and capabilities. This also reflects how they think about strategies. For example, [Ambulkar et al. \(2015\)](#) argued that resource reconfiguration is “the ability of a firm to reconfigure, realign and reorganize their resources in response to changes in the firm’s external environment”, while risk management infrastructure describes a firm’s “structure of resources designed to manage risk in the supply chain” ([Ambulkar et al., 2015, p. 112](#)). However, while much of the SCRes research draws upon RBV and focuses on the individual firm’s strategies, some studies have combined RBV with the relational view (e.g. [Brandon-Jones, Squire, Autry, & Petersen, 2014](#)). Scholars within this research stream use terms like relational practices ([Chowdhury, Quadus, & Agarwal, 2019](#)), relationship governance ([Gabler et al., 2017](#)), and relational capabilities ([Al Naimi et al., 2021](#)) to describe how companies seek to build SCRes. For example, [Dubey et al. \(2017\)](#) showed how the interplay of resources, capabilities, and relational constructs, such as reducing behavioral uncertainty among supply chain partners, may help build supply chain resilience based on bundling of resources, both tangible and intangible. Despite these examples, however, SCRM and SCRes focus on the individual firm and view strategies from a focal firm’s perspective, whereby collaboration and co-development with supply chain partners are just means to realize internal strategies (e.g. [Nandi, Sarkis, Hervani, & Helms, 2020](#)).

4.2. The view on dependence and collaborative strategies

The SCRM literature primarily sees dependence on others’ resources as risk factors in the SCRM literature (e.g. [Ho, Zheng, Yildiz, & Talluri, 2015](#)). Similarly, the SCRes literature generally considers dependence as a risk (e.g. [Rajesh, 2018](#)). Thus, the emphasis is on the point that dependence on external partners *creates* risk rather than helping to manage it ([Chaudhuri, Ghadge, Gaudenzi, & Dani, 2020](#); [Colicchia & Strozzi, 2012](#); [Ho et al., 2015](#); [Pournader, Kach, & Talluri, 2020](#); [Rajesh, 2018](#); [Zeng & Yen, 2017](#)). [Tukamuhabwa et al. \(2015\)](#) suggested that: “[...] certain practices in supply chain relationships, like just-in-time supply and single-sourcing supply partnerships create vulnerabilities that must be traded off against the benefits of these practices, like strong networks that could potentially facilitate a rapid response to a crisis” ([Tukamuhabwa et al., 2015, p. 13](#)).

While most earlier SCRM papers on strategies do not focus on inter-organizational relationships (e.g. [Kumar & Harrison, 2012](#); [Kumar, Himes, & Kritzer, 2014](#)), recent papers in our review have called for more research on this topic (e.g. [Bier, Lange, & Glock, 2020](#); [Kilubi & Rogers, 2018](#); [Norrman & Wieland, 2020](#); [Vilko, Ritala, & Hallikas, 2019](#)). For example, [Norrman and Wieland \(2020\)](#) called for more research on supply chain risk governance to increase inter-organizational coordination. In their review of collaborative risk management (CRM), [Friday et al. \(2018\)](#) complied with this view, arguing that extant literature has paid scant attention to the topic. They defined CRM as “an interactive process based on mutual commitment between firms with a common objective to join effort and mitigate supply chain risks and related disruptions through co-development of strategic relational capabilities and sharing of resources” ([Friday et al., 2018, p. 238](#)).

In contrast to the SCRM literature, SCRes scholars have focused more on collaboration (e.g. [Hendry et al., 2019](#); [Pettit, Fiksel, & Croxton, 2010](#); [Scholten & Schilder, 2015](#); [Scholten, Scott, & Fynes, 2019](#); [Vilko et al., 2019](#); [Wieteska, 2020](#)). All three of the SCRes reviews that we analyzed discuss collaboration as a strategy for improving resilience ([Al Naimi et al., 2021](#); [Ponomarov & Holcomb, 2009](#); [Tukamuhabwa et al., 2015](#)). Collaboration is identified as a key SCRes capability ([Adobor &](#)

Table 3
Strategies for managing supply chain disruptions ([Tang, 2006b](#)).

