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RESILIENCE OF FOOD SUPPLY CHAINS – A DYNAMIC CAPABILITY APPROACH

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Abstract

There are many examples of increasing risk exposure in supply chains in recent years. The Covid-19 pandemic proved to be a huge challenge in the last two years, and the war in Ukraine is currently creating uncertainty in the food industry. In our study, we specifically identify and examine risks threatening the food supply chains. In addition to classifying risks, we examine the dynamic capabilities that companies need to have when operating in the downstream supply chain processes in order to mitigate these risks. The research uses a qualitative methodology and explores the range of required corporate capabilities through interviews with manufacturers as focal companies of a food supply chain. We hypothesise that sensing capability and flexibility, as well as communication and coordination skills, will be key to managing threats. As a result of our study, we can ascertain that the security of supply chain operations does not only depend on supply chain capabilities.

Keywords: supply chain resilience, supply chain risk, dynamic capability, food industry

1. INTRODUCTION

The study addresses a wide range of risks that threaten the operational sustainability of supply chains. Threats may originate from the external

environment of the supply chain or from internal operational processes, they may be intentional or accidental (Narashimhan and Tallurin 2009; Foltin 2011). Some risks can be preliminary identified, and companies are prepared to deal with them in their business contingency plans, e.g. the loss of a supplier. To some risks it is difficult or impossible to prepare for, or even impossible to assess in advance the likely impacts and the necessary actions - think of a pandemic or even a war on European soil.

How quickly, with what tools and with what effectiveness companies can respond to such an unexpected situation depends to a large extent on their abilities to do so. In this paper, we interpret corporate capabilities in terms of the theory of dynamic capabilities. Dynamic capabilities (DC) enable firms to adapt to a quickly changing environment (Teece et al. 1997). The DCs of an organization allow to persistently innovate for sustainable competitive advantage. Competitiveness highly depends on a company's ability to acquire, reconfigure, integrate or release resources and use them to develop a new business strategy that creates higher value (Eisenhardt and Martin 2000). The aim of the paper is to identify those capabilities of firms which support their resilience and thus increase the resiliency of the entire supply chain. We propose a theoretical framework linking the capabilities to resilience and test them with qualitative research methods. The results are important from theoretical and practical perspectives as well. On one hand, there is no available theoretical model yet that highlights those company abilities that might play an extended role in handling risks. On the other hand, company professionals should also be aware of the capabilities that can help them become more resilient.

In the literature review of this paper the literature on supply chain resilience and risks as well as dynamic capabilities are briefly presented, highlighting those capabilities that are particularly relevant for supply chain resilience. The focus of the study is on the food industry since this sector plays a critical role in all national economies in meeting the basic needs of the population, making it particularly important to identify, understand, and prepare for supply chain risks. In the methodological chapter, it is shown that this theoretical framework is tested through case studies with food companies, although the qualitative methodology means that it cannot achieve full validity. In the Conclusions chapter, the main findings and conclusions of the research are presented.

2. LITERATURE REVIEW

The pandemic proved to be a huge challenge for supply chains in the last two years. They experienced unprecedented events, they were not aware of the solutions and the consequences. In the paper, we aim to introduce the theory of dynamic capabilities (DC) briefly and explore its correlation with and effects on supply chain resilience. We also search for the examples how DCs can support the adaptation of companies in the quickly changing environment. Thanks to the actual global tendencies, it is substantial to recognise those capabilities in a firm that can enable resilience and support the supply chain members to adapt successfully.

2.1. Supply chain resilience

Over the past two years supply chains have been under huge pressure thanks to the Covid-19 pandemic. Many companies started to focus on the operational sustainability of supply chains and increase the resilience to high impact events.

The effects of disruptive events can be ranked in three levels (Gaonkar and Viswanadham 2007; Heckmann et al. 2015). “Deviation” means a short-term effect that does not affect on the structure of the supply chain, but the chain moves out of the usual operating pattern, for example because of demand fluctuations. “Disruption” changes the supply chain structure radically, and companies are forced to adapt to the new situation. In the event of a “disaster”, a large-scale, complex, and drastic change occurs that results in the complete and irreversible change of supply chain operations. The first waves of a pandemic undoubtedly fall into this latter category, while later waves cause less trouble and settle down to a disruption (Tulach and Foltin 2020).

