



Effects of the Pandemic on the Supply Chain in the Construction Industry

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Abstract: *The present study focuses on digitalization strategies within the realm of supply chain management, wherein the focus is set on the specific economic environment of companies in the supply chain of critical infrastructure providers. Digitalization strategies are within this paper discussed concerning supply chain management and its relevance to the ongoing and influential COVID-19 crisis, where digital strategies of collaboration and management became imperative. To address the research question about the state of implementation of digital strategies within this specific industry, a qualitative empirical study was conducted. Experts from companies acting as suppliers of critical infrastructure were interviewed in an online setting regarding their own experiences with the implementation of digital strategies and according to challenges. Within the analysis of these interviews, it became obvious that digital strategies pre-crisis were only rarely implemented, with only one out of seven experts reporting about more advanced strategies. The COVID-19 crisis is described to be an accelerator regarding digitalization, although specific challenges resulting from unclear legal situations and frameworks are reported.*

1. INTRODUCTION AND SCOPE

The ongoing pandemic had strong effects not only on the overall economic development and social life but also on the management of supply chains (Sarkis, 2020; Swanson & Santamaria, 2021; Nikolopoulos et al., 2021) Especially global supply chains were severely affected by the early stages of the economic and societal lock-down, which proved to be a crucial problem for a wide variety of industries (Armani et al., 2020). The present study lies its focus on the specific field of critical infrastructure and its suppliers, as the description of the relevant state of research will explain. It is argued that, while critical infrastructure itself tends to have according to crisis management in place, the same cannot always be shown for companies within the relevant supply chain.

While new approaches towards supply chain management and supply chain risk management were established (Remko, 2020), even the contemporary environment that is less shaped by the effects of complete lockdowns still sees a variety of COVID-19-specific challenges to the management of supply chains.

The present paper seeks to provide insight towards two distinct perspectives regarding supply chain risk management in the context of the global crisis. The scope of the work is to showcase which specific challenges occur for SMEs in the field of the construction industry throughout the pandemic regarding the management of their (global and local) supply chains. Building on this initial assessment, the work further seeks to address the question, which strategies are employed by companies in this field to combat the challenges described above. Therefore, the paper

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builds on initial findings regarding the COVID-19 pandemic and its above-mentioned impact on the supply chains, while also acknowledging existing research on risk management in the field (Manuj & Mentzer, 2008; McMaster et al., 2020). However, therein rests the leading research gap addressed by the proposed publication: as typical risk management strategies, as they are described by Manhart, Summers and Blackhurst (2020) do not regard global crises with such substantial consequences as the COVID-19-pandemic, but rather crises of individual companies; it seems unclear, in how far they seem applicable to the present context. E.g., the decentralization of supply chains (Aydin et al., 2010) and a strategy aimed at building global supplier networks (Manuj & Mentzer, 2008) – as they are often already in place within the specific industry – seem to face significant limitations in the light of the current crisis. Thus, an empirical approach seems necessary to present the feasibility of different risk management strategies for addressing the contemporary supply chain challenges the construction industry is currently facing in the context of the COVID-19 crisis. Standardized expert interviews with thought and business leaders within the industry will be used to both assess the perceived extent of the crisis and the utilized supply chain risk management strategies as well as their perceived feasibility.

The leading research question of the present paper is derived from the specific challenges regarding suppliers of critical infrastructure providers. As will be shown throughout this publication both from the state of research and an empirical view, companies in this niche suffer from a lack of research: While they are partially responsible for the successful maintenance of critical infrastructure (also during a crisis), the strict frameworks that shape critical infrastructure providers are only partially applied to their supply chain partners, as they are in the focus of the present work. The research question, therefore, is formulated as follows: Which strategies of (digital) supply chain risk and crisis management do companies within the ecosystem of critical infrastructure apply and which challenges arose in this regard throughout the COVID-19 pandemic?

An overview of the state of research both on overall approaches to risk and crisis management – with a focus on digital measures – and on supply chain crisis management in the realm of critical infrastructure forms the foundation of the empirical work. Therein, a qualitative approach is employed, focusing on the expertise of managers and leaders of companies within the ecosystem of supply chain partners of critical infrastructure providers.

