COMPARISON OF CRITICAL TRANSPORTATION INFRASTRUCTURE OF FOOD SUPPLY IN HUNGARY AND GERMANY – IDENTIFYING KEY STAKEHOLDERS

Anna Freund
Corvinus University of Budapest, Hungary
E-mail: anna.freund@uni-corvinus.hu

Zsófia Jámbor
Corvinus University of Budapest, Hungary
E-mail: zsofia.jambor@uni-corvinus.hu

Judit Nagy
Corvinus University of Budapest, Hungary
E-mail: judit.nagy@uni-corvinus.hu

Received: July 28, 2023
Received revised: September 22, 2023
Accepted for publishing: September 25, 2023

Abstract

The pandemic caused by Covid 19, and the emergence of the Russian-Ukrainian war conflict have generated global implications, but primarily threats the stability in the European context. The key focus of this study is on the critical infrastructures (CI) and how a disruption in it can challenge the stakeholders of the food supply. Critical infrastructures are those systems that provide essential services to society (see defence, management of the economy, public health, and security of people), the failure or even their destruction would have a serious impact on the sustainability of the fundamental infrastructures of a country. The methodology applied is the exploration of the literature and available secondary data about critical infrastructures in Hungary and Germany as well as stakeholder mapping. The aim of this conceptual paper is to identify key stakeholders in case of a disruption in the critical infrastructure relevant for the food supply, especially focusing on the transportation related CI when studying Hungarian and German practices. The findings are compared based on the strong economical dependency of the two countries. Main finding of the study is that a model was used to categorize food supply stakeholders into 4 categories (supportive, marginal, mixed blessing, non-supportive). This categorization along 2 dimensions (stakeholder's potential for threat FSC's CI and stakeholder's potential for cooperation with FSC in CI) was developed and carries an important message for policy makers about who and in what processes can be involved in case of disruption. The research limitations include the number of examined critical infrastructures and the possibility of non-reachable information connected to topic hidden by the governments. The authors aim to continue the research and involve more European countries to the analysis.

Keywords: food supply chain, critical infrastructure, transportation, stakeholder analysis

1. INTRODUCTION

The Covid-19 pandemic and the Russian-Ukrainian war have global implications, particularly threatening stability in Europe. The study focuses on critical infrastructures, specifically the challenges for the food supply. Critical infrastructures are vital systems that provide essential services. Failure or destruction of these infrastructures would have a significant impact on the sustainability of society.

The methodology employed involves exploring literature, websites and other available secondary data on critical infrastructures in Hungary and Germany to reveal the most important stakeholders who have meaningful impact on the operations of the CI or the damage of the CI may affect them seriously. The research compares the critical infrastructures of Hungary and Germany, emphasizing their strong economic dependency, and aims to identify best practices in food supply.

The goal of this conceptual paper is to identify and determine the power of the key stakeholders of critical infrastructure in food supply, especially critical transportation infrastructure, which is indispensable when disruptions happen. Therefore, the main research question is when comparing German and Hungarian approaches about food supply as critical infrastructure, what kind of interdependencies exist between stakeholders, and how do they impact the operations? A proper stakeholder map might help decision makers in involving the right authorities and entities to achieve resilience. The methodology used is stakeholder mapping which assesses the stakeholders along two dimensions: concern and power.

The paper is built up as follows. In the next chapters the theoretical background will be introduced defining critical infrastructure and critical transportation infrastructure as well as the German and the Hungarian approach. It will be also pointed out how these affect the food supply. The paper will continue with the methodology introduction, stakeholder mapping and the results of the analysis. In the conclusion the findings will be summarized, the limitations and future plans will be introduced.

2. CONCEPTUALIZATION

Before moving on to the research itself, it is important to gather and define the key concepts related to the topic, such as infrastructure, critical infrastructure and critical transport infrastructure as well as its resilience. In addition, in order to properly link the concept with the food industry, the most important concerns were also collected which may characterise critical infrastructures in food supply.

Starting from the historical basis, the commitment to identify and protect critical infrastructure is not new, as from very early history, networks (e.g. a road or water pipeline network), a range of facilities, equipment, objects, products and services that played a key role in the life of a society were identified (Bonnyai, 2019).

Infrastructure is understood as a "system of interdependent networks" (Bonnyai, 2019: 31) that is "man-made" (Cecei and Mórocz, 2004) and consists of indispensable elements that are indirectly linked to production processes (Cecei and Mórocz, 2004), which already includes both tangible (e.g. a road network) and intangible (e.g. a supply chain that uses the physical infrastructure) assets (Fjäder, 2016). Connected to this, Stone and Rahimifard (2018) define resilience as the speed at which a system resists and returns to its original equilibrium state. However, it is also possible that there are multiple equilibrium states rather than a return to the original state. The concept of adaptive resilience challenges this closed system thinking, recognizing that constant interactions and environmental changes prevent the attainment of a stable equilibrium state (Folke, 2016).

Critical infrastructure types or categories are not independent, they are interconnected and rely on each other. The volume of this interdependency is shown in Table 1. For example, the focus of the paper is food supply which is considered as part of a nation's critical infrastructure (in Germany and in Hungary, too), but it is highly dependent on the critical transportation infrastructure (transporting goods), the critical cyber infrastructure (communication between supply chain members), critical financial infrastructure (payments through banks) etc. From these all, this paper will focus on critical transportation infrastructure from the food supply perspective.

