How Critical is Critical? Towards a Decision Framework for Disaster-specific Critical Entities

Niklas Sommerer
AIT Austrian Institute of Technology
Center for Digital Safety and Security
Sommererniklas@gmail.com

Stefan Schauer
AIT Austrian Institute of Technology
Center for Digital Safety and Security
Stefan.Schauer@ait.ac.at

Martin Latzenhofer
AIT Austrian Institute of Technology
Center for Digital Safety and Security
Martin.Latzenhofer@ait.ac.at

Andreas Schnabl
Federal Ministry of the Republic of Austria
for Agriculture, Forestry, Regions and
Water Management
Andreas.Schnabl@bml.gv.at

ABSTRACT

During recent disaster and crisis events, it became more and more evident that critical infrastructures are of utmost importance for a quick recovery from these events. However, not all infrastructures might be equally critical in a crisis scenario; some organizations might be more critical during some disasters than during others. Additionally, due to current regulation, even more organizations are categorized as "critical", which makes it more difficult to the most relevant ones during a crisis. In this paper, we present an identification and classification approach for the importance of critical entities during a disaster or incident. This approach is related to standard risk and resilience management processes and can be directly integrated into the first phases of these processes. In particular, it takes the nature of the disaster as well as of the respective entity into account and sets them in relation to each other. Additionally, it also considers the economic and societal role of the individual entity, i.e., their importance for different industry sectors and their supply chains as well as for the well-being of society in general. To show how the decision process would work in a realistic scenario, we apply it for a pandemic scenario and a supply shortage scenario. Additionally, we also generally discuss how the process can be applied in other domains.

Keywords

Disaster Specific Critical Entities, Identification Process, Resilience Management.

INTRODUCTION

Critical infrastructures (CIs) are physical and cyber-based systems essential to the minimum operations of an economy and government (World Economic Forum, 2022), and whose destruction would have a "debilitating impact on security, national economic security, national public health or safety, or any combination of those matters" (U.S. Department of Defense, 2025). Subsequently, these systems require enhanced protection against threats, including that during a disaster, the restoration of CIs gets prioritized to ensure that they can quickly continue their operations and reduce the disaster's impact on a nation's economic and societal security. Particularly in the course of recent crises and disasters such as floodings, earthquakes or the COVID-19 pandemic, CIs and their resilient operations have been in the focus of the broader public, governmental organizations and emergency responders. Thus, governments around the globe have established frameworks and directives over the last decades to address this matter and define and identify CIs.

In 2008, the European Union (EU) published the Council Directive 2008/114/EC for the "identification and designation of European critical infrastructures and the assessment of the need to improve their protection" (European Commission, 2008). This was extended to the NIS1 and NIS2 directives, which focus on enhancing the cybersecurity posture in critical sectors (European Commission, 2022b), and the Critical Entities Resilience (CER) Directive, which requires critical entities to improve and manage their network and information security posture (European Commission, 2022a). as well as the respective national laws implemented by the Member States. In these directives, the term "critical infrastructure" was changed into "critical entity" to account for the fact that not only entire infrastructures but also parts thereof can be "critical." Additionally, the EU also defines 18 critical sectors (e.g., energy, transport, and banking) that are affected by those regulations (European Commission, 2022b).

The United States (US) have a similar approach to identifying its critical infrastructures, which a first definition starting in 1996 with the Executive Order 13010 (US Government, 1996). In 2003, the US established the Homeland Security Presidential Directive 7 to identify and prioritize critical infrastructure and protect them from terrorist attacks (CISA, 2003). Within this directive, the US identified 16 critical sectors, including the chemical, communications, water, or food and agriculture sector (The White House, 2013). In recent years, the focus became broader (also compared to the EU) and the National Resilience Strategy (The White House, 2025) as well as the Executive Order 14028 (Executive Office of the President, 2021) were introduced. Together with the National Institute of Standards and Technology (NIST) SP800-161 (Boyens et al., 2024), these directives cover similar aspects as the European directives regarding the protection and resilience of CIs.

While these directives provide a high-level classification of which organization might be relevant for national security and resilience, they are static and fall short of adapting to various crisis scenarios and differentiating between the criticality of different entities during an incident. This can become problematic in the course of a specific incident or disaster: not all infrastructures might be equally critical in a crisis scenario, some organizations might be more critical during an earthquake or flooding than during a cyber-attack or pandemic. Moreover, with the recent directives more and more organizations and systems are considered as "critical" according to one or the other directive. As an example, in the EU Member State Austria, the number of organizations categorized as "critical" or "essential" will expected to increase from roughly 400 to about 4.000 in response of the evolvement from NIS1 to NIS2. Additionally, also specific raw material and resources, such as lithium, cobalt, phosphorus, or boron (European Commission, 2024), have been considered "critical" as they play a crucial role for various industry sectors – as well as for the functioning of critical entities.