2. STATE OF RESEARCH

2.1. Risk and Crisis Management – an Overview

The COVID-19 pandemic not only brought about drastic medical problems and associated social consequences (Ratten, 2020, p. 503), but also lead(s) to an economic crisis (Borio, 2020, p. 2f; Nicola et al., 2020, p. 187f; van der Ploeg, 2020, p. 944), which is compared with that of 2008 in terms of its impact (Yap, 2020, p. 1ff). The crisis of 2008, as summarized by Haron and Nomran (2016, p. 462), for example, emphasized the role of working capital management - its mismanagement by many companies, according to the authors, is described as a contributory aspect of the crisis at that time. Similarly, Ramiah, Zhao, and Moosa (2014, p. 13) also explain that the management of working capital has a special role to play, especially in times of crisis, although a distinction can be made here between resilience-oriented explanations and those focusing on mismanagement or failure. In any case, the key indicators show the degree of COVID-19's impact on the economy. It is evident in the declines of key stock indices such as the Dow Jones by as much as 35%, and the price of oil - as an indicator of economic activity - is at a 21-

year low. Moreover, various countries are expecting recessions of 5% to 10% even for advanced economies (Jones, Palumbo & Brown, 2020, n.d.).

Although the current economic crisis was not triggered by management (mis)decisions, it must be critically questioned to what extent these at least play a supporting role (Cowling, Brown & Rocha, 2020, p. 2 f.). What is clear from this observation is that this crisis also poses significant challenges for many companies and sometimes ensures that bottlenecks occur in the availability of working capital. This represents a reference to two related concepts or approaches - that of risk and crisis management (Burns, Peters & Slovic, 2012, p. 660) and that of research on economic resilience (Wrigley & Dolega, 2011, p. 2337).

It also seems worth mentioning with regard to the crisis triggered by COVID-19 that it not only triggered a general economic impact (which, for example, is particularly evident in the service industry; see Stephany, Stoehr, Darius, Neuhäuser, Teutloff & Braesemann, p. 1ff), but that the management of supply chains, in particular, was threatened and affected by the crisis in many ways. Thus, the concept of resilience is clear in terms of general management. Concerning the supply chain, as Ponomarov and Holcomb (2009, p. 140) argue, the approach seems less clear to many: typically, little is understood about how the idea of resilience can be applied to supply chain management, which poses a threat to companies that rely heavily on these supply chains on the one hand and fail to fully manage them in an appropriately resilient manner on the other. Therefore, supply chain disruptions typically have serious negative impacts on both revenue and cost factors; a problem that can be avoided or at least minimized through more resilient supply chain management. Supply chain management is generally described as complex because it must involve a large majority of stakeholders-mostly, but not limited to the suppliers themselves and logistics partners. Logistics partners form the central theme of this thesis and therefore of this recommendation, but the role of suppliers themselves as potential threats or risks in the supply chain cannot be negated.

The immense relevance of supply chain resilience, especially in times of global (financial) crises, is highlighted by research on the 2008 financial crisis: Companies that were aware of the potential risks and of possible strategies to avoid or minimize them were able to build more resilient supply chains that were not limited to a small number of partners, and were thus able to ensure a secure supplier network both upstream and downstream even in times of crisis (Jüttner & Maklan, 2011, p. 246ff).

The findings addressed here lead to the emergence of new areas of responsibility or objectives for managers, particularly in times of crisis. The resilience of the company must be secured or increased (Tate, Bals & Ellram, 2018; Popa, 2013), which is also reflected in leadership tasks. Also, in order to manage working capital appropriately, appropriate leadership efforts are necessary, which ensure that the workforce is able and willing to act in line with the working capital strategy. However, this seems to be a particular challenge in times of crisis, since - as Wooten and James (2008) argue - leadership is considered particularly difficult in this context.

The context of the COVID-19 crisis also shifted the focus of overall crisis management to digital measures. Digitalization methods can be evaluated via the lens of crisis management, especially in light of the continuing COVID-19 situation.