Table 1 Interdependency of critical infrastructures

	Energy	ITC	Transport	Water	Food	Health	Fin.	Industry	Gov.	Pub.Sec
Energy		xx	xxx	xx	xx	xxx	xx	xxx	x	x
ITC			xx	x	x	xx	xxx	xxx	xx	x
Transport				x	xxx	x	x	xx	x	xx
Water					xx	x	x	x	x	xx
Food						xx	x	x	x	xx
Health							x	xx	x	xx
Finance								xx	xx	xx
Industry									x	xx
Legal order - Government										xx
Public Security										

Source: own edition (the growing number of "X"-s means the increasing volume of interdependency

The reviewed critical infrastructure literature deals mainly with energy security (Yusta et al., 2011), cyber security (Linkov et al., 2019) and financial infrastructure security (Langenohl, 2020), but less emphasis is placed on food supply and the food supply chains. This paper aims to fill this gap. The aim of the study is to examine the German and Hungarian critical transport infrastructure from the perspective of the food supply chain and to identify the stakeholders which can contribute to the resilient operations in this economically important sector.

2.1 Critical infrastructure, threats and sectors

In this section, it is worthwhile to interpret the concepts of critical infrastructure (CI) as defined by the EU and at national level. Critical infrastructure, as defined by the EU, is *"those physical assets, services, information technology facilities, networks and property, the disruption or destruction of which would have a serious impact on the health, peace, security or economic well-being of Europeans or on the effective functioning of the EU and its Member States' governments"* (EUR LEX Green Book, 2005). Critical infrastructure, therefore, is understood at EU level as an interdependent network between two or more Member States, not specifically defined for military purposes, but as a definition of unity for the EU, based on principles such as subsidiarity, complementarity, confidentiality, cooperation and proportionality (EUR LEX Green Book, 2005)

At the national level, Brown et al. (2006) argue that critical infrastructure can be defined as infrastructure that represents a significant public investment and where even minor disruptions can degrade system performance and cause significant social harm. According to Barroca et al. (2012), an infrastructure should be considered critical if its failure, disruption, breakdown or damage threatens the security, economy, livelihood, well-being and/or public health of a city, region or even state.

Critical infrastructure is defined at the national level as *"a network of interconnected, interactive and interdependent infrastructure elements, facilities, services, systems and processes that are vital to the functioning of the country (population, economy and government) and play a meaningful role in maintaining a socially required minimum level of legal certainty, public safety, national security, economic viability, public health and environmental condition"* (Hungarian National Legislative Reference Manual, 2008).

The critical infrastructure definitions have similarities as well as differences. The EU's approach has been extended with cyber-security in the recent years, as a reaction to the Covid19-crisis. All in all, the definitions contain the following common components which can be regarded as fundamental characteristics of CI:

- network of facilities or entities
- vital role from the society's point of view
- which in case of demage, could lead to severe econonomic and social consequences.

Even though the CI is interpreted by each nation which all have national strategies, these infrastructure elements are not independent, heavily interconnected and this way the countries rely on each other.

2.1.1 Critical infrastructure's threats

Critical infrastructure threats can be classified in a number of ways, including Bonnyai's (2019) categorisation based on the Green Paper, which classifies threats into three broad categories: "malicious acts", "natural hazards" and "civilisation-originated technological hazards". While the first group includes acts of terrorism, cyber-attacks, riots, wars and various economic and political motivations, the second group includes events that are natural (e.g. a tsunami following a volcanic eruption but we can consider here the climate risks as well), i.e. events that occur independently of human actions. Finally, the third group includes 'civilisation-originated technological hazards', which can be defined as hazards with industrial (e.g. nuclear disruption, disaster, programming errors) or civilisation (e.g. the coronavirus pandemic) sources (Bonnyai, 2019; Government National Legislative Reference Manual, 2008). However, it is also possible to distinguish internal as well as external hazards affecting the critical infrastructure.

2.1.2 Sectors of critical infrastructure

It is also important to identify the sectors, industries and sub-sectors that have critical infrastructure, or are affected by the CI's proper operations. The Hungarian government decision 2080/2008 (30.VI.2008) applies the EU decree and includes the elements of critical infrastructure in each sector, as shown in Figure 1.

Figure 1 Identified sectors of critical infrastructures

I. Energy
II. Information and communication technologies
III. Transport
IV. Water
V. Food
VI. Health
VII. Finance
VIII. Industry
IX. Legal order – Government
X. Public Security – Defence

Source: Hungarian government decree 2080/2008 (30.VI.) in line with EU regulations

Of the sectors listed in Figure 1, critical transport infrastructure will be analysed from the perspective of food supply.

2.2 Critical transport infrastructure

Critical transport infrastructure refers to the physical and virtual systems, facilities, and networks that are essential for the transportation of people, goods, and services. It encompasses a wide range of modes of transport, including road, rail, air, waterways, and pipelines. Critical transport infrastructure plays a vital role in facilitating economic activities, supporting social mobility, ensuring public safety, and maintaining the functioning of a society. According to Pavić et al. (2021) *"a critical transport infrastructure includes the physical elements, services, supply chains, information technology (network and infrastructure) that play a key role in the transport of people and goods, the health of the population, national security and the efficient functioning of the state, society and economy"* (Pavić et al., 2021).

