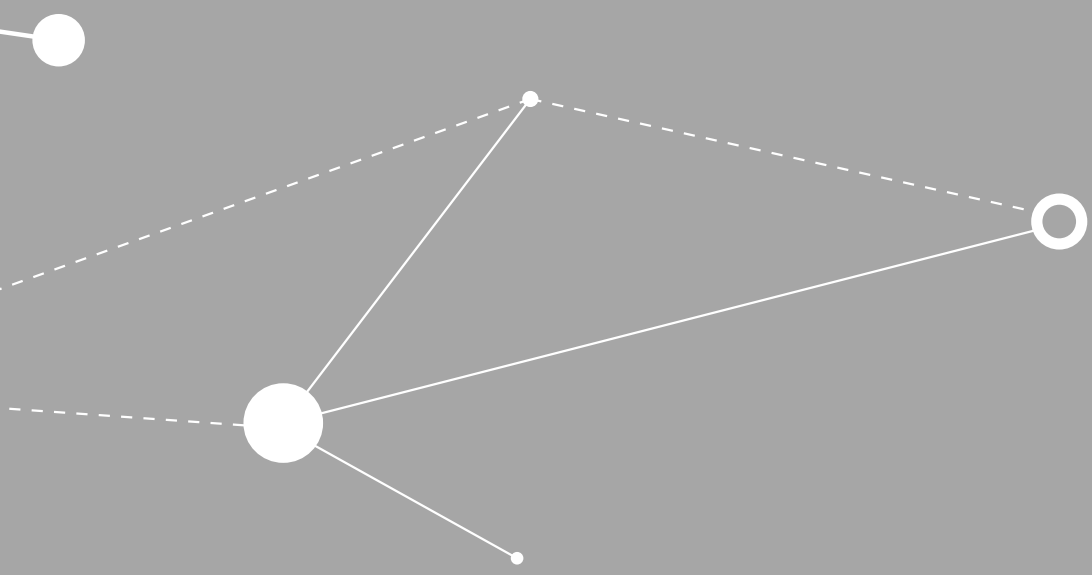
Boundaries as opportunities: A multilevel investigation of resilience

van den Adel, Mitchell

DOI:
10.33612/diss.203014243

CHAPTER 1

GENERAL INTRODUCTION



1.1 | Introduction

Early 2020, solar companies across the globe were suddenly unable to satisfy the ever-increasing demand for solar power systems, as their suppliers of solar panels in the Hubei province in China were locked down by the government (McNair, Williamson, Loekman, & Bell, 2020). Specifically, a coronavirus that—at first—was deemed not to be transmissible between humans, had rapidly spread within this province as people had travelled home or to relatives in anticipation of the Chinese New Year festivities. The accelerating number of infected people had forced the Chinese government to act and put a number of cities in the Hubei province in lockdown, among which Wuhan. Wuhan is one of the most important logistical hubs in China, with the country's largest inland port (located along the Yangtze) and connecting cities such as Beijing and Guangzhou by rail. It is, therefore, not surprising that more than 40 percent of the 500 largest companies worldwide have a direct presence in Wuhan. Similar figures suggest that 163 of the 1,000 largest American companies are directly supplied by manufacturers in Wuhan. In addition to these so-called first-tier suppliers, close to 95 percent of these companies also have indirect (or second-tier) suppliers in Wuhan that deliver to the companies' first-tier suppliers (Kilpatrick & Barter, 2020).

With Wuhan's global outreach, solar companies were not the only ones struggling with the nearly entirely halted supply of materials and components from the Hubei province. Across numerous industries, supply problems confronted prominent companies such as Apple (regarding their newest iPhone model), AkzoNobel (decorative paints), Philips (CT scanners), and Volkswagen (car parts). These and other companies had quickly used up their inventory buffers and were experiencing substantial shortages due to the closure of their Chinese suppliers, even if life initially continued as normal in their domestic markets (Bursztynsky, 2020; Elliott, 2021). That is, although the coronavirus itself only spread to the rest of the world weeks or even months after the lockdown of Wuhan, and became known as COVID-19, companies already globally experienced the virus' repercussions as soon as the Chinese government implemented its first countermeasures. Companies' initial concern was, therefore, not the virus itself, but the temporary shutdown of their suppliers (Bursztynsky, 2020; Kilpatrick & Barter, 2020). Understandably, more than a third of the companies worldwide has since moved suppliers or shifted to more local suppliers (Elliott, 2021).

Not only such large disruptions (i.e., shutting down an entire region) can reverberate across the globe, but also smaller and—initially—seemingly local disruptions can have a potentially global impact. On March 23, 2021, for example, unexpected gusts of wind and counterproductive course corrections caused a container ship to lodge itself diagonally on both sides of a canal whose width

spans less than 60 meters in places (the average container ship measures more than 300 meters). The ship would not budge and the soft, sandy shoreline of the canal made freeing it difficult. After six days, the ship was finally dislodged, but not before causing direct damages (e.g., lost transit fees, damage to the canal, costs of dredger ships and other equipment) that were eventually claimed for more than 450 million EUR (El-Fekki, 2021). The ship had further held up close to 350 million EUR worth of goods each hour that it had been lodged (Andersen & Heijkants, 2021). In particular, the ship, called the *Ever Given*, had been lodged in the Suez Canal in Egypt, through which passes approximately 12 percent of global trade. The *Ever Given* itself carried almost 20,000 containers, with the more than 400 ships waiting on either side of the canal carrying a multitude of that (Andersen & Heijkants, 2021; Russon, 2021). After being dislodged, the *Ever Given* was confiscated by the Egyptian government and only released when payment of the direct damages was agreed upon more than three months later (El-Fekki, 2021).