During the pandemic, many of the arising problems were solved ad-hoc though some supply chains are still bearing the consequences (Yazir et al. 2020; Skare et al. 2021; Hoeft 2021). Regarding the long-term effects, they are like those of a disruption. After supply chains have survived the initial panic, they rebuilt the structure as it was possible and fit to the new operating environment. However, supply chains still have to operate under uncertainty, far from normal operations – just think about the problems of global supply chains, international maritime transport and the shortage of containers (Guan et al. 2020).

It has been proven in the last two years that supply chain risk management is extremely important and has made it obvious that companies need to develop capabilities that help them to return to normal operations. Resilience has become a focal question since this capability enables the operational sustainability of the supply chain. Researchers extensively deal with finding potential solutions to increase the flexible adaptation of companies or supply chains to environmental challenges (Rojo et al. 2018), by proactive adaptation (Jia et al. 2020) or agile management of unexpected situations (Chen 2019). This paper discusses the main aspects of supply chain resilience and reveals the capabilities that companies need for successful adaptation to the quickly changing business environment. The approach of dynamic capabilities is applied when studying capabilities. It is suspected that firm-level capabilities add up the resilience of a supply chain. The traditional collaborative capabilities such as mutual efforts for maintaining the relationship, collaborative communication and information sharing, help to develop supply chain resilience by enhancing speed, flexibility and visibility, of supply chain members (Scholten and Schilder, 2015). The paper attempts to fill a research gap where the importance of dynamic capabilities in ensuring supply chain resilience is explored through company case studies. Although the generalizability of the case study methodology is limited, it is able to reveal trends and point to areas that require further, deeper research.

2.2. Supply chain risk

The concept of risk is complex and has different definitions. In the field of supply chain management literature as a part of management science, risk typically refers to a negative deviation from the expected performance (Szász and Demeter, 2017). There are several classifications to understand and address more specifically the source of supply chain risk (Zsidisin et al., 2000; Svensson, 2002, Johnson, 2001). The source of each supply chain risk can be interpreted as risks occurring at firm level (i.e. within the firm), outside of the firm (but still within the supply chain), and risks threatening the supply chain from outside (Christopher and Peck, 2004). This can be complemented, following Jüttner (2005), by distinguishing supply (i.e. from the supplier side) and demand (i.e. from the buyer side) risks from the perspective of the focal company. It is also important to note that the supply chain structure itself determines the exposure of the whole supply chain in case of a disruption. A single actor in the supply chain can also be a source of risk to the whole supply chain. For example, in a food supply chain, consider the potential food safety risks of a raw material supplier, which may affect the entire supply chain, both on the supply and demand side.

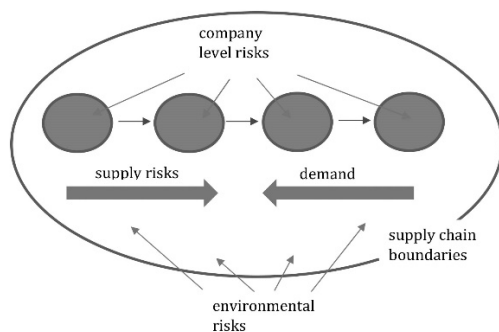


Figure 1 - Risk categorization

Source: authors

Supply chains are therefore exposed to multiple risks from multiple sources, against which they need to be resilient (Figure 1). However, supply chain resilience is also determined by the capabilities of the companies that of the supply chain consists, which will be discussed in the next chapter.