Critical transport infrastructure is characterized by its strategic significance, high dependency, and potential impact on economic stability, public safety, and national security. Disruptions or failures in these infrastructures can lead to serious consequences, including the following (Taylor, 2008; Kiel et al., 2016; Horváth & Csaba, 2015):

- Disrupted supply chains, causing shortages of essential goods and services.
- Economic losses due to reduced productivity, increased transportation costs, and decreased trade.
- Impaired emergency response capabilities during natural disasters, accidents, or public health crises.
- Restricted mobility and limited access to critical services, impacting public welfare and social well-being.
- Compromised national security if transport assets are targeted or compromised by malicious actors or occurring events.

Given the critical nature of transport infrastructure, it is crucial to ensure its protection, resilience, and continuous operation. This involves implementing robust security measures, regular maintenance programs, contingency planning, technology enhancements, and collaborative efforts among various stakeholders, including government entities, transportation agencies, operators, and private sector partners.

2.3 Critical transport infrastructure and food industry

It can be stated that critical transport infrastructure and the food supply chain are closely interconnected and rely on each other for the efficient movement of food products from producers to end consumers. If the vulnerability of the food supply chain is seen and compared to the vulnerability of other networks classified into critical transport infrastructure, it can be concluded that this structure is one of the most vulnerable supply chains from many perspectives. It was proved during the early stages of Covid-19 pandemic, in many cases caused by extreme climate events and now during the Ukrainian-Russian war that disruptions in transportation can cause desperate situations on the market. Therefore, it is necessary to examine the entities of the food supply chain that are likely to be affected by a crisis situation (Horváth,

2013). The whole food supply chain should therefore be examined, from raw material supply to manufacturing and final product distribution, involving the possible stakeholders. The main points to describe are the connection between the critical transport infrastructure and food supply which are the following:

- Supply chain logistics: critical transport infrastructure plays a crucial role in the food industry's supply chain logistics. It enables the transportation of raw materials (for example: from farms, fisheries, and agricultural regions) to food processing facilities, food processing plants. It also facilitates the movement of processed food products to distribution centres, markets, restaurants, and retail outlets for consumers.
- Timely delivery: efficient and reliable transport infrastructure is essential for ensuring the timely delivery of perishable food items. Fresh products (for example: different dairy products, seafood, and other temperature-sensitive goods) require relatively quick transportation to maintain their quality and safety.
- Food safety and quality: reliable transport infrastructure supports food safety and quality standards. Proper transportation conditions, including temperature control, hygienic handling, and compliance with regulations, help prevent contamination and maintain food integrity throughout the supply chain.
- Regional and international trade: transport infrastructure facilitates the import and export of food products, allowing regions to access a diverse range of food items and enabling countries to participate in the global food trade. Ports, airports, and road networks are crucial for transporting food commodities across borders, across the world.
- Accessibility and food security: and adequate transport infrastructure contributes to ensuring food accessibility and availability, particularly in remote or underserved areas. Efficient transportation networks enable the timely delivery of food to areas with limited local food production, enhancing food security and reducing food deserts.
- Emergency response and disaster management: during natural disasters or emergencies, critical transport infrastructure is vital for delivering emergency food supplies, humanitarian aid, and relief materials to affected regions. Accessible and resilient transport systems are crucial for timely response and recovery efforts.
- Sustainability and environmental impact: transport infrastructure in the food industry has implications for sustainability and environmental impact. Efficient logistics planning, optimizing routes, and reducing carbon emissions from transportation contribute to sustainable food systems and the overall environmental footprint of the industry.

Overall, it can be concluded, that critical transport infrastructure is integral to the functioning of the food industry, supporting the efficient movement of food products, ensuring food safety, enabling regional and global trade, and contributing to food accessibility and security, the relevance of the topic is crucial due to the

vulnerability and sensitivity of the food supply chain (Horváth, 2013). Collaboration between the transport and food sectors is crucial for addressing challenges, improving efficiency, and promoting sustainable practices throughout the food supply chain.

3. RESEARCH METHODOLOGY

Freeman (1984) contends that in order to accomplish an organization's objectives, it is crucial to acknowledge the impact of all stakeholders, whether they are individuals or groups. The initial stage involves recognizing these stakeholders and evaluating the extent of their influence and involvement. Each organization possesses a unique stakeholder network that evolves dynamically over time, with interests closely tied to different strategic matters. Therefore, decisions should consistently identify the pertinent stakeholders and their interests, considering the particular circumstances of each decision situation.

There are various methodologies to map the relationships between entities (e.g., organizations, industry actors, civil actors, governments… etc.). To map the links between actors, value chain mapping, supply chain mapping or even stakeholder mapping methodologies are suitable.

According to Mehrizi et al. (2009) the actors of the examined complex system are linked together in several forms (Mehrizi et al., 2009). These factors can be the level of interest, internal or external position, degree of relationship power (Styk & Bogacz, 2022), or even the responsibilities, tasks, competencies and motivation can determine the role of a stakeholder. The first step is always to understand their role within the observed system, so mapping their relation power must be prioritised (Nyström et al., 2014).