Besides, the development of directives and regulations aiming to protect critical infrastructures not only coined the term "critical infrastructure" (U.S. Election Assistance Commission, 2017) but also increased research interest in CIs and services. Scholz et al identified that the publication of literature regarding critical infrastructures began in 2001 and increased by almost 80% after the COVID-19 pandemic (Scholz et al., 2022). While most of the research about CIs focuses on the dependencies (e.g., (Rinaldi et al., 2001; Turoff et al., 2016) and others), protection (e.g., (O'Rourke, 2007; Pesch-Cronin & Marion, 2016) amongst others), or failures of CIs (e.g., (Schneidhofer, 2015; Hassanzadeh et al., 2020) just to name two examples), there exists only limited research that focuses on the identification of critical entities, which can most likely be attributed to the criticality identification and classification by directives. However, with the increased complexity of supply chains and the growing interdependence of global markets, it becomes increasingly difficult to identify, which infrastructures or resources should be considered critical. Thus, the stiff and inflexible classification of critical infrastructures by directives and the lack of research on this topic leads to a blind spot that makes it difficult to determine which entities should be considered critical. Especially under the consideration that significant events, such as the COVID-19 pandemic, can cause infrastructures that are usually not considered critical to fall under this classification (Scholz et al., 2022).

Addressing the shortcomings requires a more dynamic identification process that accounts for different circumstances, such as the disaster event type and its impact on a critical entity. Accordingly, this paper introduces the concept of disaster-specific critical entities (DSCEs) and proposes an adaptive identification process for such entities. This process builds upon the identification efforts of CIs in existing regulations and directives and particularly accounts for the nature of a specific disaster or incident and how that influences the critical entity. Further, the economic and societal role are considered as well to account for the importance of the DSCE for different industry sectors and their supply chains as well as for the well-being of society. We achieve that by introducing a set of general criteria and integrating them into a generic decision process. Therein, each path has a particular weight leading to a score, which allows decision makers to decide whether an organization, system or resource is critical for a specific scenario.

In the following section, we present the criteria for the identification process and briefly discuss why they are important for the decision process. Afterwards, we describe the setup of the generic decision process and also present the proposed scoring method. Furthermore, we provide two use case scenarios to showcase how the decision process can be applied in a pandemic scenario and for a supply disruption scenario. In the end, we conclude the paper with some discussion on the limitations of the framework and an outlook on the next steps.

CRITERIA FOR THE IDENTIFICATION PROCESS

Identifying an entity as critical during a specific disaster or incident requires distinct criteria to obtain a comprehensive picture of the disaster, the examined entity, and the entity's environment. While a hospital might be highly critical during a pandemic, its criticality would be significantly lower during a power outage. Therefore, we propose four criteria that aim to achieve the objective of collecting and assessing relevant information to identify disaster-specific critical entities and allow for the quick prioritization of relevant entities during a particular disaster. The criteria for identifying disaster-specific critical entities are:

1. **Impact by the disaster:** the first criterion focuses on whether and to which degree an entity is impacted by a particular disaster scenario. This includes evaluating disruptions to its infrastructure, operation, or services.
2. **Operational resilience of the entity**: the second criterion examines the entity's resilience towards a particular disaster, i.e., how resilient the entity's operations or functionality during a specific disaster is and whether that entity can implement measures to mitigate and reduce the impact of the disaster.
3. **Systemic relevance of the entity**: The third criterion determines whether an entity is already considered critical ("essential" or "important", respectively) according to the NIS2 Directive or the CER Directive, or if an entity is producing a critical raw material (e.g., lithium, cobalt, phosphorus), based on the European Critical Raw Materials Act (European Commission, 2024). Additionally, this criterion also evaluates the entity's role within supply chains and its relevance within the entity's region.
4. **Societal role of the entity**: The fourth criterion aims to capture whether the entity's societal role is crucial for public safety, public health and societal stability

These four criteria form the foundation for identifying DSCEs and ensure a structured, standardized, and comprehensive approach to assess and evaluate the criticality of an entity.

Impact by the Disaster

The first step of identifying a DSCE is to assess whether and how an entity is impacted by a particular disaster event. In general, there are three different impact types that need to be considered: first, the entity could be directly impacted by the effects of an incident. Second, the entity could experience an indirect impact of a disaster event, which means that the entity experiences supply chain disruptions. In this scenario, the entity would theoretically still be able to operate normally; however, the loss of a business-critical supplier or customer would still lead to delayed business continuity. Third, an entity could also experience collateral impact due to regulations and measures that governments implement during a crisis scenario.