2.3. Dynamic capabilities

Ponomarov and Holcomb (2009) state that supply chain resilience is "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"

(Ponomarov and Holcomb, 2009: p. 131). In the literature, researchers mention several key capabilities that can support supply chain resilience. Jain et al. (2017) identified 13 enabling factors in their study: collaboration and trust among players, risk and revenue sharing, adaptive capability, technological capability, risk management culture, sustainability, market sensitivity, agility, supply chain structure, supply chain visibility, and minimising uncertainty. One can find dynamic capabilities (e.g., adaptive capabilities) and also typical supply chain management techniques (e.g., information sharing) among these factors, which together can ensure supply chain resilience.

The companies that are successful in the global market usually can react to market changes on time with quick product innovations, flexible processes and perform appropriate leadership capability which enables them to effectively discover and integrate new internal and external competencies (Teece et al. 1997: p. 515). As the last two years have pointed out, supply chains need to be resilient in short term to be able to operate sustainably in the long term (Stone and Rahimifard 2020).

The sustainable competitive advantage depends on an organization's capability to acquire, integrate, reconfigure, or release resources and use them to develop new business models in order to create higher value (Eisenhardt and Martin 2000). Dynamic capabilities can make companies able to adapt to a turbulent environment (Teece et al. 1997). The competitive advantage of companies depends highly on how the managerial and organisational processes carried out, the routines in the firm's general activities, the culture, and the ability to learn and manage change (Teece et al. 1997).

Yao and Meurier (2012) and Stone and Rahimifard (2020) propose to interpret supply chain resilience as a set of capabilities. Yao and Meurier (2012) state that resilience is a set of capabilities that enables an organisation or a supply chain to reach balance again after a crisis situation and respond the changes in the environment. Continuous adaptation requires specific capabilities such as identifying risks. A network of organizations, like a supply chain can be a basis of capability sharing, transfer and development. In the following chapter, the critical capabilities for supply chain resilience are examined.

3. LINK BETWEEN SUPPLY CHAIN RESILIENCE AND DYNAMIC CAPABILITIES

The chapter aims to link the dynamic capabilities with the abilities necessary for a supply chain to become resilient. The value added by this part is to initiate a theoretical framework that helps companies structure their capabilities and point out the ones that need improvement to increase resiliency.

According to Lin et al. (2016), dynamic capabilities have multiple dimensions, namely the sensing, absorptive, integrative, and relational dimensions. The sensing dimension means how companies sense their surroundings, absorptive

dimension means how firms can absorb knowledge from the changing environment, integrative dimension means how companies can modify and transform their operations based on the knowledge absorbed and how they can integrate this new knowledge into their operations; and the relational dimension means how companies can then use this fresh knowledge in their inter-organisational relationships (Lin et al. 2016). Table 1 summarizes the main dimensions and the relevant capabilities from a resiliency point of view.

Table 1

Framework of dynamic capabilities relevant for resiliency

DC dimension	Sensing	Absorptive	Integrative	Relational
Capabilities relevant for resiliency	Perceive the environment Identification of threats Risk awareness in the culture Organisation's preparedness for different sources and types of risks (Business Contingency Plan, BCP) Market sensitiveness Leadership commitment to execute BCP Learning new knowledge from lived crisis situations Adaptive management	Interpret, structure, understand and assimilate newly acquired information Knowledge acquisition and assimilation Combining new and existing knowledge Knowledge management Agility Creating new knowledge	Redesign and reconfigure existing enterprise resources Refresh and relocation of corporate resources Coordinate internal competencies Flexibility Organizational change management Change of the organizational culture Technological capability Vertical integration	Collaborative capability Information sharing with the network on risks and preparation possibilities Integrating the acquired knowledge in the network Coordination Risk and revenue sharing Strengthen alliances Reputational asset Co-learning

Source: authors based on Cohen and Levinthal 1990; Teece et al. 1997; Eisenhardt and Martin 2000; Ponomarov and Holcomb 2009; Danneels, 2010; Beske et al., 2014; Lin et al. 2016; Jain et al. 2017; Stone and Rahimifard 2018

To sense and understand the changes of the environment and identify threats are crucial capabilities at companies which for they have to develop procedures, methods and routines (Ponomarov and Holcomb 2009). Based on the identified risks, firms should create business continuity plans (BCP) and be clear about the expanse and scale of risks they want to respond to (Stone and Rahimifard 2018).