Factors which influence the stakeholder mapping can be categorised in five ways. *Belonging factors (1)* show information about to which stakeholder group belongs the observed stakeholder. S*takeholder factors (2)* refer to the possible role characteristics e.g.: decision making, consulting, monitoring, supporting, while the *planning stage factors (3)* introduce the phases where the stakeholder group is at the moment of the observation (Zingraff-Hamed et al., 2020, p. 10). The category of *relation to the hazards (4)* should be interpreted specifically in the case of CIs. They tell about how strongly the stakeholder group is affected by the hazards regarding CIs, are they key targets (direct affects) or side participants (indirect affects). At the end the *relation to CIs factor (5)* highlights risk management tasks, it is observed how strongly is the stakeholder group affected by negative events (Zingraff-Hamed et al., 2020). After having collected the required data about the examined stakeholders the visualisation of their relations is the next step.

For presenting a stakeholder there are various ways. An important tool is to collect data using the above listed factors and turn them into variables for quantitative purposes or we can focus on the value-added information competing the links between the actors (Giordano et al., 2018; Walker et al., 2008). Both ways require detailed information about the observed actors, that is what significantly differentiates stakeholder maps from value or supply chain maps (Donaldson et al., 2020; Smith, 2012; Taylor, 2005).

In this study, the stakeholder map of Polonsky (1996) will be used. In every stakeholder mapping, the first step should be the identification of the stakeholders. Everyone – individual or organization – have stake if they have a potential or ability to influence the behaviour of an organization or a company (Polonsky, 1996 p.213).

Organizations can classify stakeholders along to their potential to threat or to cooperate with an organization into 4 categories (Figure 2), along which different strategies can be followed with them (Savage et al., 1991).

Figure 2 Classification of stakeholders

	Stakeholder's potential for threat to organization		
		High	*Low*
Stakeholder's potential for cooperation with organization	*High*	Mixed Blessing stakeholder (iv)	Supportive stakeholder (i)
	Low	Non-supportive stakeholder (iii)	Marginal stakeholder (ii)

Source: Savage et al, 1991 p.65

Organizations aspire to have stakeholders who align with the organization's objectives and initiatives. They prefer stakeholders of this kind, who demonstrate a low potential for posing threats and a high potential for cooperation (i). Marginal stakeholders (ii) are characterized by being moderately involved in the organization, neither highly threatening nor remarkably cooperative. While they may have a stake in the organization and its decisions, they typically display limited interest in most issues. However, specific matters such as product safety, pollution, or greenmail have the potential to mobilize these stakeholders and cause their willingness for either cooperation or posing threats to rise. An organization and its managers find stakeholders who exhibit a high potential for threat but a low potential for cooperation to be particularly distressing (iii). When dealing with non-supportive stakeholders, it is advisable to employ a defensive strategy initially. This defensive approach aims to diminish the reliance that forms the foundation of these stakeholders' interest in the organization. The mixed blessing stakeholder (iv) holds significant importance as the organization deals with an individual or other organization whose potential for both posing threats and cooperating is equally high. Collaborative efforts may be the most effective approach in managing such stakeholders. By maximizing their cooperation, potentially threatening stakeholders will encounter greater difficulties in opposing the organization (Savage et al., 1991; Polonsky, 1996).

Since neither critical transport infrastructure nor food supply chain can be regarded as an organization, the paper interprets to them as systems. So, in this paper Savage's stakeholder map will be applied to discover the entities which have influence on or are affected by the critical transport infrastructure (CTI) system in food supply chains (FSC).

4. RESULTS AND DISCUSSION

In this chapter the authors will present systematically the critical infrastructure approach of Hungary and Germany, the similarities and differences between them. Then food supply's critical infrastructure will be in the focus especially the critical transportation infrastructure dimension. The main findings are introduced in the third sub-chapter whereas the stakeholders of the critical food supply infrastructure are presented and classified.

4.1 Comparison of German and Hungarian CI approach

Based on secondary data (official communication of the governments of Hungary and Germany and related organisations) we conducted an analysis to detect the differences and common characteristics within the management and strategy building of the two observed nations. Table 2 shows the factors and result of the analysis.

Table 2. Comparison of German and Hungarian CI approach

	Hungary	**Germany**
Definition at a national level	Critical system element: a service, asset, facility or system element belonging to one of the specified sectors, as well as the services provided by them, which are essential for the performance of vital social functions - in particular, health care, personal and property security of the population, provision of economic and social public services, national defence - and the loss of which would have significant consequences due to the lack of continuous performance of these functions (Act CLXVI of 2012, § 1 (j))	Critical infrastructures (KRITIS) are organisations and facilities of vital importance to the state community, the failure or impairment of which would result in lasting supply bottlenecks, significant disruptions to public safety or other dramatic consequences (BSI website, 2023).
Methodology for management	Centralised, outsourced into the hands of disaster management authorities (65/2013 (III. 8.) Government Decree)	Centralised (governmental level) and decentralised both (individual decision-making power of Federal states)
Content (sector)	10 sectors, separated regulations per sector	10 sectors, separated regulations per sector

Content (food as subsector)	Specialisation for food producers and traders, food service Task-responsibility declaration	Specialisation for food producers and traders Task-responsibility declaration
Relation to the EU strategy	Direct (national regulation followed the EU reg. 4 years later) derived from the EU directive (COUNCIL DIRECTIVE 2008/114/EC, 2008)	Direct, completed with resilience questions from 2022
Way of communication	Based on regulations, representatives of some sectors communicate on their own	Derived from EU strategy, centralised through the website of the government and each Federal states, websites from charities
Stakeholders involved	Government, disaster management authority (enabled for management of CIs in Hungary)	Government, Federal states, charities