For a considerable share of the cargo on the *Ever Given*, the more than three-month delay was particularly problematic because it involved seasonal products. Stranded products such as barbecues, sun loungers, swimwear, lawnmowers, and camping equipment only arrived at their destinations long after the summer had ended. Many of the affected companies, therefore, have had to order new shipments of the same products or even resort to expensive air freight to ensure that they had sufficient inventory of the delayed seasonal products (Michaelson, 2021). While the delay for the more than 400 waiting ships eventually only amounted to one or two weeks, several of them carried fresh products or even livestock. Special precautions helped save nearly all of the livestock, but a substantial part of the fresh products had to be discarded (Chapa, 2021). In addition to these immediate supply problems, the confiscation of the *Ever Given* and the delay of the many other container ships have further fueled the global shortage of empty shipping containers. The demand for these containers has increased steadily for years, but surged during the COVID-19 crisis as consumer demand shifted away from the largely curbed services (e.g., holidays abroad, nightlife) to products, especially equipment to work from home or sports articles. Because these products are still largely manufactured in China, the price of transporting a twenty feet container from China to Northwestern Europe has increased more than sevenfold in one year: from approximately 850 EUR in august 2020 to more than 6,000 EUR in august 2021 (Benjamin, 2021; Kuipers & van Dijk, 2021).

These real-life situations illustrate how organizations rarely work in isolation anymore and are, as such, increasingly affected by events that they are not directly involved in. Indeed, organizations often form networks around the

production of goods or the delivery of services, and subsequently depend on one another for input materials and services. The term supply chain (SC) is predominantly used in regard to such networks, even if the concept of a linear chain insufficiently reflects the complexity of the connections between member organizations (Carter, Rogers, & Choi, 2015; Choi & Dooley, 2009). SCs enable organizations to focus more fully on their own core competencies and source from other organizations the materials and services that they need to execute these competencies. Although SCs thus enable a better and more efficient use of resources, they also create complex vulnerabilities between different organizations' operations. Specifically, when one organization's operations are disrupted—even by a seemingly small or local incident—other organizations in the broader network across the globe may also suffer (Kim, Chen, & Linderman, 2015; Zhao, Zuo, & Blackhurst, 2019), as the examples above illustrate.

While nearly all organizations experience one or more disruptions in their SC every year (Elliott, 2021), they differ greatly in how successful they are in dealing with them, which is reflected in the organizations' *resilience*. In particular, resilience refers to the ability of an organization to withstand or diminish a drop in operational and financial performance following an adverse event, and, subsequently, to "bounce back" to the same—or even better—level of performance as prior to the event (Sheffi & Rice, 2005, p. 41; see also Ponomarov & Holcomb, 2009). Two central measures of resilience are, therefore, the degree to which a decline—if any—in performance is minimized following a disruption and the time, in turn, it takes for the organization to recover this lost performance (van der Vegt, Essens, Wahlstrom, & George, 2015; Wieland, 2021). The growing interdependencies between organizations and the associated increase in the frequency of disruptions have accentuated the need for organizations to ensure both their individual resilience, as well as that of their broader network (i.e., their SCs' resilience). However, despite the evident need to ensure resilience and the substantial increase in top management support to do so following the coronavirus crisis (Elliott, 2021), organizations continue to struggle with managing disruptions effectively. Why? Because ensuring resilience is both complicated and costly, while its benefits may, surprisingly, remain uncertain.

1.1.1 | Complicated and costly

An important reason as to why organizations often fail to ensure resilience successfully is because doing so is notoriously complicated. First, precautionary investments in resilience will and cannot possibly cover all potential origins and types of disruptions. That is, a disruption may emerge at any tier up- or downstream an organization's SC. Organizations, however, typically know very little about suppliers (upstream) or buyers (downstream) beyond their second or

sometimes even first tier, which makes anticipating and dealing with disruptions that originate from beyond those known tiers particularly challenging (Bode & Wagner, 2015; Lu & Shang, 2017). In addition, disruptions—irrespective of their origin—can be of any type and, as such, may differ widely from one another. For example, while some disruptions emanate from within the SC, such as equipment failure or telecommunications outages, others are external and caused by, among other causes, adverse weather conditions or government restrictions (e.g., the Wuhan lockdown). Similarly, disruptions can be the result of a natural event (e.g., earthquake, flood) or be man-made (e.g., terrorist attacks, counterfeiting), each requiring a distinctive response (Pournader, Rotaru, Kach, & Hajiagha, 2016; Scholten, Stevenson, & Van Donk, 2020). Managing this diversity in potential origins and types of disruptions is an important impediment for organizations in ensuring resilience.