Absorption refers to the ability to build new knowledge from knowledge gathered from the environment and assimilate it into the existing knowledge base of the firm (Lin et al. 2016). The combination of the existing and new knowledge will also define the extent and the successfulness of the firm to develop new technologies (Stone et al. 2018). This needs an innovative approach from the top management side.

The success of *integrating* the new knowledge can be traced by how the companies respond the identified risks (BCPs recovery plans). Key dimensions of this are how the newly acquired knowledge is used (Cohen and Levinthal 1990) and exploited, how the competencies evolve and change the old routines (Eisenhardt and Martin 2000).

During the crisis situation, companies establish new relationships (Lin et al. 2016) which can be sources of future resilience as e.g. offering new market

opportunities (Eisenhardt and Martin 2000). Through vertical integration they can give access to critical resources or can be sources of additional knowledge and information. It is also important, how and what information and knowledge the firms share within the network (supply chain) (Lin et al. 2016) or what have been learnt from the previous crises and their own response to them (Teece et al. 1997).

The main research question of the study is: what challenges were experienced by the analysed companies coming from the external environment's uncertainty caused by Covid-19 and other supply chain and internal risks, and what capabilities they need to be resilient to them? We hypothesise that, in addition to supply chain capabilities, general organisational capabilities also play a role in the development of supply chain resilience.

4. METHODOLOGY

The study uses a qualitative methodology to test the relevance of the theoretical framework presented in the previous chapters. In 2022, interviews were conducted with two food companies, during which we focused on the corporate capabilities needed to deal with the crisis situation experienced during the Covid-19 outbreak. Experiences were summarized in a case study.

The data collection for case studies through semi-structured, in-depth interviews helps researchers understand the interviewee's point of view on specific incidents and is more of an exploratory methodology. Kvale (1994) calls attention to the fact, that interviewing can be a valid method if it really reveals the original purpose, while in the case of reliability, predetermined questions can support that the same result can be obtained if the interview is carried out by other researchers next time. Additional data collection methods were the review of the public data sources and financial statements of the analysed companies.

A limitation of the current study is that the interview results are not generalizable due to the low number of respondents as well as the selection of the interviewees being not representative. However, the results are promising and necessitate further research into the topic to understand the supply chain capabilities responsible for resilience.

Case study methodology was selected because it is an appropriate method to get a better understanding of phenomena. Its results are not generalizable either but can produce benchmarks and serve as best (or sometimes worse) practices for professionals (Yin 2011; Denzin and Lincoln 2011).

The main contribution of the selected method is the discovery of new possible aspects and capabilities that might be necessary for firms to handle crisis situations and become resilient, as well as testing the previously defined ones.

Table 2

Interview details

Company ID	Industry	Supply chain role	Position of interviewee	Date of interview
MP	Milk producer	Raw material producer	Plant manager	18/05/2022
PM	Pasta manufacturer	Manufacturer/ Processor	Plant manager	09/05/2022

Source: authors

The researchers followed the same interview protocols at each meeting. The interviews were carried out on the MS Teams platform and took 90 minutes each. All the interviewees were top managers at their companies. We accepted their opinion as relevant to the analysed topic.

5. ANALYSIS

Table 3 is an example of the risk sources presented in subsection 2.2 of the study. In it, some examples of so-called environmental risk sources at company level, supply chain level, and outside the supply chain have been collected based on the interviews conducted. In addition, spill-over effects were identified.