| Strategy | Definition |
|--------------------------------|---|
| Dynamic assortment planning | Can be used to influence choice and demand, and to entice customers to purchase products that are widely available when certain products face supply disruptions. |
| Economic supply incentives | Encourage additional suppliers to stay in or enter a certain market to avoid monopolistic situations, and to secure multiple sources should a disruption occur. |
| Flexible manufacturing process | Allow for adjustments in quantity and quality produced in their network; for example, varying between plants and/or production lines. |
| Flexible supply base | Multiple sourcing options available, which allows for alternatives should one source be disrupted. One way of doing this is to develop a supply alliance network with suppliers in various countries. Also called hedging. |
| Flexible supply contracts | Agreements with suppliers allowing the customer to adjust order quantities depending on need. |
| Flexible transportation | Multi-modality, multiple carriers, and/or multiple routes. |
| Make-and-buy | Combination of in-house and outsourcing, which allows more flexibility in case of a disruption. Includes vertical integration. |
| Postponement | Utilizes product or process design concepts such as standardization, commonality, modular design, and operations reversal to delay the point of differentiation in products, services, movement, and other value-adding activities. |
| Revenue management | Dynamic pricing and/or promotion. |
| Silent product rollover | ‘Leak’ new products into a market without making formal announcements. |
| Strategic stock | Inventories at certain ‘strategic’ locations (warehouses, logistics hubs, distribution centers) that can be deployed quickly in case of a disaster. Often shared by multiple supply chain partners, such as vendor-managed inventory. |

McMullen, 2018; López & Ishizaka, 2019; Sá, Miguel, Brito, & Pereira, 2019; Um & Han, 2021). Furthermore, Tukamuhabwa et al. (2015) argued that co-evolution between supply chain partners is needed for SCRes, and concluded that “resilience of a supply chain is not the result of an individual firm’s actions in isolation. Instead, it is a network phenomenon arising from connectivity and interdependence between firms” (p. 24). Similarly, in the most recent SCRes review in our sample (Al Naimi et al. (2021)), the authors argued that even if collaboration might be a potential threat to flexibility when disruptions occur, its relationship to supply chain resilience is well documented.

Recent developments, including the COVID-19 pandemic, have accentuated the focus on collaborative strategies to cope with disruptions in the literature on managing supply chain disruptions (e.g. Azadegan & Dooley, 2021; El Baz & Ruel, 2021; Scala & Lindsay, 2021; Sodhi & Tang, 2021). For example, Azadegan and Dooley (2021) identified three types of collaboration within and between supply networks in relation to resilience strategies for dealing with the ongoing pandemic and future disruptions, reflecting different levels of collaboration: (1) micro-level strategies relate to collaboration within buyer–supplier relationships to address supply risk prevention and recovery; (2) macro-level strategies concern broad collaborations including firms (that might be competitors), governmental institutions, trade associations, etc., to manage longer-term supply risks; and (3) meso-level strategies include multiple supply networks collaborating on short- to medium-term supply risks. They argue that these meso-level collaborations can be seen as complex adaptive systems featured by self-organization and dynamism to build resilience in the realm of supply chain disruptions (see also Tukamuhabwa et al., 2015). Despite these recent contributions, our review shows that while both the pre- and post-pandemic literature acknowledges collaborative efforts as a viable strategy to enhance companies’ managing of supply chain disruptions (Azadegan & Dooley, 2021; Brusset & Teller, 2017; Friday et al., 2018), a collaborative strategy is typically seen as one strategy among several (e.g. Ho et al., 2015; Rao & Goldsby, 2009).

5. The resource interaction approach and key assumptions

5.1. The nature of resources

The Resource Interaction Approach (RIA) was developed from studies of change and development processes in business networks within the IMP research field (e.g. Håkansson, Ford, Gadde, Snehota, & Waluszewski, 2009; Håkansson & Waluszewski, 2002; Jahre et al., 2006; Prenkert et al., 2019; Wedin, 2001). Baraldi et al. (2012, p. 266) defined resource interaction as “the processes of combination, re-combination and co-development of resources that happen through the interaction among organizations.” Because of its basic assumptions about resources, RIA has been used to analyze change and development, as well as innovation across firm boundaries (see Baraldi et al. (2012) for an overview of empirical studies). This is also the reason why we find RIA particularly relevant for understanding the role of resources in managing supply chain disruptions.