A second element that complicates ensuring resilience is the interdependencies that exist between organizations within an SC. Because of these interdependencies, organizations need to consider other organizations and their countermeasures—if any—when dealing with disruptions to their shared SC. If organizations fail to do so, their own countermeasures may unwittingly duplicate or even counteract those of other, interdependent organizations (de Vries, van der Vegt, Scholten, & van Donk, 2021; van der Vegt et al., 2015). More fundamentally, however, when organizations are jointly responsible for delivering a product or service, a disruption to their joint operations typically also requires a coordinated and collective response by all involved organizations. Any uncoordinated or standalone attempts by individual organizations are unlikely to effectively resolve disruptions that affect the entire SC (Azadegan & Dooley, 2021; Harland, 2021), as was painfully illustrated in the context of the Belgian railway system (see Text box 1.1). Unfortunately, such snowballing of smaller incidents because of lacking coordination is neither unique to Belgium, nor to the railway context, with notable examples across many European railway systems (van de Velde, 2019) and more traditional SCs (Choi, Rogers, & Vakil, 2020; van der Vegt et al., 2015).

Chaos at the Belgian railway system

As is common for national railway systems, the Belgian railway system is operated and managed by a service supply network, including, among others, organizations, passenger carriers, cargo transporters, and infrastructure repair companies. The need for coordinated and collective responses to disruptions affecting such a service supply network became unmistakably evident on June 27, 2011. As people were leaving the beach and travelling back home in the afternoon of this sunny day (33 degrees Celsius), chaos erupted on the Belgian

railway system due to two routine incidents on different trajectories: a torn overhead contact line and a train with malfunctioning brakes. These two small and seemingly isolated incidents eventually paralyzed much of the national railway system, stranding thousands of people in overcrowded and sweltering trains and train stations. The involved rail organizations issued a joint apology the next day, claiming *force majeure* (i.e., conditions and events beyond their control), which an in-depth investigation later proved "it was definitely not" (Roman, 2011, p. 47). Specifically, this investigation revealed that the primary explanation for the escalation of these two small incidents was the severely lacking coordination between the responsible organizations. Lacking a shared information system within the network, many of these organizations were not in direct contact with one another. Instead, they had to rely on a central communications office for exchanging information and updates regarding the incidents. The resulting lines of communication were slow to develop (the communications office was understaffed), complex, and often failed to convey all the relevant information. The different organizations' responses to the incidents were, therefore, fragmented and mostly based on incomplete information, preventing the overall service supply network from effectively dealing with otherwise non-exceptional disruptions (Roman, 2011).

Text box 1.1

In addition to that ensuring resilience is complicated, organizations also struggle because it is costly and time consuming. For example, organizations have been recommended to keep more inventory or invest in backup production capacity that they can use in case of a disruption (Bode, Wagner, Petersen, & Ellram, 2011). Alternatively, organizations can engage in the intricate process of mapping all of their suppliers beyond the first tier, and, subsequently, identify each supplier's associated risks (Kim et al., 2015). As noted above, however, it is unlikely that such precautionary investments in resilience will cover all potential disruptions. At the same time, it even remains unsure whether organizations will use (i.e., recuperate) any costly investments at all, considering that the disruptions they seek to protect against may never happen. As their benefits, as such, remain uncertain, justifying investments in resilience to shareholders or board members can be challenging (Ivanov, Blackhurst, & Das, 2021; Manhart, Summers, & Blackhurst, 2020). Consequently, organizations may decide to invest in more accessible (i.e., less expensive), but also often less effective preventive measures, or not to invest in resilience at all—even after they have been warned (see Text box 1.2).

Global semiconductor shortage

An illustrative example of companies being reluctant to invest in resilience because of its high costs is offered by the global shortage of semiconductors that emerged in the summer of 2020. Semiconductors are used in all electronic devices (e.g., cars, TVs, computers, medical equipment), and manufacturers were producing them at full capacity when they had to temporarily shut down their operations early 2020 because of COVID-19. In addition to the subsequent backlog when they reopened, these manufacturers faced surging demand because of the sudden and global need for consumer electronics (e.g., equipment to work from home) and the faster-than-anticipated recovery of the demand for cars (car manufacturers had cancelled many of their orders at the start of COVID-19). Because of the resulting shortage, car and truck manufacturers have had to lower their production by the millions, Apple expects lost sales of its new Mac and iPad of three to four billion EUR, and Sony's new gaming console (the PS5) is still almost impossible to purchase even one year after its launch (Dantuma, 2021; King, Wu, & Pogkas, 2021).

In the summer of 1997, semiconductor manufacturers—and the companies that depend on them—had already been warned about the impact of such a shortage when the immensely popular Tamagotchi toy had largely depleted the global semiconductor supply. Another warning was received in 2011, when the Fukushima earthquake largely destroyed one of the leading producers of semiconductors for cars. Following each of these disruptions, semiconductor manufacturers were, however, reluctant to invest in measures to increase their resilience to similar future disruptions. That is, investments in backup production capacity were not made because these were highly expensive, and because the manufacturers were afraid that this "overabundance" of potential supply would crash the semiconductor price. In other words, customers' demands for low prices are in large part to blame for the manufacturers' hesitance to invest in such resilience measures (King et al., 2021; Vakil and Linton, 2021). With no backup capacity and it being largely impossible to keep extra inventory due to the rapid technological advancements of semiconductors, the COVID-19 crisis once again depleted the global supply. Only following this latest shortage, semiconductor manufacturers have started to invest in additional production facilities. However, until these are finished in late 2022, the current global shortage is expected to continue (Dantuma, 2021).