Table 3

Interview results

Source of risk	Risk	Impact on supply chain
Risk at company level	Shortage of labour (locksmiths, electricians) in a specialised sector in a pasta company	Pasta supply chain: It slows down the operational process, thus compromising the achievement of production volumes, and therefore has an impact on the demand side (not being able to meet customer demand).
Risk at company level	Reduced workforce in dairy producer (due to retirements and the livestock sector not popular amongst young people)	Milk and dairy supply chain: The production of the raw material for dairy processing is at risk, affecting operations on the supply side of the supply chain and spilling over to the demand side.
Risk within the supply chain	Pasta and dairy supply chains: non-integrated IT system (each actor uses a different platform)	Supply chain level: Information flow is slower and more difficult, slower reaction time by supply chain actors.
Risk outside the supply chain (environmental)	Milk and dairy supply chain: Covid-19 pandemic	Milk and dairy supply chain: Due to the vertically integrated supply chain, the external environmental impact was mostly absent on the demand side, with short term and manageable impacts on the supply side (e.g. lack of packaging material).
Risk outside the supply chain (environmental)	Pasta supply chain: Russian-Ukrainian war	Pasta supply chain: Due to the vertically integrated supply chain, the external environmental impact is mostly on the demand side (having a secure raw material supplier), but export activity is significantly affected.

Source: authors

Based on the interviews, the analysed companies perceive risks as a direct or indirect impact of the Covid-19 epidemic from several directions. Table 4 summarises the capabilities that are possessed by the companies in order to develop

resilience. Three different levels of capability (high, medium, and low levels) are indicated in the table below, depending on the type of capability observed in the sample.

Table 4

Dynamic capabilities presence in the analysed companies

DC dimension	Dynamic capability	Pasta manufacturer	Milk producer and processor
Sensing	Perceive environment	high	high
	Identification of threats	medium	medium
	Risk awareness in culture	high	high
	Preparedness to different types of risks	high	high
	Market sensitiveness	high	medium
	Leadership commitment to execute BCP		low
	Learning from crisis situation	high	high
Absorptive	Adaptive management	high	medium
	Analysing, processing, interpreting and understanding information	high	medium
	Knowledge acquisition and assimilation	low	low
	Combining new and existing knowledge	high	high
	Knowledge management	low	low
	Agility	medium	medium
Integrative	Creating new knowledge	low	low
	Integrate and reconfigure existing resources	high	medium
	Renew, relocate resources	high	high
	Coordinate internal competencies	high	medium
	Flexibility	high	medium
	Organizational change management	high	high
	Change of the organizational culture	high	medium
Relational	Technological capability	high	high
	Vertical integration	high	high
	Collaborative capability	high	medium
	Information sharing with the network on risks and preparation possibilities	high	high
	Integrating the acquired knowledge in the network	medium	medium
	Coordination	high	low
	Risk and revenue sharing	low	low
Strengthen alliances	low	low	
Co-learning	Reputational asset	low	low
	Co-learning	medium	medium

Source: authors

As a result of the analysis, it can be said that the companies studied already have a number of capabilities that are important for operating a resilient supply chain. The analysis shows that the companies are especially good at sensing, varied capabilities are used to observe and study the environment they operate in. Surprisingly, the absorption and incorporation of the knowledge gathered on the market about the changes is less developed. The case studies show that in analysing

the situation and combining existing and new knowledge as capabilities, they are present in the companies. However more complex activities, like assimilating and creating new knowledge, are only at a low level. In terms of integrative capabilities, the analysed companies are also good. We interpret many of these as supply chain capabilities, like renewing and relocation of resources, vertical integration, technological and organizational capabilities. It was found, however, that the relational capabilities that are particularly important at the supply chain level are very lacking.

6. DISCUSSION

Regarding how companies in food supply chains sense the environment affecting their dynamic capabilities (categorisation according to Lin et al. 2016) and the identified risks, the authors draw the following conclusions. Sensing of risks is of fundamental interest to all supply chain actors in order to survive and remain competitive (Ponomorov and Holcomb 2009). The supply chains studied performed better than we preliminary expected in the application of integrative dynamic capabilities: in adaptation to change, flexibility, management of organisational change or technological capabilities. This is due to the fact that both cases studied are vertically integrated groups of companies that form the supply chain. This is an interesting lesson learnt from the research, which is not solely dependent on the Hungarian context, that the lack of international links, i.e. the fact that there are practically only national actors in a given chain, causes the challenge that they need to further develop their relational dynamic capabilities. Learning from supply chain partners with different activities and knowledge sharing is important but limited. In addition, compared to global food supply chains, the process and structure of knowledge sharing have room for further development, which would facilitate the sharing and learning of best practices at the supply chain level.