Taneja, Pryor, Sewell, and Recuero (2014) propose that utilizing the benefits of digital solutions to address the negative consequences of corporate crises is a generally applicable strategy. This

appears to be especially true in the aftermath of the COVID-19 crisis, which witnessed a significant surge in digitization methods across several businesses. Predictions of social and economic changes in the aftermath of the current scenario are still speculative (Bühren & Schüppler, 2020).

Measures implemented by the government to combat the Corona pandemic have created significant problems for a variety of industries, including design and engineering enterprises (Neuhuber, 2020). The current scenario would be far more disastrous if not for the Internet and digital innovations of recent years (Bühren & Schüppler, 2020). Because of technological advancements and the transition to home offices, digitalization can be very beneficial in the long run (Schraml, 2020). Collaborations and meetings conducted across great distances and without face-to-face contact were once deemed troublesome and unsafe in many regions. With the transition, it became obvious that digital work tools can be successfully used and are now a part of regular working life (Bühren & Schüppler, 2013).

Looking at current studies, it is obvious that the digital transformation, in particular, is substantially altering the expectations on businesses, as seen by the introduction of new business models (Frank, Mendes, Ayala & Ghezzi, 2019). This is coupled with shifting expectations for staff competences and skills (Ley & Albert, 2003). This includes the use of digital technology and work tools, new modes of communication and collaboration, and altered, more flexible, and dynamically changing client expectations (Verbeke, Dietz & Verwaal, 2011). Leadership and management must be successful in responding to these changes through suitable measurements and incentives, i.e., enabling people to master these new difficulties and establishing a productive atmosphere to do so.

2.2. Supply Chain Crisis Management – The Perspective of Critical Infrastructure

The research work is located in the environment of the mechanical engineering industry in the German-speaking region, whereby a further restriction is made here, which is presented critically at this point. The restriction is made to those companies or sub-aspects of the mechanical engineering industry which see themselves as part of the supply chain of so-called critical infrastructure. In the following, definitions are presented that describe critical infrastructure: “The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.” (Moteff & Parfomak, 2004, p. CRS-1). This general explanation of what infrastructure means in a national economic context is further qualified when it comes to critical infrastructure. The definition presented by Moteff and Parfomak (2004, p. CRS-4) refers to the U.S. legislative directive E.O. 13010, which provides the following delineation for critical infrastructure: “certain national infrastructures are so vital that their incapacity or destruction would have a debilitating impact on the defense or economic security” (Moteff & Parfomak, 2004, p. CRS-4).

The nature of this specific sector is its great relevance, especially in the context of crises: As the above definition shows, it is the specific characteristic of organizations that can be classified as critical infrastructure that absolutely must be maintained, especially in the context of crises, since a failure would typically have devastating consequences. This research paper focuses on those companies that are part of the ecosystem of this critical infrastructure and act as suppliers for it. The aim is to investigate the extent to which these companies have implemented strategies that take into account the high systemic relevance of such infrastructure.

In this context, reference can again be made to the COVID-19 crisis, where Krebs (2020) points out that critical infrastructure seems to have been partially endangered here, in particular, due to personnel bottlenecks - caused by various lockdowns measures. This is also described by Groenewold et al. (2020) as a central challenge in the context of the pandemic, where it is pointed out that operators of critical infrastructure were consistently endangered by the absences of employees with regard to their operations. Reference can be made in this context to the concept of risk aggregation, which is addressed in the context of the COVID-19 crisis and critical infrastructure by Clark-Ginsberg, Rueda, Monken, Liu, and Chen (2020). In this regard, they refer to the fact that the pandemic itself already represents a crisis for corresponding organizations, but that other incidents or crises can occur independently of it, which must be addressed with sometimes significantly limited resources: “Maintaining critical infrastructure resilience to natural hazards during the novel coronavirus outbreak (COVID-19) is crucial yet challenging.” (Clark-Ginsberg et al., 2020, p. 1). Companies in this field, the authors continue, must thus succeed in maintaining resilience even in crises, in order to be able to address even an aggregation of corresponding problem cases appropriately. The concept of resilience thus refers to one of the contemporary ways of looking at the issue: for critical infrastructure, it is assumed here that not only the active management of crises and risks - i.e., an event-driven approach - but the proactive design of a healthy, resilient, and thus resilient environment is of importance (Rød, Lange, Theocaridoi & Pursianen, 2020).