Text box 1.2

1.1.2 | Motivation for the present dissertation

Although ensuring resilience is pertinent to organizations' survival, the different real-life cases explored so far are only a few examples of the numerous organizations that have failed to (fully) do so. Considering that the topic of resilience has been of interest to the SC literature for nearly two decades, what has inhibited these organizations from using insights from this literature in managing their disruptions more effectively? Take, for instance, the chaos at the Belgian railway system: how could two small and seemingly isolated incidents escalate and eventually paralyze the entire nation's railway system? Surprisingly, extant resilience research offers little guidance for these incidents, as it has largely overlooked how organizations may best deal with such smaller, more typical disruptions that may occur on a daily basis. Instead, this research has primarily studied large-scale disasters (e.g., natural hazards, terrorist attacks), since an organization's ability to manage these disasters is generally regarded to be the foremost indicator of the organization's resilience. Similarly, how should the Belgian rail organizations have worked together to resolve these small incidents before they escalated? Again, a common notion in the SC literature prevents this literature from offering detailed insights into how the interdependent rail organizations may collectively have resolved the incidents. That is, extant resilience research generally considers a focal or buying organization's resilience to be of primary importance, and also often indicative of the resilience of this organization's entire SC. Resilience studies focusing only on the organizational level of analysis thus dominate the SC literature. This evident mismatch between the struggles that managers face and the prevalent notions that have guided extant resilience research further does little to alleviate organizations' concerns regarding the costly investments into resilience strategies.

Accordingly, this dissertation departs from the dominant focus of extant resilience research on large-scale disasters and individual organizations' countermeasures, to explore obstacles in ensuring resilience that organizations—individually and collectively—experience on a more daily basis. Specifically, the purpose of this dissertation is to address the above notions that prevail within the SC literature, and that have inhibited a more comprehensive understanding of when and how interdependent organizations can effectively and efficiently increase their resilience. Serving this aim, we continue by surveying the SC literature on resilience and exploring these two prevailing notions in more detail. Next, we summarize the key ambiguities that subsequently remain in this literature. We conclude this general introduction with an overview of how our empirical chapters will address these key ambiguities.

1.2 | Setting the scene: A review of extant resilience research

1.2.1 | Large-scale disasters and day-to-day disruptions

While the COVID-19 crisis is a disruption of a nearly unprecedented scale, even disruptions that start out small and local can have a considerable impact on organizations and their SCs. However, whereas this smaller type of disruption is much more likely to occur and is, therefore, a foremost managerial concern, extant SC literature offers few insights on how best to manage them. Specifically, prior resilience research in this field has primarily focused on high-profile disruptive events with a large impact (Cantor, Blackhurst, & Cortes, 2014; Pournader, Kach, & Talluri, 2020), such as the 2008 global financial crisis (Jüttner & Maklan, 2011), the 2011 earthquake and tsunami in Fukushima (e.g., Norrman & Wieland, 2020; Son, Chae, & Kocabasoglu-Hillmer, 2021), climate change (e.g., Ali & Gölgeci, 2021; Alves, de Sousa Jabbour, Kannan, & Jabbour, 2017), and—indeed—the COVID-19 crisis (e.g., Harland, 2021; Ivanov & Dolgui, 2020). Such large-scale disasters have an enormous impact across the globe, and understanding how not only organizations, but also broader institutions or even national governments can minimize their impact has been a primary focus within the resilience literature (e.g., Azadegan & Dooley, 2021; van der Vegt et al., 2015). Naturally, then, organizations' resilience has also been largely understood in relation to their ability to deal with such disasters. This research focus is highly understandable and the resulting insights have proven invaluable, but large-scale disasters are rare and sharply contrast with managers' daily concerns. Even when considering that the underlying mechanisms across large-scale disasters may be comparable (see the work of Akkermans & Van Wassenhove, 2013, 2018), most organizations and SC managers are much more likely to be dealing with repeated, but smaller disruptions, such as adverse weather, late or cancelled deliveries, malfunctioning equipment, and scheduling or planning issues (cf., Donadoni et al., 2019; Scholten et al., 2020; Tukamuhabwa, Stevenson, & Busby, 2017). Unfortunately, a scarcity of resilience research into these day-to-day disruptions has prevented existing SC literature from offering useful insights for managers on how to effectively deal with them.

Disruptions are generally defined as "unplanned and unanticipated events that disrupt the normal flow of goods and materials" (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007, p. 132). Day-to-day disruptions represent a subcategory of such events that are described as "less dramatic but more frequent events, such as suppliers' delivery failures, machine breakdowns, and changes to the specifications of customer orders, which nonetheless represent an important managerial concern" (Tenhiälä & Salvador, 2014, p. 439). The primary difference between large-scale disasters and day-to-day disruptions is that the latter often

start out small and local, with their origin in unexpected, yet not uncommon events. Although day-to-day disruptions may gradually escalate and eventually cause SC-wide failure if left unaddressed, they thus essentially emerge as small discrepancies. As such, day-to-day disruptions differ from the predominantly studied large-scale disasters that cause immediate and full SC failure (Rudolph & Repenning, 2002; Tenhiälä & Salvador, 2014). SC scholars increasingly recognize this and suggest that "there should be a clear differentiation between crises (low probability—high-impact events) [...] and other types of disruptions with varied levels of impact/likelihood, as they require different responses and different kinds of recovery and resilience planning" (Pournader et al., 2020, p. 898; see also Scholten et al., 2020; Tukamuhabwa et al., 2017).