Source: Hungarian: Act CLXVI of 2012, § 1 (j)), 2012, 65/2013 (III. 8.) Government Decree; German: BSI website, 2023; Both: COUNCIL DIRECTIVE 2008/114/EC, 2008

The Hungarian and the German governmental strategies regarding critical infrastructures can be followed back to the legislation of the European Union from 2008 (Council Directive 2008/114/EC, 2008). Both governments apply the definition from the EU directive and frame it in form of domestic legislatives (BSI website, 2023, 2080/2008. (VI. 30.) legislative, 2008). The first differences appear within the applied methodologies in the management tasks of critical infrastructures. Hungary directly delegates the task to a subordinated public organisation specialised for disaster management (disaster management authority), while the German government selected in addition to the disaster management representatives. This shows that the management tools are differently selected, and this might probably thank to the size and structure specialities of the countries. Germany highlights the importance in IT safety and starts dealing with critical infrastructures from the perspective of IT safety (PWC website, 2023). On the other hand, both governmental organisations established for disaster management deal with the following topics: identification of CI-s, risk management, crisis management (BBK website, 2023a, DMA website, 2023.). Germany allows the Federal states to complete the governmental legislations and strategies on their own. In comparison Hungary gives the decision-making power to one centralised public organisation (controlled by the government), not to the counties.

There is no significant difference within the critical infrastructures, both governments focus on the 10 sectors determined by the European Union (Council Directive 2008/114/EC, 2008). In addition, Germany has given an updated

complement to the previous existed legislation since 2022 with a special focus on resilience (Bundestag report, 2023). This effort shows that Germany wants to focus on prevention and resilience not only disaster management (when the disruption has happened). This perspective is rarely applied by the Hungarian government, it behaves mainly reactively in a crisis situation, and rather the procedures come to the fore first.

This pro-, and reactive behaviour also appears in the way of communication of both countries. In Hungary there is no well-structured webpage of the government (or a governmental authority) which tells transparently and in detail the public about the critical infrastructures and the emergency procedures. They mainly communicate in forms of legislations (Act CLXVI of 2012, § 1 (j)), 2012, 65/2013 (III. 8.) Government Decree, BSI website, 2023).

The last factor to be observed is the composition of stakeholders involved. It is seen that the interdependence of critical infrastructures is enormous. They even might cause a domino effect in the case of electricity blackout, natural hazards, epidemics, pandemics, or cyber hazards (BBK website, 2023a, McGee & Penning-Rowsell, 2022). Based on the analysis of the context presented previously, the goal of this paper is to detect the interdependencies between stakeholders with a special focus on the food industrial actors.

4.2. Food supply as critical infrastructure

In this chapter the Hungarian and German approach will be compared, how this two EU member stated handle food supply as part of the critical infrastructure.

Table 3. Critical Infrastructures with a special focus food sector

	Hungary	**Germany**
Sub-legislation	Yes	Yes
Related sub-sectors	Food industry (if production is above the determined limit from the legislative): - Gene bank for the conservation of plant and animal genetic resources, - seed production facility, production of vaccines for animals, - slaughterhouse activities, processing of meat and poultry meat, - keeping livestock (e.g., cattle, pigs, geese, turkey),	Food industry: supply of food to the public, food production, food processing - live animals which may be used to produce food and hatching eggs, - feed, - plants before harvesting that can be used to produce food or animal feed, - seeds, - reproduction material.

	- fruit and vegetable processing, preservation, - dairy processing, - manufacture of grain mill products (e.g., bread, fresh bakery products). Food trade: - logistics facilities for the storage and distribution of food Food service: Cooking kitchen for public services (e.g., schools, hospitals)	Food trade: food supply and trade - placing on the market - trading activities.
Content	List of actors who belong to the critical infrastructures, description of the production limit above they're considered as CI actors, the process for designation as a critical system element	The process for designation as a critical system element, list of actors who belong to the critical infrastructures, providing facilities and equipment for the CI actors, ensuring the basic supply regarding orders concerning the production, handling placing on the market, order the purchase, collection, storage, transportation, distribution or dispensing of products order, prohibit, restrict, or place under sovereign supervision, Application guides of: - machinery - fuels and combustibles for machinery - emergency power supply equipment - secure product - regulations for temporary maintenance,

		taking measures for the sovereign distribution of food to the population.
Responsible organisation(s)	National Food Chain Safety Office	Federal Ministry of Food and Agriculture

Source: own edition, based on BBK website, 2023b; ESVG, 2017; Government Decree 540/2013 (XII. 30.), 2015

Table 3 shows that both Hungary and Germany prepared individual regulations for the food sector. The form of regulations is a governmental legislative (ESVG, 2017; Government Decree 540/2013 (XII. 30.), 2015), but the contents are differently structured. The common characteristics of these regulations are that they describe the actors who is responsible for the management task in the case of a crisis. The decision-making and intervention processes are strongly determined in the legislations, so they can be interpreted as procedural guides. Sub-sectors linked to critical infrastructure also show divergence. While Hungary directly mentions the cooking kitchens (as caterers empowered to supply warm and cold food for public organisations), Germany embedded this service into the term "supply of food to the public) rather focusing on production, processing, and distribution. The content of the regulations differs in some points. Hungary focuses on the production limits from which an actor of the food sector is considered as a CI member. Analysing both documentations, it is seen, that the requirements for being able to manage crisis situations can be categorised as follows. First, the CI members must be determined. Governments should deal with the key stakeholders, who play an important role within the food supply. Second, the naming of the responsible authority and the publication of the rules of procedure are required to be able to track the triad of task-responsibility-competence (Eraut, 1998). The intervention guideline seems to be the most important if an authority has to inform and even lead food sector actors in direction to work resilient and cooperating with other CI members within a crisis.