Domestically, both supply chains and their operators are among the market leaders, as are their final products. However, there is a lack of experience and knowledge on operating in international markets, and the actors in the analysed supply chains do not have the benchmarking knowledge that would help them to share and further develop the knowledge they have acquired at the level of the group of companies. It has to be noted that for each type of risk identified, whether it is a threat from within the company, within the supply chain, or from outside the supply chain, the actors themselves have to identify, find solutions, and adapt to a new situation. Competitive benchmarking (Tenner and De Toro 1997) is the only means available to identify best practices in many cases. In this respect, benchmarking against a global food supply chain is more challenging.

7. CONCLUSION

The paper admits that change is continuous and that adaptation to environmental changes and different kinds of risks is a constant constraint for

companies. Fortunately, change is usually a deviation and rarely reaches the disaster level. Since dynamic capabilities can be manifold, they can be interpreted on company level but also on the level of interconnected companies (e.g. supply chains). In latter case the combination of different capabilities can be advantageous in risk handling.

However, it is an important message of the case studies that resilience depends on general organisational capabilities and not solely on the specific supply chain (management) capabilities.

On the basis of the interviews conducted and other secondary company documentation, it was concluded that the companies had made great progress in the use of dynamic capabilities. Despite not being a typically dynamic, evolving industry, the food industry has been able to respond reasonably well to the environmental challenges of recent years. Due to domestic nature of the food supply chains analysed, the results of the case studies cannot be generalised. In addition, their domestic nature has a number of advantages. Operating in a domestic environment makes their knowledge of the regulatory environment uniform, their communication between each other as actors from the same culture, and their geographical proximity simplifies logistical challenges.

The two case studies are not enough to formulate a general opinion, although they are good to indicate the need for additional research in this area. Further research could have two additional directions. Firstly, carry on with the qualitative way. Entire supply chains – capabilities of each actor – should be analysed in order to get a whole picture of how supply chain capabilities are built up and serve resiliency. On the other hand, exploration should also be extended toward understanding the capability structure of global and international supply chains and their answers to threat exposure.

Secondly, the research can be continued with quantitative methods. In this case, companies in food supply chains have to be surveyed, collecting data about their capabilities and how resilient they are. This requires a well-edited questionnaire and a rigorous data collection procedure. Results would allow researchers to perform analyses on a large sample and achieve more generalizable conclusions.

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Orcid: <https://orcid.org/0000-0001-8275-1550>**OTPORNOST LANACA OPSKRBE HRANOM – PRISTUP
DINAMIČKE SPOSOBNOSTI*****Sažetak***

Posljednjih godina ima mnogo primjera izlaganja povećanom riziku u opskrbnim lancima. Pandemija COVIDA-19 bila je velik izazov u posljednje dvije godine, a rat u Ukrajini trenutno stvara nesigurnost u području prehrambene industrije. U ovom istraživanju identificiraju se i istražuju rizici kojima su izloženi lanci opskrbe hranom. Osim klasifikacije rizika, ispitali smo dinamičke sposobnosti koje poduzeća trebaju imati kad posluju u downstream procesima opskrbnih lanaca kako bi se umanjili rizici. U istraživanju koristi se kvalitativna metodologija, a istražuje se niz traženih korporativnih sposobnosti na temelju intervjua s proizvođačima kao središnjim poduzećima u lancu opskrbe hranom. Postavljena je hipoteza da će sposobnost osjećanja i fleksibilnost te komunikacijske i koordinacijske vještine biti ključne u borbi s izazovima. Rezultati istraživanja pokazali su da sigurnost poslovanja opskrbnih lanaca ne ovisi samo o sposobnostima opskrbnog lanca.

Ključne riječi: otpornost opskrbnog lanca, rizik opskrbnog lanca, dinamička sposobnost, prehrambena industrija.

JEL klasifikacija: F17, F43, L66, O24, R41.