Although the literature identifies challenges especially in the context of medical care (employees are also so-called frontline workers who are particularly exposed to health risks), Galbusera et al. (2021) further explain that other sectors of critical infrastructure must also be considered accordingly: “The global escalation of the crisis forced these systems into unexplored operational conditions. Evidently, in the eye of the storm are hospitals and the healthcare sector, which in many cases are simultaneously facing high patient pressure and issues with critical supplies” (Galbusera et al., 2021, p. 105161).

Accordingly, especially in the context of the resilience of corresponding systems, which the authors also refer to as the nervous system of modern society, the corresponding ecosystem seems to be relevant. This is discussed accordingly by Trump et al. (2017) in general for large-scale incidents, where reference is made to the resilience of the system, which must be ensured not only by designated infrastructure operators themselves but also by their partners (see also Shakou, Wybo, Reniers & Boustras, 2019). Thus, if the strengths and weaknesses of critical infrastructures are to be assessed, it also seems obvious to take into account accordingly the corresponding companies that partly condition or at least can influence them (Linkov, Wenning & Kiker, 2007; Karvetski, Lambert & Linkov, 2011) Suo, Zhang and Sun (2018) further explain in this regard that there is a high degree of interdependence especially in this field: Different types of interdependence seem to be relevant here - for example, these result from the geographical arrangement, which can lead to different critical infrastructures being affected at the same time, especially in the case of (large-scale) damage, which in turn results in corresponding requirements for management. However, the functional interdependence seems to be of particular relevance for the present work: “It is due to exchanges of material and information between CIs. Under normal conditions, this type is fairly stable.” (Suo, Zhang & Sun, 2018, p. 693). However, such normal conditions do not seem to exist, especially in the context of the problem to be addressed in this research.

Despite the interdependence of critical infrastructure - both in terms of other operators within this niche and in terms of external actors - research related to the supply chain of this industry seems to present few results. In this regard, reference can be made, for example, to a research paper by

Brown, Carlyle, Salmeron and Wood (2006), where it is also emphasized that the role of critical infrastructure suppliers is also insufficiently considered in practice: “Supply chains are critical to our nation’s well-being despite their omission from the Department of Homeland Security (2002) list of critical infrastructure.” (Brown, Carlyle, Salmeron & Wood, 2006, p. 541) Accordingly, it is precisely this supply chain that is particularly vulnerable to crises or attacks, since it is considered to be comparatively less secure and also less intensively regulated by law than the critical infrastructure itself. Its high systemic relevance thus seems to make it particularly vulnerable to targeted attacks, as the authors further emphasize (see also Nagurney & Qiang, 2008).

The focus of scientific interest is placed on that aspect of the mechanical engineering industry which is responsible for the critical infrastructure as a supplier. This specific focus is set to illustrate the particular relevance of crisis management in the industry and at the same time to focus on the specificity of the challenges. The German Federal Office of Civil Protection and Disaster Assistance describes critical infrastructure as follows: “Critical infrastructures (CRITIS) are organizations or facilities of vital importance to the state polity, the failure or impairment of which would result in sustained supply shortages, significant disruptions to public safety or other dramatic consequences.” This critical infrastructure, according to the basic assumption, must therefore be available and usable without restrictions not only also, but especially in the event of a crisis, as the definition itself makes clear. This high relevance for society as a whole is used here as an opportunity to focus on those companies that are jointly responsible for operating and maintaining this infrastructure: While there seems to be a broad body of research on the preservation, importance and defense of critical infrastructure (Aradau, 2010; Brown, Carlyle, Salmeron & Wood, 2006; Rinaldi, Peerenboom & Kelly, 2001; Murray & Grubestic, 2007), this cannot be confirmed for the corresponding supply chain or the companies operating in the context of critical infrastructure. In this regard, Rinaldi et al. (2001), for example, explain that for the successful management of critical infrastructure, the interdependencies with other undertakings must also be taken into account. In addition, there is another specificity that seems to be of importance in the context of the COVID-19 pandemic and the context of large-scale incidents and (global) crises in general: While this crisis is accompanied by reports of difficulties in the (global) supply chain in many places (Sarkis, 2020; Swanson, 2021; Nikolopoulos et al., 2021), the supply chain in the area of critical infrastructure, in particular, must be established in a crisis-resistant manner or (as called for by Sarkis, 2020) in a sustainable manner even in such situations. This will be the focus of this empirical work, which will examine crisis and risk management in German companies in the environment of suppliers and maintainers of critical infrastructure (basic classification: mechanical engineering) and will address the interdependencies and potential disruptions caused by the pandemic.