Further research is warranted because dealing with smaller, more typical disruptions that affect organizations on a daily basis is challenging and differs from resolving large-scale disasters in three important ways. First, because the impact of day-to-day disruptions develops much more gradually than that of large disasters, the overall impact of day-to-day disruptions is more dependent on how effectively organizations manage the characteristics of the disruptions at the moment at which they emerge (Pournader et al., 2020; Rudolph & Repenning, 2002). Second, in managing day-to-day disruptions, the overall SC and other involved organizations cannot draw on the support and direction that an incident command system offers for disasters (Bigley & Roberts, 2001; Williams et al., 2017). Instead, organizations inside the SC are jointly responsible for ensuring sufficient coordination to overcome different or even competing (commercial) interests and to develop well-integrated countermeasures (Antonsen, Almklov, Fenstad, & Nybø, 2010; van der Vegt et al., 2015). Third and finally, organizational members' efforts in dealing with day-to-day disruptions frequently add to their regular daily activities. Their limited time and attention for managing day-to-day disruptions contrasts sharply with those of dedicated personnel assigned solely to resolving large disasters (Blackhurst, Dunn, & Craighead, 2011; Scholten, Scott, & Fynes, 2014).

Given these distinctive challenges of managing day-to-day disruptions, it is unlikely that insights into large-scale disaster management from existing research can inform organizations regarding how to deal effectively with the smaller disruptions that are more frequent and varied (Tenhiälä & Salvador, 2014; Tukamuhabwa et al., 2017). It remains unclear, for example, which characteristics make a day-to-day disruption more harmful, and how, in turn, these characteristics should be managed to contain the disruption's impact. Similarly, existing research offers few suggestions on how organizations can ensure effective and efficient coordination in their overall SC when no centralized support is in place. The lack of such coordination is what prevented the Belgian

rail organizations from successfully dealing with otherwise non-exceptional disruptions (i.e., the experienced equipment failures occur at least once or twice every month). Scholars and practitioners alike have, therefore, requested more research that helps in understanding how organizations and SCs may ensure their resilience to day-to-day disruptions (cf., Donadoni et al., 2019; Pournader et al., 2020; Scholten et al., 2020).

1.2.2 | Resilience at and across different levels of analysis

In addition to struggling with managing day-to-day disruptions, the introductory examples also showed that while disruptions may have an SC-wide impact, managers often do not—or are unable to—devise SC-wide responses. Rather, managers focus primarily on what their organization by itself or together with a first-tier supplier can do to minimize disruptions' impact. This is perhaps understandable considering that first-tier suppliers are the primary source of SC disruptions (Elliott, 2021; Lu & Shang, 2017). Resilience research in the SC literature has likewise focused on how a single (buying) organization or buyer-supplier relationship can ensure its resilience to disruptions in their broader SC. This research has, for example, suggested that an organization can develop back-up suppliers in case their preferred supplier can (temporarily) not deliver the required materials (Bode & Wagner, 2015; Tomlin, 2006). Alternatively, organizations may wish to establish contingency plans (Pettit, Fiksel, & Croxton, 2010; Urciuoli, Mohanty, Hintsa, & Boekesteijn, 2014) or invest in shared information systems with critical suppliers to make information sharing more accurate and timelier (Fiksel, Polyviou, Croxton, & Pettit, 2015; Ghadge, Weiß, Caldwell, & Wilding, 2019). However, a focus on individual organizations or relationships offers insufficient guidance to managers on how they can resolve disruptions collectively with organizations beyond their immediate suppliers and, as such, ensure the resilience of the *entire* SC (e.g., Azadegan & Dooley, 2021; Pournader et al., 2016; Scholten et al., 2020; Zhao et al., 2019). Resilience research that moves beyond these organizational and relationship levels of analysis is, therefore, imperative. Below, we first provide a brief overview of the levels of analysis generally identified within the SC literature, before discussing at and across which of these levels scope for further resilience research remains.

Including both the organizational and the relationship level, the SC literature broadly distinguishes between five levels of analysis that are of interest in studying resilience and that have been explored to varying degrees (cf., Azadegan & Dooley, 2021; Scholten et al., 2020; Wieland, 2021). Closely building upon behavioral research, the smallest level of analysis revolves around the role of individuals and teams in ensuring, primarily, organizational resilience. While these individuals and teams have received some acknowledgement in the SC

literature, few studies have explored these micro-level, behavioral foundations of resilience (Mena, Melnyk, Baghersad, & Zobel, 2020; Scholten et al., 2020; see de Vries et al., 2021, and Reimann, Kosmol, and Kaufmann, 2017, for examples of notable exceptions). The second and, again, most adopted level of analysis is the organizational level, which focuses on what an organization can do to recover functionality after its operations have been disrupted, or to prevent them from being disrupted in the first place. The third level, the dyadic or interorganizational relationship level, is concerned with how two organizations (usually, a buyer and its first-tier supplier) can jointly prevent their combined operations from being disrupted. As research at this level typically requires dyadic data, studies are not as plentiful as at the organizational level, but a number of important advancements have been made (see, for example, Pereira, Lago da Silva, Tate, and Christopher, 2020, and Ro, Su, and Chen, 2016).