RIA scholars commonly refer to four basic assumptions underpinning resource interaction (Baraldi et al., 2012; Bocconcelli et al., 2020; Prenkert et al., 2019). Firstly, resources are only resources to the extent that they are appropriate for a current or potential use. Secondly, the networked contexts of resources imply that no company holds or controls all the resources it needs, so a company depends on the network to access them. Thirdly, resources are subject to heterogeneity, meaning that their value depends on how they are connected to other resources and how they are used. Originating from Penrose (1959), resource heterogeneity is a key notion in the IMP, with an emphasis on inter-organizational resource interaction. Regardless of organizational scope, resource heterogeneity points to the need to consider the context in which resources are situated and used. The fourth assumption relates to the openness and variety of resources, meaning that they can be

related in different ways and gain different values through their interaction with other resources.

5.2. Types of resources and how they interact

Over time, various classifications of resources have emerged in the IMP literature for different purposes. Lately, a more distinct categorization has been developed, known as the four resources (4R) model (Håkansson & Waluszewski, 2002; Wedin, 2001). The 4R model captures interaction between four types of resources: products and production facilities (being physical resources) and business units and business relationships (being organizational resources). The organizational resources are considered critical in resource interaction. First, business relationships are resources in themselves, but also essential in the resource interaction. Second, business units are important because they constitute the knowledge and organizing efforts in which other resources are combined through relationships.

Even if there is variety in how resource interaction has been defined and applied in studies within RIA (Bocconcelli et al., 2020), the key notion that resources are embedded in inter-organizational networks is common for RIA-related studies, as well as in other IMP-based models or frameworks (Håkansson et al., 2009). Similarly, the notion of interaction in business relationships, and how interaction is necessary to develop resources through mutual adaptations and the interdependencies that follow from such adaptations, is also well grounded in extant IMP literature (Håkansson & Ford, 2002). Because resource interaction spans firm boundaries, a key implication is that every change in or of the connections to other resources and/or the use (s) of a resource potentially impacts on other connections and uses, as well as their value (Baraldi et al., 2012). According to Prenkert et al. (2019), resource interaction creates interfaces that constitute the contact points between resources. The resource interface concept focuses on the interaction at the resource level of analysis to unveil the development of new features of resources and resource combinations (Jahre et al., 2006; Prenkert et al., 2019), as well as their potential for value creation (Huemmer & Wang, 2021).

The literature identifies three types of interfaces: technical interfaces between products and facilities, organizational interfaces between business units and business relationships, and mixed interfaces between technical and organizational resources. The latter is particularly potent in terms of driving value creation (Dubois & Araujo, 2006; Jahre et al., 2006). However, to understand the development and value potential (as well as the constraints) of resource interfaces, it is necessary to consider notions of heaviness and variety (Prenkert et al., 2019). Heaviness relates to difficulties in breaking apart resource interfaces and changing established resource combinations, while variety relates to the many possibilities of combining resources in new ways (Håkansson & Waluszewski, 2002).

According to Prenkert et al. (2019), high resource variety might create low variety and subsequent heaviness in resource interfaces because of the substantial adaptations required to accommodate all demands, restrictions, and requirements across a set of resources. These notions are important when seeking to understand and pursue change and development efforts. For example, Holmen (2001) pointed to the versatility of resources and how this must be explored in interaction. Similarly, Huemmer and Wang (2021) argued that tensions occurring in connected resources when changing an individual resource might be reduced by changing the resource so that it creates a matching interface with the other resources. The authors refer to this as cogency and suggest that resource bundling capabilities are important because they allow firms to re-combine resources to optimize interfaces, cogency effects, and imprints (Huemmer & Wang, 2021).

Resource interaction has been studied in a variety of different empirical contexts, ranging from permanent supply chains and networks (Jahre et al., 2006) to temporary forms such as inter-organizational projects in the construction industry (Bankvall, Bygballe, Dubois, &

Jahre, 2010) and research projects (Lind, 2015). A common feature of these studies is that priority is given to change and development processes in which resource interaction plays a critical role. Despite the insights provided in these studies, Bocconcelli et al. (2020) argued that further development of the RIA can be inspired by contemporary contexts, such as the COVID-19 pandemic.