3. METHODOLOGY – A QUALITATIVE STUDY

3.1. Approach

A qualitative research approach is used to address the above-mentioned study challenge. While the article builds on early findings about the COVID-19 pandemic and its impact on supply chains, it also acknowledges current risk management research (Chan, Huang, Lo, Hung, Wong & Wong, 2020). The foundation of the empirical work lies in the assumption, that the COVID-19 pandemic strongly influenced the field and the supply chain management within it. Digital measures of supply chain management, as they were briefly described within the previous sections, are considered to be among the potential solutions to addressing the challenges.

The empirical study examines the industry's current concerns in the context of the COVID-19 crisis, focusing on the digitization of supply chain logistics in the context of an ongoing crisis - with the resulting difficulties for field managers. Standardized expert interviews with industry thought and business leaders will be utilized to assess the perceived severity of the problem as well as the current supply chain risk management strategies, as well as their practicality. In general, the technique for conducting the preliminary investigation outlined here is qualitative. As a result, standardized expert interviews are employed to gather the most valid and reliable answers to the research topic posed at the outset.

As a result, the current effort is guided by a research philosophical worldview based on a constructivist understanding of reality. This worldview, which is especially common in the humanities and social sciences, is inspired by the realization that reality, as it may be grasped through scientific inquiry, is shaped not just by objective but also by subjective forces.

Because the assessment or perception of variety in the entrepreneurial and therefore operational environment is of essential (research) interest in the context of this work, it appears that this technique is appropriate for the current study. Subjective impacts are inherent to this topic, both from the standpoint of managers and from the perspective of company personnel.

A constructivist worldview appears to be an advantageous platform for tackling the research topic, following this line of thinking and hence the research philosophical approaches of, for example, Pfadenhauer and Knoblauch (2018). One of the approach tried-and-true methodologies is the expert interview, which focuses on subjective reality judgments.

The key themes of this research paper were digitization initiatives in the company's own business of logistics in the construction sector, as well as the associated and industry-wide repercussions of the COVID-19 problem. Questions posed to the experts, therefore, included – alongside the sociodemographic variables – mostly the search for information regarding their digitalization strategies, both in general – thus as a natural part of business development – and in response to the COVID-19 crisis.

The goal was to see how far the topic of digitalization is being pushed in this setting, as well as how much the COVID-19 situation - which was also examined in the context of the theoretical approach in this thesis - is having a disruptive effect.

3.2. Sampling

A total of $n = 7$ experts from various companies within the sector of the supply chain of critical infrastructure providers were interviewed. This specific industry was chosen in accordance with the specifics of the research question presented above. A strong focus was laid on identifying experts who can speak to the particular situation of supply chain (risk and crisis) management in accordance with the specific challenges of the ecosystem of critical infrastructure. As Bogner, Littig and Menz (2009) argue, it is considered to be among the main challenges of qualitative, empirical research to achieve an optimal fit between the research problem on the one hand and the particular experiences and knowledge contents of the participating individuals on the other. As the descriptive information about the experts (see below) shows, they have strong experience within their specific field and should therefore be able to present meaningful information regarding the state of supply chain crisis management within this environment These

professionals were recruited from the main researcher's professional context, resulting in a so-called convenient sampling strategy — an aspect that should be scrutinized accordingly. The participants' average age was $M = 33.57$ years (range from 21 to 43 years old), and their average experience in the industry was $M = 9.71$ years (ranging from 3 to 18 years of experience).

4. RESULTS – DIGITALIZATION IN TIMES OF THE COVID-19 CRISIS

4.1. Overall State of Digitalization

The general state of digitization in the sector was one of the key areas to be addressed in the current study. Participants were asked to evaluate how far their digitization strategies have progressed, which tools are currently being used, and how their stakeholders are reacting to these efforts.