The fourth level moves beyond the dyad and explores opportunities and threats for ensuring resilience at the level of the entire SC. With the exception of several modeling papers (e.g., Chen, Li, & Linderman, 2021; Demirel et al., 2019; Kim et al., 2015; Zhao et al., 2019) and a few case studies (e.g., Martins de Sá, de Souza Miguel, de Brito, & Pereira, 2020), surprisingly little research has adopted this level of analysis in studying resilience. Although some scholars (e.g., Scholten et al., 2020) combine the relationship and chain levels, the nature of the underlying mechanisms and the correspondingly required data (i.e., dyadic versus chain) are substantially different, compelling us to consider them separately. The fifth and final level focuses on how multiple organizations or SCs can work together at the industry, national, or supra-national level to ensure resilience, and is, correspondingly, mostly associated with natural hazards and other large-scale disasters (Azadegan & Dooley, 2021; Scholten et al., 2020). Insights at this level are scarce and typically concern humanitarian logistics and disaster management (see, for example, Altay and Pal, 2014, and Kunz et al., 2017).

Considering important insights across these five levels of analysis, the predominant focus of extant resilience research on the organizational level is both understandable and surprising. It is, on the one hand, understandable for the body of research that explores a specific category of resilience strategies. That is, as the threat of disruptions for organizations primarily arises because they depend on other organizations for specific materials or services, resilience strategies are typically grouped based upon whether they reinforce or soften organizational boundaries with respect to these interdependencies, respectively distinguishing buffering and bridging actions (e.g., Bode et al., 2011; Manhart et al., 2020; Timmer & Kaufmann, 2019). Buffering actions are aimed at strengthening an organization's boundary and protect it from being overly

dependent upon other organizations (Kalaitzi, Matopoulos, Bourlakis, & Tate, 2019; Mishra, Sharma, Kumar, & Dubey, 2016). Such actions may, for example, include establishing redundant inventory or identifying and using more than one supplier for the same type of material or service (i.e., multiple sourcing). Centrally, buffering actions thus seek to enable an organization to switch easily to alternative means of production or supply in case of a disruption, making the organization more agile and flexible (Bode et al., 2011; Manhart et al., 2020). For research into this specific category of resilience strategies, an organizational level of analysis is thus an appropriate and understandable choice.

The predominant focus on the organizational level is, on the other hand, surprising given that the second category of resilience strategies is—by definition—more appropriately studied beyond the organizational level. Specifically, bridging actions strive to connect interdependent organizations more strongly with one another through, for example, intensifying information sharing or establishing personal relationships. These actions thus transpire across or bridge organizational boundaries, and allow organizations to work together and make use of information and resources that they do not possess themselves (Bode et al., 2011; Durach, Felix Wiengarten, & Choi, 2020). Underlying the proposed benefits of bridging actions is the premise that a single organization is unlikely to successfully implement a solution that helps its entire SC to deal with a disruption (Mishra et al., 2016; Timmer & Kaufmann, 2019). Bridging actions have, therefore, broadly been regarded as the most implemented and effective strategies for ensuring resilience at the SC level (e.g., Manhart et al., 2020; Scholten & Schilder, 2015). As the chaos at the Belgian railway system illustrates, however, bridging actions can be complex and time consuming, and increasingly so when more organizations become involved. The benefits of bridging actions beyond the dyad are, as such, far from guaranteed. Unfortunately, considering the lack of resilience research that moves beyond the dyad as the level of analysis, extant SC literature offers managers few insights into how multiple organizations within an SC can collectively ensure that their SC *as a whole* maintains or recovers functionality following a disruption. To offer such insights, it is thus imperative for resilience research to study bridging actions at the SC level or higher.

Research at the SC level will, however, need to overcome "the limited availability of longitudinal supply network data" (Son et al., 2021, p. 785) that offers an additional explanation for the lack of resilience research beyond the organizational and dyadic level. That is, collecting data on how different organizations collectively dealt with disruptions to their shared SC is complicated and time consuming, if data is available at all (van der Vegt et al., 2015; Zhao et al., 2019). Empirical research at the level of a focal organization or single, dyadic relationship is, however, unlikely to fully capture the complex and interdependent relationships

that exist within an SC. In particular, as Choi, Dooley, and Rungtusanatham (2001, p. 354) already proposed, the "behavior [of the SC system] [. . .] is induced not by a single entity but rather by the simultaneous and parallel actions of agents within the system itself." In this regard, modeling or simulation studies such as Kim et al. (2015) and Zhao et al. (2019) have made several contributions toward understanding what organizations (nodes) and relationships (arcs or links) make an SC vulnerable. Nevertheless, how organizations within the SC can, in turn, collectively *deal with* these vulnerabilities and disruptions remains a promising and underdeveloped area within the SC literature. To summarize, while the predominant focus of extant resilience research on the organizational and dyadic levels of analysis is understandable for studying buffering actions and in light of the poor availability of SC-level data, this focus has left important gaps in our academic understanding of how multiple, interdependent organizations may collectively enhance their shared resilience through bridging actions.