6. Discussion

The preceding sections identified key assumptions about resources and how companies are assumed to relate to each other in the SCRM and SCRes literatures and in the RIA. Table 4 provides a summary of the similarities and differences between these assumptions.

6.1. Comparing key assumptions about resources

The assumption about resources illustrates key differences between the SCRM and SCRes literatures, and the RIA. The SCRM literature has traditionally been concerned with mobilizing and storing of individual, physical resources (Tang, 2006a). Even if it is not explicitly discussed in this literature, the way in which resources are treated indicates that they are considered to have fixed values. The SCRes literature provides a slightly different view. Even if many SCRes scholars also talk about resources in more general terms, and more specifically ‘capabilities’, much of this literature focuses on the combination of resources (e.g. Ambulkar et al., 2015). Furthermore, the SCRes literature relies heavily on the RBV, where resource heterogeneity is a key assumption (Barney, 1991). This point is reflected in the emphasis on adaptive capability (Ponomarev & Holcomb, 2009). The RIA shares the notion of resource heterogeneity, meaning that both the SCRes literature and the RIA acknowledge that resources gain their value through their use and how they are combined with other resources. As such, they differ from the SCRM literature. However, even if the SCRes literature acknowledges the combinations of resources, this primarily concerns reconfiguration and orchestration of the organization’s internal resource base. The RIA, on the other hand, assumes that resource interaction is inter-organizational and that through these interactions, resource interfaces are created across organizational boundaries (Huemer & Wang, 2021; Prenkert et al., 2019). The RIA offers a categorization of resources: the 4R model (that is, products, facilities, organizational business units, and relationships) (Jahre et al., 2006). As such, the RIA offers a more specific categorization of resources than both the SCRM and SCRes literatures. Furthermore, the RIA emphasizes the role of mixed interfaces between the technical and organizational resource across organizational boundaries and argues that it is within these interfaces that the potential for change and value creation particularly resides. As such, the RIA partly complies to the SCRes literature, which focuses on the role of capabilities in resource configuration (e.g. Tukamuhabwa et al., 2015), but adds to this literature by specifying the interfaces and the implications thereof. For example, the RIA highlights that mutual adaptations of resources and their interfaces created through interaction processes also

create heaviness, which, in turn, complicates change (Prenkert et al., 2019).

6.2. Comparing key assumptions about strategies to manage supply chain disruptions

While the RIA takes interdependencies between firms as a fundamental characteristic of business exchange rather than as something a company can choose, the SCRM and SCRes literatures primarily focus on internal control of resources with the purpose of avoiding external dependence (e.g. Ho et al., 2015; Rajesh, 2018). Thus, in contrast to RIA, the SCRM and SCRes literatures are concerned with risks *because of* relationships with others (Colicchia & Strozzi, 2012). Consequently, several of the suggested strategies (Table 2) build on ways to reduce risks emanating from being dependent on others (Pournader et al., 2020; Skilton, 2014).

For example, two key strategies that have also been suggested as a response to the COVID-19 pandemic are relocating production locally (that is, make or buy) and establishing stocks of vital resources (that is, strategic stock), including personal protection equipment (PPE) and medicines (Azadegan & Dooley, 2021; Sheffi, 2020). However, these strategies pose several challenges that follow from resource interdependence assumptions in the RIA. Firstly, the production still relies on the supply of input materials from suppliers that may be located far away. Secondly, if all organizations, or countries, decide to establish large stocks, the scarcity increases. The latter points to the wider system aspects of risks (Fagundes, Teles, de Melo, & Freires, 2020) and can be exemplified by the severe shortage of semiconductors that became an unanticipated consequence of the COVID-19 crisis (see, for example, <https://theconversation.com/how-the-world-ran-out-of-semiconductors-15653>). Such system-level risks cannot be influenced directly by individual organizations, and the strategies to cope with them look very different from the SCRM and SCRes perspectives compared to the RIA, where the latter would imply interaction across organizational boundaries to cope with the situation. More importantly, from the RIA perspective, it would be difficult to assign a fixed value to a resource beforehand, and therefore to determine which resources should be considered as critical and thus subject to strategic stock strategies. The criticality of PPE, such as face masks during the pandemic, may illustrate this challenge.