In terms of the overall state of digitalization, four of the seven participants stated that no such strategies or tools are currently in place: they told the interviewer that digitalization efforts are not yet underway within their company, or that these strategies do not go beyond the typical use of office applications in daily workflow. While such generic apps are in use, no digitalization initiatives for supply chain management are made (I1, I4, I6, I7): “Up until now, digitalization was never an issue within our company. Of course, we do use software tools like Microsoft Word or Microsoft Excel to manage our daily business, but – I think, this is outside of the scope of what you are asking. We did not get around to implementing a more strategic approach here, however, it is something we might discuss in the future.” (I4, 2021)

Building Information Management (BIM) is becoming increasingly important for his organization, according to one of the participants (I2): “It is not something we can ignore. Building Information Management is what our partners use, it is what our younger employees learned how to use. Thus, there is really no way around it, you know, even if some of our managers would prefer this, it is the future, it is even the present time for many of us.” (I2, 2021)

The primary motivation for adopting this modern management technique within the area is regarded as a direct response to increased cost pressures and the hunt for more efficient methods. Here, I2 further explains, that while the general approach to these digital measures might be not very popular within his company, there is still a clear understanding of changing requirements within the ecosystem.

As I4 highlights, efficiency is described as the key force driving the digitalization of the field: “We do notice that our competition is moving fast – some seem to be able to do more with fewer resources, so this is, of course, something, we aim to implement as well.” (I4, 2021).

This is also mentioned by I7, who, while not naming any digitalization efforts within his own organization, points out that efficiency might be one of the most significant benefits of a more digitalized supply chain management strategy.

I5 indicates that his organization has implemented several digitalization initiatives, but only the early stages are detailed, with no explicit mention of unique driving reasons: “We did hire outside counsel for improving our digital strategy – it is something we felt we need to drive, even before the onset of the corona, the pandemic – I don't know if this is something that got strongly implemented so far, however, while it is within my field, it is not something we actively

pursue at the moment, it is rather just something, that develops alongside the actual business development” (I5, 2021).

In response to the question of how stakeholders react to digitization initiatives in general, I5 claims that collaboration is primarily defined by legal contracts and frameworks, and that the relationship is not molded by individual reactions to strategies, but rather by a set of rules. According to I2, who informed about BIM-related digitalization activities, stakeholders such as partners largely cooperate with these efforts, but do not appear to play a driving role inside the system. I3 describes the most significant influence of digitalization on the sector, stating that numerous ways are used within his organization to boost overall efficiency. As stated by I3, techniques such as the deployment of digital twins and tracking software are utilized to increase overall efficiency and supply chain transparency: “There is really no way around utilizing these tools and frameworks, especially as our main stakeholders – all within what you labelled *critical infrastructure* at the beginning – expect a certain level of professionalism from our side. They already do use these technologies either way, so it is not fully up to us to decide whether we do as well. Still, it might be one of our USPs here, yes”. (I3, 2021).

4.2. State of Digitalization in Crisis Management

The overall COVID-19 crisis is described by multiple interview partners as one of the most pressing challenges of their collaboration with critical infrastructure providers (I1, 2021; I3, 2021; I4, 2021; I5, 2021): “Of course, the situation early in spring of 2020 was a new situation for all of us. The main problem was the overall work situation itself, nobody knew how to react at all. So what did we do? We moved everything online, our whole work became digital” (I4, 2021). This is also pointed out by other interview partners (I1, 2021, I3, 2021) who explain, that at the early onset of the pandemic, there was no clear solution in sight for how to handle the changes. Of course, production and transport of goods had to continue as it did before, while a majority of service department functions moved online (I1, 2021): “It was a general problem here – most of us did not have the right infrastructure, so to speak, we did not have the right tools. Somehow you could call it a grassroots-movement, we as a company did not have the right measures in place, it was some of our younger employees who took – proactively – a leading role here, who said – we need to move this online, there is this app, there is this tool, you all have to log into it, make these accounts, push this” (I1, 2021).