In addition to the need for more resilience research beyond the organizational and dyadic levels, more research is also necessary *across* different levels of analysis (i.e., multilevel research; e.g., Pournader et al., 2020; Reimann et al., 2017; van der Vegt et al., 2015). For example, it remains insufficiently understood when and how individual- or team-level processes may contribute to or impede organizational or even SC resilience (e.g., Fahimnia et al., 2019; Mena et al., 2020; Scholten et al., 2020). While extant research has recommended managers to use cross-functional teams to help their organization deal with disruptions, it offers very little guidance on more detailed considerations such as who to assign to the team and whether to appoint one or more team leaders (de Vries et al., 2021). At the same time, insights from practice have shown that cross-functional teams frequently fail and do not meet up to their organization's expectations in managing disruptions (Mosier & Fischer, 2010; Uitdewilligen & Waller, 2018), signaling that the role of cross-functional teams is more complicated than extant research suggests. Similarly, only limited insights are available on how individual organizations can influence and are influenced by their overall SCs' resilience. In this regard, a recent case study by Martins de Sá et al. (2020) surprisingly illustrated that when the overall interdependence between organizations within an SC is low, the resilience of the SC is primarily determined by the organizations' isolated rather than joint solutions. Understandably, both academics and practitioners have therefore urged for a closer consideration of how actions and processes at one level of analysis influence and are influenced by those at other levels of analysis.

1.3 | Research aim

All in all, understanding how interdependent organizations within an SC can advance not only their own resilience, but also that of their overall SC is invaluable for academics and practitioners alike. The introductory examples demonstrate, however, that managers struggle noticeably with ensuring resilience, and the literature review showed that corresponding opportunities for further (empirical) work remain. Specifically, there is limited research on the smaller disruptions that confront managers on a daily basis, because of which extant SC literature may have few implications for organizations' management of these day-to-day disruptions. Moreover, there are only a few resilience studies beyond the organizational and dyadic levels of analysis, inhibiting a more complete understanding of how multiple organizations within an SC may collectively use bridging actions to increase their joint resilience. Relatedly, resilience research across levels of analysis is also limited, where the individuals and teams that actually engage in bridging actions have largely been ignored. Consequently, there is ambiguity on whether and how insights into behaviors at this micro level translate to higher levels of analysis. In light of these research opportunities, it becomes evident that extant SC literature offers insufficient guidance for managers on ensuring resilience within and across their organizations' boundaries.

Against this background, the purpose of this dissertation is threefold. First, we aim to advance knowledge on the intricacies and characteristics of day-to-day disruptions, and how managers can best anticipate on them to minimize these disruptions' adverse consequences. Second, we intend to develop novel insights into various bridging actions at multiple levels of analysis, primarily focusing on how such actions at an SC level can foster the entire SC's resilience. Third and finally, we set out to develop a more complete understanding of when and how individual-level and team-level processes can strengthen organizational resilience.

1.4 | Research approach

Serving these aims, we empirically studied different bridging actions in response to various types of disruptions and across multiple levels of analysis, using quantitative and mostly objective data. Figure 1.1 provides an overview of this dissertation's overall research framework, and illustrates how the three main chapters supplement one another. Specifically, the structure of this dissertation largely follows the levels of analysis identified above, where each main chapter offers insights at successive levels, respectively exploring resilience across the team and organizational level, at the relationship level, and at the overall SC level.

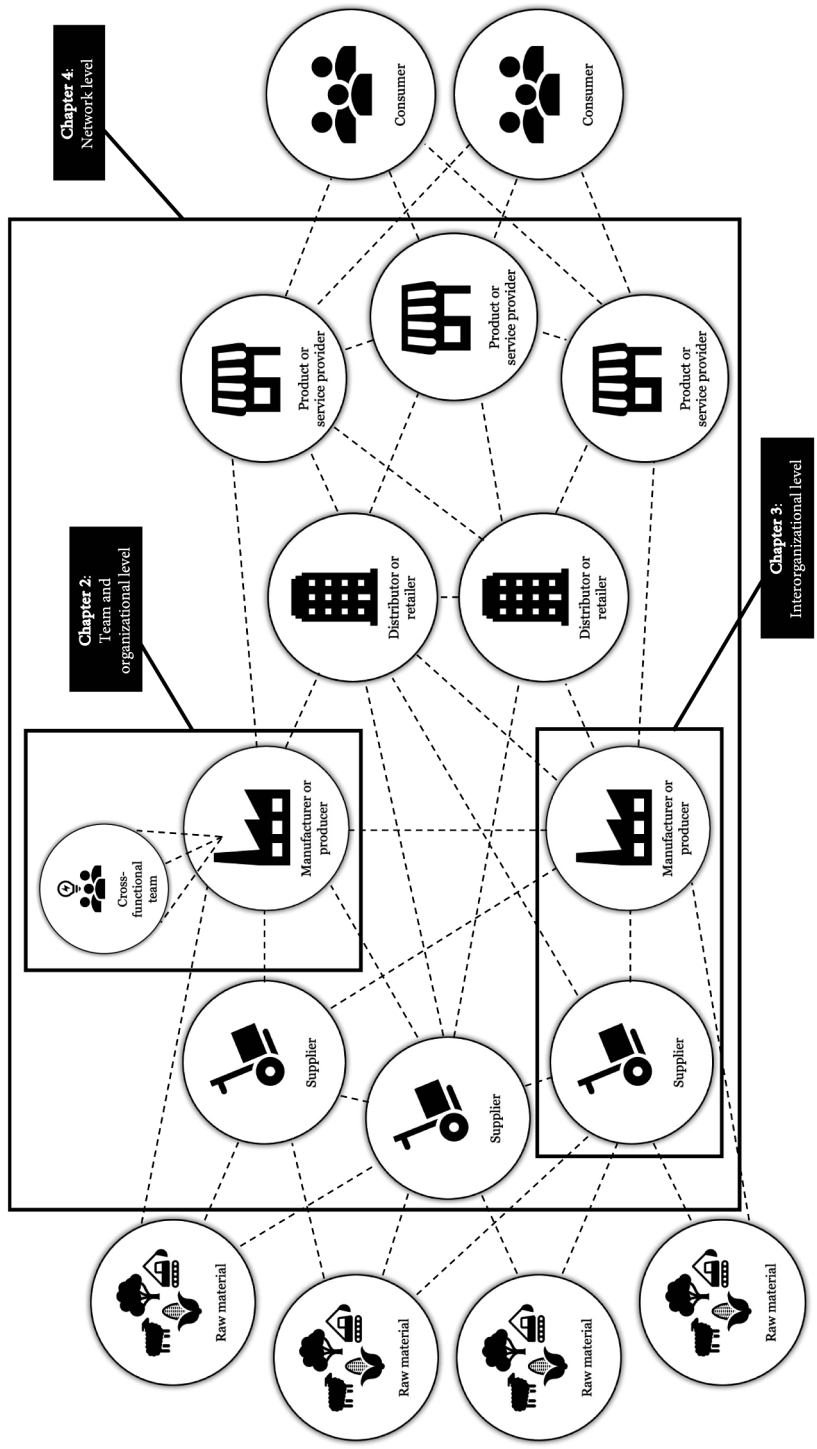
Starting at the smallest and most elementary level of analysis, **Chapter 2** takes an important first step in exploring how individuals and teams can be used such that resilience at the level of the organization is ensured. In this chapter, we study when and how an organization can ensure its resilience by relying on a cross-functional team to engage in information scouting with outside parties such as suppliers and buyers, governmental bodies, or even competitors. As a central bridging strategy (Bode et al., 2011; Manhart et al., 2020), information scouting involves gathering task-relevant information and expertise that is not available internally (Ancona & Caldwell, 1988), and is a task that cross-functional teams are uniquely well-equipped to perform (Stolze et al., 2018; Tasheva & Hillman, 2019). Empirical studies have, however, illustrated that cross-functional teams often struggle to benefit from information scouting and resolve disruptions effectively (e.g., Mosier & Fischer, 2010; Uitdewilligen & Waller, 2018). In this chapter, we draw from micro-level insights on bridging actions' potential drawbacks and propose that the benefits of a cross-functional team's information scouting for its organization's resilience are contingent upon both internal team conditions and macro-level conditions of the organization. We test our conceptual framework using multi-source, multi-informant data from 80 groups functioning as cross-functional teams exposed to SC disruptions in a realistic SC management simulation. The insights presented in this chapter illustrate the importance of considering micro-level processes and behavior in ensuring organizational resilience, thereby accentuating the need for more multilevel research in the SC literature.