4.3 Stakeholder mapping of the food supply chain from Critical Transport Infrastructure perspective

The aim of this study is to examine the key stakeholders in critical transport infrastructure, which plays a prominent role in food supply, and their importance for critical infrastructure in the event of a disruptive event. To classify the stakeholders, the work of Savage et al. (1991) has been used (Figure 3).

In food supply, the transport infrastructure is critical to the provision of food to society. The location of food production often does not coincide with the location of its consumption, either locally (e.g. dairy products) or globally (e.g. chocolate), and the same is true for the timing of consumption. In addition, the consumption of products rarely coincides with the time of production (e.g. sugar, flour). These two dimensions (place and time value), which contribute to the creation of customer value, need to be addressed through the transport infrastructure and its stakeholders.

The stakeholders of critical transport infrastructure in this respect can therefore be diverse. The creation of the infrastructure is a public task, a state decision, but the operational implementation itself and then the operational management is typically in the hands of some public authority. Users include food supply chain actors, farmers (worldwide), processors, retailers and wholesalers, and logistics service providers that carry out the actual transport processes. Civil society can also be seen as part of this chain, because they are the ones who go to the retail unit to buy food and also use the CTI. In case of a disruptive event an obstruction of CTI can lead most quickly to social tension.

Critical transport infrastructure has other types of stakeholders, too. NGOs or other charity and social organisations that are involved in e.g. food supply in the event of a disaster, or reverse processes in the food chain to avoid food waste and redistribution. Stakeholders also include chambers and trade associations that represent the professional or interest groups of the above and convey a unified position to the state or the authorities. Disruptive events are often reported by the media, which has a role in informing the public and will be taken into account when drawing up the relevant map.

The listed stakeholders are classified in Figure 3.

Figure 3 Classification of stakeholders of food supply in CTI context

		Stakeholder's potential for threat FSC's CTI	
		High	*Low*
Stakeholder's potential for cooperation with FSC in CTI	*High*	*Mixed Blessing* supply chain downstream and upstream members	*Supportive* EU, State government, operative authorities, NGOs,
	Low	*Non-supportive* news and media, nature, human	*Marginal* trade associations, chambers, civil society

Source: based on Savage et al., 1991 own edition

In their study, the authors identified as "*supportive stakeholders*" primarily those who have a primary influence on the design and operations of the CTI in a crisis situation, who are unlikely to threaten the CTI or the FSC, but who nevertheless play a critical role in a crisis situation. This includes the EU and individual national governments as well as authorities, who develop and operate the infrastructure based on common principles and define the crisis procedures. NGOs are also included here because they are, alongside the former, the most intensively involved in providing for civil society in the event of a disruptive event.

In the "*marginal*" category are those stakeholders who, although important, do not really have any influence or pose a threat. Chambers and professional associations enable other actors to act in a united way, e.g. in crisis management. Civil society has little advocacy capacity at the level of individuals, but the whole system under review works in their interests and seeks to build resilience.

Members of the "*mixed blessing*" group can become supportive or non-supportive. Here, mainly upstream and downstream actors of the FSC were

categorised whose cooperation is of paramount importance in the event of a disruptive event in the FSC or CTI, but who may also be the source of a disruptive event themselves. The reactions of FSC members to a crisis event, the way in which a crisis is handled, or even how a member who has dropped out can be replaced.

The last group, the "*non-supportive*" category, includes elements and stakeholders that cannot be influenced externally (natural disasters) or are difficult to predict (terrorist groups), but whose impact can be drastic. The influence of the media in the mass media is of great importance, but distorting or exaggerating the news can cause unnecessary panic among civil society.

The identified stakeholders are therefore all of great importance, and a further option could be the naming of specific governmental organisations and authorities, through which individual states can be aware of the range of organisations and entities that could be involved in the event of a disruptive event, and their potential responsibilities.

5. CONCLUSION

This is a conceptual paper which aims to highlight the importance and applicability of a stakeholder analysis as a particular area of critical infrastructure analysis from a decision maker's perspective. To ensure credible and informative data besides the literature review, websites from the examined governments and the linked stakeholders were analyzed.

The main research question of the paper was to compare German and Hungarian approaches about food supply as critical infrastructure, and to reveal that what kind of interdependencies exist between stakeholders, and how do they impact the operations.

From the analysis conducted it can be seen that there are some stakeholders which may seem obvious, but not all, and there are others that can be key to address consciously (media). The matrix helps to group and assign strategies to them and is also a good indication of who can be involved in what kind of processes during a disruption. Based on the model presented, it is worthwhile in the future to examine each group (supportive, marginal, mixed blessing, non-supportive) in more depth and in more detail, in order to better understand the objectives and conflicts of interest of each group concerned and to propose effective solutions.