I6 (2021) points out one of the core challenges he and his company encountered during the COVID-19 pandemic and the subsequently implemented government measures: “We are not critical infrastructure, at the bottom of what we do, however, we are: Legally, we are just a regular company, but when you look at our client lists, most of them are critical infrastructure. So what happened here? There were a lot of regulations in place for how to handle the pandemic – especially during the lockdowns. Who was still allowed to come to work, who had to close down? Well, those within the critical infrastructure itself had a very clear picture of all of this, they stayed open, they continued working, of course. But for us it was never specified, so we handled it in [...] a grey area, one way or the other: When we got a call saying, guys, we need you to step up and provide this, deliver that, support us here, we just did. But we never really knew if what we were doing in these situations was alright from a legal point of view, so we were mostly acting in optimism”. (I6, 2021). I7 (2021) points out a similar situation, explaining that the company used additional legal counsel to evaluate their optimal strategy within the lockdown situation, as some of their services are crucial for critical infrastructure, despite

being conducted by an outside company. He adds, that the situation was even more complicated as they work with freelancers and outside providers (namely, I7 mentions here third party logistics partners), whose situation seemed even more unclear in this particular constellation, he argues. Another legal issue arose from the field of data security and data privacy, I7 (2021) further points out: “It is quite easy with the collaboration of our, I will call them, regular clients – we are bound by the foundation of the current regulation, we comply with them and that is it. Before projects we agree on the software tools, we will use during the project, that’s mostly it. Things are harder when we work with our hospital partners, this usually does not work: We are strictly limited regarding which software we can use and how we can handle data. This was never a challenge, we had our infrastructure, our software, all set up in the offices. Now [with the onset of the pandemic, comment of the author] everything changed, we had to use digital tools that we did not even really know about it before. The hospitals, our contact persons there at least, of course, said they would not mind, but they also stated that they cannot guarantee us, that the legal departments will agree with this. That said, we managed to survive all of this without further legal trouble, things were thankfully handled in a throughout positive way by all stakeholders” (I7, 2021). To summarize, all the interview partners agreed that the COVID-19 situation posed an overall threat to their organizational work and presented itself to be a challenge to their core processes.

5. DISCUSSION AND CONCLUSIONS

These findings showcase how practitioners in the field can use contemporary strategies to cope with the current crisis and enable researchers with new insight into a highly complex topic. The specifics of the logistics industry are critically discussed and lead to a description of further research topics that need to be addressed within this context. What became especially evident is the specific constellation of challenges arising from the COVID-19 pandemic regarding the management of supply chain partners of critical infrastructure providers, as they were the focus of the present work. A majority of the interview partners reported only using a minimum set of digital strategies within the management of their supply chain and logistics processes as well as within their internal processes. The onset of the pandemic and the subsequently induced measures of lockdowns and social distancing accentuated the problematic situation: Necessary infrastructure for enabling remote work was only partially in place, which was complicated by an unclear legal environment. In this regard two of the interview partners clearly stated that they considered the legal uncertainty from various perspectives to be among the most pressing issues they were facing within their crisis management. First, it remained unclear, whether these supply chain partners of critical infrastructure providers were considered to be exempt from certain measures, which leads to a legal grey area, in which they had to operate with a pragmatic imperative: As critical infrastructure providers needed their services, they continued to provide them, even during unclear situations. The second challenge arose from data-security and privacy related issues, that complicated the move towards contemporary collaboration tools that enabled the companies to continue their administrative and organizational work during periods of lockdown from remote locations.

This goes in alignment with relevant findings from the state of research, where authors such as He, Zhang and Li (2021) point out, that the necessary conditions often had to be created quite spontaneously during the first stages of lockdown and crisis reaction. However, the present paper also points out, that it often was employees who took on a leading role in enabling organizational change as a reaction to the changing demands of the pandemic environment.

Another main contribution of the present work lies in the focus of suppliers of critical infrastructure providers: As it was described introducing this work, legal and technological frameworks in this regard are typically assessed from the perspective of the providers themselves, only rarely mentioning and acknowledging the relevance of the related ecosystem. This seemed to arise as one of the challenges in tackling the current pandemic as well, where it was revealed that suppliers in this niche suffered from uncertainty regarding their positioning.

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