In response to the evident lack of insights into managing day-to-day disruptions, **Chapter 3** makes important headway by exploring when such disruptions may have more adverse consequences and, in turn, under what conditions managers can diminish these consequences. Specifically, this chapter investigates how the characteristics of the relationship between an organization and a first-tier supplier can help mitigate the impact of the smaller disruptions that occur within such a relationship on an almost daily basis. For an organization, engaging in bridging actions with its suppliers—particularly those in the first tier—is broadly stimulated to increase its resilience to the large-scale disruptions primarily studied in the SC literature (e.g., Jüttner & Maklan, 2011; Scholten & Schilder, 2015). At the same time, however, these first-tier suppliers are also the largest source of the more typical, day-to-day disruptions that confront the organization (Elliott, 2021; Lu & Shang, 2017). In this chapter, we explore this interesting duality of suppliers and determine when day-to-day disruptions are more harmful and how developing specific characteristics in the supplier relationship can enable the organization and the supplier to resolve these disruptions within their relationship more quickly. We test our predictions using

objective, quantitative data on nearly 2,000 day-to-day disruptions, involving almost 200 different suppliers, encountered over the course of six years, by an order-driven assembler of high-tech products. Moving beyond the level of an individual organization, the findings from this chapter shed light on when day-to-day disruptions in supplier relationships are more harmful and how managers may adopt bridging actions to help mitigate this.

In **Chapter 4**, we both extend on insights from Chapter 3 regarding day-to-day disruptions, as well as address the limited empirical resilience research beyond the organizational and dyadic levels of analysis. That is, Chapter 4 explores how interdependent organizations within a distinct type of SC, a service supply network, can use bridging actions to collectively mitigate the impact of day-to-day disruptions within their network. We collected data from the specific context of critical infrastructures (CIs), which provide essential services such as water supply and electricity delivery, and are notoriously vulnerable to day-to-day disruptions. Examining the service supply network that operates and manages the Dutch national railway CI, we analyze when and how day-to-day disruptions may be particularly harmful for the overall network, and what, in turn, the organizations inside the network can collectively do to mitigate this impact. We test our predictions using longitudinal archival data on 277 day-to-day disruptions that have affected the Dutch railway CI. The observations resulting from Chapter 4 contribute to a more complete understanding of when day-to-day disruptions are more harmful, as well as of what organizations inside an SC can subsequently do to increase the resilience of their SC as a whole.

Finally, **Chapter 5** brings the individual chapters of this dissertation together by discussing how their combined findings contribute to the SC literature on bridging actions and resilience. This concluding chapter further relates each chapter's findings to one another, and offers interesting directions for future research.



Note: Please take into account that this figure serves as an illustration only. Each chapter involves a distinct research setting and there is no overlap in studied organizations, relationships, or networks.

Figure 1.1 | Overview of chapters