Another key strategy is concerned with reducing dependence on individual suppliers through multiple sourcing (that is, having a flexible supply base). This strategy suggests that dependence on individual suppliers can be reduced without sacrificing the value or benefits that are the very reason for investing in relationships with external partners in line with the RIA reasoning. Tukamuhabwa et al. (2015) recognized this potential trade-off between vulnerability caused by partnerships and single sourcing and the value of networks for providing resources needed in responses to disruptions. However, maintaining multiple suppliers for this reason contrasts with the RIA, wherein relationships are considered vital resources in themselves as they enable access to and

Table 4
Key assumptions in the SCRM and SCRes literatures and in the RIA.

| Key Assumptions | Dimensions | SCRM | SCRes | RIA |
|---|--|--|--|--|
| Assumptions about the nature of resources | Types of resources in focus Single vs combination Homogenous vs heterogenous | Tangible resources Single Homogenous | Intangible resources (capabilities) Combination Heterogeneous | Tangible and intangible/4R Combination Heterogeneous |
| Assumptions about strategies | Assumptions about dependence The role of resources Collaboration | Dependence as risk Mobilization and flexibility One among several strategies | Dependence as both risk and opportunity Internal combinations One among several strategies | Interdependence as unavoidable Resource interaction across firms and embeddedness Fundamental for all strategies |
| Assumptions about unit of analysis | Focal unit of analysis | Firm | Firm | Relationship |

interaction with (other) external resources. It can also be argued that even without considering the costs of multiple sourcing (Dubois, 2003), having multiple (arms-length) suppliers might cause risks of not being prioritized if resources become scarce.

Moreover, in line with Prenkert et al. (2019), the heaviness following from established resource interfaces and the possibilities inherent in their variety both have major implications. Because of the mutual adaptations and complexities in these varieties, the embedded nature of resources challenges the notion of flexibility, which is so central in the SCRM and SCRes literatures on strategies. These features are outcomes of and dependent upon resource interaction. Essentially, by considering resource interaction and interdependence that spans organizational boundaries as unavoidable, collaborative strategies are necessary from the RIA point of view. Together, organizations can mobilize and change resource interfaces to manage supply chain disruptions. The RIA would suggest that team effects resulting from a wide variety and pool of resources offer a basis for collaborative strategies to manage both normal fluctuations and major disruptions in the supply chain. Collaborative efforts may also improve ex ante risk assessments because of joint efforts instead of each actor assessing potential risks on their own. A relevant example in today's context is the development of COVID-19 vaccines. A key reason for the short development time is the Coalition for Epidemic Preparedness Innovation (<https://cepi.net/>), which in 2017 established a global cooperation among (intensively competing) vaccine manufacturers to be ready for the next epidemic, which turned out to be COVID-19. As part of these joint efforts, the development of mRNA-vaccines (such as Pfizer and Moderna) also exemplifies the use of the postponement strategy (Table 3). The vaccines build on the "plug-and-play" principle, where the parts of the vaccine can be combined in various ways, and small elements can be changed to adapt to new mutations, without starting from scratch.

According to Pournader et al. (2020), strategies for managing supply chain disruptions typically do not differentiate between disruption categories, even if the notion of risk magnitude is mentioned (Chopra & Sodhi, 2004; Lavastre et al., 2014; Tang, 2006a). Sodhi and Tang (2021) realized this in relation to the pandemic, arguing that alternative understandings and strategies are needed. The RIA would suggest that unexpected disruptions make it even more important with strategies based on a wider scope of external resources. Access to a large resource pool and opportunities to jointly address resource combining in view of a disruption also makes it easier to explore resource versatility (Holmen, 2001); that is, if and how the use of certain resources can be changed or expanded. Thus, considering such strategies in terms of inter-organizational resource interaction entails considerations of whom to interact with to identify and access what would be critical resources and how to (re)combine and (re)configure internal and external resources. As such, a key difference between the SCRM and SCRes literatures and the RIA concerns the focal unit of analysis; the former literature has a clear focus on the firm and when collaborative strategies are considered, it is from the perspective of a focal firm, while in the RIA it is the relationship. This notion further incurs a need to consider how to organize the interactive response in a flexible and ad-hoc manner.