NGOs and other social organizations, trade associations and chambers are not an integral part of the system and could play a role. They should be involved in gathering sectoral information, providing credible information, communicating sectoral expectations for CTI development, reaching a broad cross-section of society, involving and mobilizing civil organizations to achieve resilience. They might also have a role in cooperating with similar foreign organization organizing cross-border intervention, sharing information, collect best practices.

Certainly, this research has its limitations. On one hand, the examined critical infrastructures focus on one area (food supply where water is excluded), but the extension would have caused conceptual troubles (e.g., water supply is separated from food in general). Furthermore, the appearance of non-reachable information

connected to topic hidden by the governments might not cover all research questions (e.g., Hungary does not provide that detailed and publicly available communication about the critical infrastructures as Germany does). In the future, the authors aim to conduct a bibliometric literature analysis with which the research streams and the thematic evolution could be interpreted. Their aim is to formulate possible practical implications for both decision makers and citizens in form of a collection of best practices which highlights the possible preventing methodologies for both entities.

Acknowledgement:
Anna Freund: "Supported by the DAAD "Research scholarship" program for scholars of the University of Corvinus and University of Passau 2023."
Zsófia Jámbor: "Supported by the ÚNKP-23-4-II-CORVINUS-18 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund."

6. REFERENCES

65/2013 (III. 8.) Government Decree. (n.d.). Government Decree 65/2013 (III.8.) on the implementation of Act CLXVI of 2012 on the identification, designation and protection of critical systems and facilities. https://nki.gov.hu/wp-content/uploads/2020/11/Gov.Dec_.-65_2013-on-CIP-Act-1.pdf

Act CLXVI of 2012 § 1 (j). (2012). *Hungarian Legislation - Act CLXVI of 2012 on the identification, designation and protection of critical systems and facilities*. https://nki.gov.hu/wp-content/uploads/2020/11/CIP-Act_2012_166.pdf

Barroca, B., Serre, D., Youssef, D. (2012). Le concept de résilience à l'épreuve du génie urbain. *VertigO - la revue électronique en sciences de l'environnement,* https://doi.org/10.4000/vertigo.12469, 12(2).

BBK website. (2023a). *KRITIS - Gefahren*. https://www.bbk.bund.de/DE/Themen/Kritische-Infrastrukturen/KRITIS-Gefahrenlagen/kritis-gefahrenlagen_node.html

BBK website. (2023b). Kritische Infrastrukturen - Sektoren - Ernährung. https://www.bbk.bund.de/DE/Themen/Kritische-Infrastrukturen/Sektoren-Branchen/Ernaehrung/ernaehrung_node.html

Bonnyai T. (2019): *A kritikus infrastruktúra jelentése és kapcsolódási pontjai*, in Bognár – Bonnyai (Eds.) (2019): *Kritikus infrastruktúrák védelme I*., Dialóg Campus Kiadó, Budapest

Brown, G., Carlyle, M., Salmerón, J., & Wood, K. (2006). Defending critical infrastructure. *Interfaces (Informs)*, 36(6), p. 530-544.

BSI website. (2023). *Definition KRITIS*. https://www.bsi.bund.de/DE/Themen/KRITIS-und-regulierte-

Unternehmen/Kritische-Infrastrukturen/Allgemeine-Infos-zu-KRITIS/allgemeine-infos-zu-kritis_node.html

Bundestag report. (2023). *Schutz kritischer Infrastrukturen*. https://www.bundestag.de/resource/blob/945532/888b342ce610fb078fc3c3ada7d39bc5/WD-3-176-22-pdf-data.pdf

Cecei, K. & Mórocz, A. (2004). Klímaváltozás és a kritikus infrastruktúra. *AGRO-21 Füzetek*, 36, p. 32-63.

COUNCIL DIRECTIVE 2008/114/EC. (2008). *COUNCIL DIRECTIVE 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0114

DMA website. (2023). *Hungarian regulatory tasks and legislation related to critical infrastructure protection*. https://www.katasztrofavedelem.hu/109/kritikus-infrastrukturak-vedelmevel-osszefuggo-hatosagi-feladatok-jogszabalyok

Donaldson, A., Brice, J., & Midgley, J. (2020). Navigating futures: Anticipation and food supply chain mapping. *Transactions of the Institute of British Geographers*, *45*(3), p. 606–618. https://doi.org/10.1111/tran.12363

Eraut, M. (1998). Concepts of competence. *Journal of Interprofessional Care*, *12*(2), 127–139. https://doi.org/10.3109/13561829809014100

ESVG. (2017). Ernährungssicherstellungs- und -vorsorgegesetz - ESVG - Food Security and Precautionary Measures Act. https://www.gesetze-im-internet.de/esvg/ESVG.pdf.

EUR LEX Green Book. (2005). Green paper on a European programme for critical infrastructure protection. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52005DC0576

Fjäder, C.O. (2016). *National Security in a Hyper-connected World*, in Masys (ed.) (2016): *Exploring the Security Landscape: Non-Traditional Security Challenges*, Springer, p. 31-59.

Folke, C. (2016). Resilience. Ecology and society, 21(4).

Freeman, R.E. (1984). *Strategic Management: A Stakeholder Approach*, Boston: Pitman Publishing Inc.