6.3. Implications for organizing in managing supply chain disruptions

What we have witnessed during the pandemic demonstrates that managing disruptions often relies on resource interaction at the intersection between temporary and permanent contexts. Organizing in view of disruptions may take on a special, temporary character in contrast to the permanent, or continuous, supply chains focused in the SCRM and SCRes literatures. Sodhi and Tang (2021) claimed that COVID-19 has shown the weakness of our current, permanent supply chains, and "... similar to humanitarian project-based supply chains, COVID-19 has necessitated creating [...] project-based supply chains" (p. 10). These observations can be related to the RIA, and Håkansson (1989, p. 34) notion that "a unique network can be identified in relation to every

specific problem situation". The pandemic and the various responses to it, as well as the preparations for managing future disruptions, constitute situations that translate into unique networks, in which temporariness is a key feature. Nevertheless, these temporary networks rely on resources mobilized from the permanent network, and relationships between actors become critical because they represent latent ties that might be reactivated in new situations (Havenvid, Bygballe, & Håkansson, 2019). Hence, relationships represent resources that provide stability and continuity when facing disruptions. The interplay between temporal and permanent networks is also vital to learning and innovation (Bygballe & Ingemansson, 2014), which has implications for how experiences from previous disruptions can be taken advantage of in preparation for managing upcoming ones.

6.4. Towards an alternative approach to strategies for managing supply chain disruptions

The above discussion forms the basis for three main propositions (Bacharach, 1989), which we suggest are key building blocks in a RIA-based approach to strategies for managing supply chain disruptions. The first two concern the notions of relationships and collaboration as fundamental tenets of all strategies, while the third concerns the organizing that follows from these notions.

Proposition 1. *Organizations depend on external resources, and therefore strategies for managing supply chain disruptions need to include how to handle and utilize these (inter)dependencies instead of reducing or avoiding them.*

Proposition 2. *Collaboration is a critical element in any strategy for managing supply chain disruptions since it enables open-ended resource interaction across organizational boundaries, in contrast to limiting the solutions by pursuing an internal focus.*

It follows from these two related propositions that organizations should identify the scope of involvement with other organizations and their resources in terms of direct and indirect relationships on the network level. It makes little sense for an organization to develop its own strategies independently of others and/or to consider collaborative strategies as only one option among many. Instead, relying on the RIA, relationships with other organizations are fundamental, which means that collaboration is a necessity not a choice to realize strategies for managing supply chain disruptions. Moreover, managing supply chain disruptions often incurs changes in existing resource interfaces, which transcend organizational boundaries. The embedded nature and heaviness of these interfaces indicate that an individual organization cannot comprehend the needs and implications of these changes.

Proposition 3. *Temporary organizing in which technical and organizational resources are mobilized and recombined is needed in response to major disruptions, in contrast to maintaining the reliance on the permanent organizing.*

It follows from this proposition that since organizing is an inherent part of any strategy, strategies for managing supply chain disruptions rely on the interplay between permanent and temporary organizing. A disruption often requires the involvement of multiple organizations, and the temporary networks established necessitate the organizations to (re) consider their own roles and how the relationships in the permanent network can be utilized and developed.

7. Conclusions and implications

In this paper, we have elaborated on the importance of resources in managing supply chain disruptions. We started with an integrative review of SCRM and SCRes literatures to scrutinize their views on resources and how organizations are assumed to relate to each other. The analysis of the key assumptions on resources and how actors are

assumed to relate to each other in the SCRM and SCRes literatures formed the basis for discussing the implications of the RIA for our purposes. We continued by presenting key assumptions within the RIA and then discussed the main differences and similarities between the key assumptions revealed in the literature review and in the RIA, as summarized in Table 3. We concluded the discussion by offering three propositions forming the basis for an alternative approach to strategies for managing supply chain disruptions based on the RIA.

The paper makes two overall contributions to extant literature. Firstly, it contributes to the literature on managing supply chain disruptions by highlighting the importance of resource interaction across organizational boundaries in strategies for managing supply chain disruptions. Inter-organizational relationships are key in this respect and might be considered an organization's most valuable resources. Thus, in contrast to views in much of the SCRM and SCRes literatures, our discussion suggests that interdependencies and collaboration are fundamental in all these strategies and, consequently, that collaboration cannot be regarded as an alternative to other strategies. This argument addresses recent calls in extant literature for a stronger focus on collaborative strategies and inter-organizational relationships (e.g. Bier et al., 2020; Friday et al., 2018; Norrman & Wieland, 2020).

Secondly, the paper adds understanding of the inter-organizational context of resources and resource interaction. As such, it contributes to the extant literature on RIA by showing the relevance of the perspective for understanding how to manage supply chain disruptions. Such empirical settings have not previously been a subject of interest in the RIA literature, but have been called for in recent literature (Bocconcelli et al., 2020). The discussion also highlights how managing supply chain disruptions relies on resource interaction at the intersection between temporary and permanent inter-organizational contexts. In the broader IMP literature, resource dependence has been studied in temporary contexts in terms of projects, but primarily in traditional project-based settings, including construction (Bankvall et al., 2010) and research projects (Lind, 2015). These studies have highlighted the importance of latent ties between organizations and their resources, which can be mobilized in new projects. The SCRM literature has primarily focused on permanent contexts, but the current situation has entailed a rise in temporary organizing. Hence, our study answers the recent call by Sodhi and Tang (2021) for new perspectives acknowledging that today's extreme situations challenge the permanent nature of supply chains.

For practitioners operating in an increasingly uncertain business context, we offer an alternative approach to strategies for managing supply chain disruptions. We suggest that a RIA-based approach implies that the classic strategies, such as strategic stock, flexible supply base, contracts, and transportation, make and buy, economic supply incentives and postponement must all *build on* and *utilize* interdependencies between organizations rather than seeking to avoid them. Hence, we suggest that, going forward, supply chain organizations need to rely on collaboration rather than independence to better prepare for disruptions. Essentially, we argue that inter-organizational relationships need to play a prominent role in managing supply chain disruptions since they are key resources in themselves, and since they provide access to other vital external resources. Moreover, as key resources, such relationships are important both in the preparation and in joint actions to deal with disruptions when they have occurred (expected or otherwise), reflecting the interplay between temporary and permanent organizing. Self-sufficiency is simply not an option in this setting, either for organizations or for countries.

The present study has certain limitations. First and foremost, it is a conceptual discussion, which draws on a review of extant SCRM and SCRes literatures and a discussion of key assumptions within these literatures in comparison with key assumptions within the RIA to create new insights, not on an empirical study. However, our three propositions form a basis for future empirical research. One of the most obvious next steps would be to study the processes of resource interaction on

multiple levels to cope with ongoing supply chain disruptions in relation to contemporary crises. Other studies could look at the institutional barriers of collaborative efforts in response to disruptions; this would accentuate the relevance of a multi-level approach, ranging from the organizational level (including cross-sectoral partnerships) to include the institutional and societal level, and how issues occurring on each of these levels impact each other. Such studies could make good use of other recent research, including Azadegan and Dooley (2021) with their three collaboration levels, Blondin and Boin (2020) on collective action in cross-sectoral and cross-country risk mitigation and handling, and research on social capital (e.g. Krause & Ellram, 2014; Olcott & Oliver, 2014). Finally, we suggest that future studies empirically explore resource interaction at the intersection between temporary and permanent organizational contexts in the realm of disruption. The pandemic provides ample examples of such collaborative efforts that could inspire further inquiries.

CRedit authorship contribution statement

Lena E. Bygballe: Conceptualization, Writing, Analysis, Methodology. **Anna Dubois:** Writing – review & editing, Conceptualization. **Marianne Jahre:** Conceptualization, Funding acquisition, Data curation, Writing, Analysis, Methodology, Supervision, Resources and Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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