Giordano, F., Morelli, N., De Götzen, A., & Hunziker, J. (2018). The Stakeholder Map: A Conversation Tool For Designing People-Led Public Services. *ServDes2018 - Service Design Proof of Concept*, *June*, 16. https://www.la27eregion.fr

Government Decree 540/2013 (XII. 30.). (2015). *Government Decree 540/2013 (XII. 30.) on the Identification, Designation and Protection of Critical Agro-Economic System Elements and Installations*. https://net.jogtar.hu/jogszabaly?docid=a1300540.kor

Horváth, A. (2013). Terror threats of critical infrastructure of food supply chain. In. *Economics and Management*, University of Defence, Czech Republic, p. 31-43.

Horváth, A., & Csaba, Z. (2015). Critical transport infrastructure protection: a research on the security of the supply chains. *Economics and Management*, (2), 47-54.

Hungarian government decree 2080/2008 (30.VI.). (n.d.). *Government Decision on the National Programme for Critical Infrastructure Protection*. https://njt.hu/jogszabaly/2008-2080-30-22

Kiel, J., Petiet, P., Nieuwenhuis, A., Peters, T., & Van Ruiten, K. (2016). A decision support system for the resilience of critical transport infrastructure to extreme weather events. *Transportation research procedia*, 14, 68-77.

Langenohl, A. (2020). Articulating sovereignty within the infrastructural imagination: the case of the securitisation of finance as 'critical infrastructure'. *Politikon*, 47(1), p. 4-23.

Linkov, I., Roslycky, L., & Trump, B. D. (Eds.). (2019). *Resilience and hybrid threats: Security and integrity for the digital world*, 55, IOS Press.

McGee, T. K., & Penning-Rowsell, E. C. (Eds.). (2022). *Routledge Handbook of Environmental Hazards and Society.* Routledge.

Mehrizi, M. H. R., Ghasemzadeh, F., & Molas-Gallart, J. (2009). Stakeholder mapping as an assessment framework for policy implementation. *Evaluation*, *15*(4), p. 427–444. https://doi.org/10.1177/1356389009341731

NAK Website. (2020). *Critical infrastructures from the perspective of the National Chamber of Agriculture in Hungary*. https://www.nak.hu/tajekoztatasi-szolgaltatas/koronavirus/101520-mi-az-a-kritikus-infrastruktura

Nyström, A. G., Leminen, S., Westerlund, M., & Kortelainen, M. (2014). Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management*, *43*(3), p. 483–495. https://doi.org/10.1016/j.indmarman.2013.12.016

Pavić, M., Eng, M. C., Jokanović, I., & Eng, G. C. (2021). Critical transport infrastructure. Conference proceedings, *8th International Conference, 2021, Contemporary achievements in civil engineering,* 22-23. April 2021. Subotica, Serbia

Polonsky, M. J. (1996). Stakeholder management and the stakeholder matrix: potential strategic marketing tools. *Journal of Market-Focused Management*, 1, p. 209-229.

PWC website. (2023). *Sicherheit in Kritischen Infrastrukturen*. https://www.pwc.de/de/im-fokus/cyber-security/sicherheit-in-kritischen-infrastrukturen.html?utm_source=google&utm_medium=cpc&utm_campaign=CROSSMEDIA_thenewequation_CS&utm_id=suche&utm_content=text&utm_term=kritische infrastrukturen

Savage, G. T., Nix, T. W., Whitehead, C. J., & Blair, J. D. (1991). Strategies for assessing and managing organizational stakeholders. *Academy of management perspectives*, 5(2), p. 61-75.

Smith, C. (2012). *Net-Map - A Toolkit to Understand and Visualise Stakeholder Influence*. InfoQ. https://www.infoq.com/articles/net-map/

Stone, J. & Rahimifard, S. (2018). Resilience in agri-food supply chains: a critical analysis of the literature and synthesis of a novel framework. *Supply Chain Management: An International Journal*, 23(3), p. 207-238.

Styk, K., & Bogacz, P. (2022). A Method for Stakeholder Mapping in Connection with the Implementation of a Development Project. *Energies*, *15*(4). https://doi.org/10.3390/en15041592

Taylor, D. H. (2005). Value chain analysis: An approach to supply chain improvement in agri-food chains. *International Journal of Physical Distribution and Logistics Management*, *35*(10), p. 744–761. https://doi.org/10.1108/09600030510634599

Taylor, M. A. (2008). Critical transport infrastructure in Urban areas: impacts of traffic incidents assessed using accessibility-based network vulnerability analysis. *Growth and Change*, 39(4), 593-616.

Walker, D. H. T., Bourne, L. M., & Shelley, A. (2008). Influence, stakeholder mapping and visualization. *Construction Management and Economics*, *26*(6), p. 645–658. https://doi.org/10.1080/01446190701882390

Yusta, J. M., Correa, G. J., & Lacal-Arántegui, R. (2011). Methodologies and applications for critical infrastructure protection: State-of-the-art. *Energy policy*, 39(10), p. 6100-6119.

Zingraff-Hamed, A., Hüesker, F., Lupp, G., Begg, C., Huang, J., Oen, A., Vojinovic, Z., Kuhlicke, C., & Pauleit, S. (2020). Stakeholder mapping to co-create nature-based solutions: Who is on board? *Sustainability (Switzerland)*, *12*(20), p. 1–23. https://doi.org/10.3390/su12208625