The interpretation for this criterion would be that a direct impact has the most severe consequences and poses the greatest risk for an entity because it could either cause the destruction of physical or digital assets, lead to significant downtime or generate substantial financial loss. Accordingly, entities that are directly impacted by a specific disaster are more critical during that scenario because they experience more significant disruptions, which could lead to cascading effects on other organizations, services, or supply chains. Subsequently, these entities will require more help and resources than less impacted entities to maintain the normal state of an industry or society. In this context, the assessment does not account for an organization to be impacted directly and indirectly simultaneously because once an organization is directly impacted by a disaster, its ability to function is immediately compromised, and its supply chain dependencies become minor or irrelevant.

Operational Resilience of the Entity

Once it is determined if and how an entity is impacted by a disaster scenario, the next aspect would be to assess how resilient the organization is to counteract the direct, indirect, and collateral effects. In other words, it must be assessed how much the operational or functional capacity is reduced and how long it would take to get the entity back to an (almost) normal or satisfactory operational ability. In this context, it also needs to be evaluated if the entity prepared mitigation actions that would help to reduce these effects, e.g., reduce the risk of a disaster or to maintain the operational capacity with fewer resources available. Additionally, it is essential to figure out if those mitigation actions allow the organization to remain fully operational or if those mitigation tactics still only allow for reduced operational capabilities.

For example, during a power outage, organizations with backup power solutions will probably be able to reduce the impact and maintain operations, which decreases their criticality during this scenario. While a hospital with a backup generator will be able to stay operational, a small grocery store without a backup power supply would lose its ability to process transactions and refrigerate perishable foods, making the retail store less resilient. Hence, it is more critical to provide immediate resources to the small grocery store since it will become inoperable and ultimately, the disaster will have a more significant impact on the grocery store compared to the hospital.

Systemic Relevance of the Entity

After the entity's resiliency is determined, it is necessary to check whether it is already considered as "critical" (or "essential" or "important") under a given directive, e.g., the NIS2- or the CER Directive. If an entity is characterized as critical, it can be assumed that it operates in a vital sector and plays an important role in maintaining the crucial functions of society and, accordingly, can also be considered critical during a disaster event. In this context, it is also important to capture entities that are not characterized as critical according to these directives because they are too small or are below the official threshold to be characterized as critical. However, these entities still need to be considered in case they do have a significant role in the supply chain for one of the NIS2- or CER-specific critical entities. The significance of such an entity relates to the impact it has on a critical entity's operational capacity. For example, entities that source, process, or recycle critical raw materials play an essential role in securing supply chains and deserve special consideration within this process.

For example, an organization in the health sector that provides sterilization services for surgical instruments might be too small to be considered as a critical entity according to the NIS2 or CER Directive. However, if this organization is significant for big hospitals, e.g., since it carries out all the sterilization services for that hospital, it should also be considered as a disaster-specific critical entity.

Societal Role of the Entity

The last criterion of the identification process focuses on the societal role of an entity. Entities with a significant social role are crucial for public safety, public health, and societal stability. Entities with substantial social roles, such as healthcare institutions, government bodies, essential service providers, and communication platforms, are pivotal in managing crisis scenarios, ensuring the provision of vital services, and disseminating accurate information. Their functions and responsibilities directly impact public behavior and policy adherence, which is critical for effective incident response and mitigation. Recognizing and prioritizing these entities ensures that essential societal functions are maintained, and resources are allocated effectively to those impacted the most by a disaster event.

DECISION PROCESS

Structure

Based on the criteria outlined in the previous section, a structured decision process can be designed to determine whether a given entity should be considered critical during a particular disaster scenario. The process is intentionally kept straightforward to minimize the time required for assessment during an incident. It involves a series of key questions that address the respective criteria, ensuring a rapid as well as comprehensive evaluation. Each possible response connected to a specific weight, contributing to an overall criticality score. The most influential criterion is the systemic relevance of an entity because if an entity is considered to be "critical," according to relevant directives, this entity most probably will also have a high priority during a disaster event. The second most significant factor is whether and how an entity is impacted by a disaster event followed by the entity's operational resilience since a highly resilient entity will also be able to cope with a pandemic and will have a lower priority compared to other entities. The least significant criterion revolves around the societal role of an entity, as this factor will usually be already covered by the previous criteria.

The decision process is divided into four steps which correspond to the four criteria. In the first step, three questions are formulated to capture whether an entity is experiencing direct or indirect impacts (with direct impacts contributing more significantly to their criticality score) and whether they are experiencing collateral damage (helping to distinguish between varying degrees of impact). All questions use a general three-tiered response system – "High," "Medium," and "Low" – to categorize the severity of the effect. The second step covers the resilience criterion with one question and uses the same three-tiered response system applies, where a low resilience score suggests that the entity is inadequately prepared, making it more vulnerable to the disaster's effects. In this context, the answer is an estimation of the resilience rather than a precise rating as usually the data for a precise rating is not at hand.

The third step is directly related to the NIS2- and CER Directives, capturing whether an entity is already falling under these directives. Hence, entities classified as “essential” under NIS2 are deemed more critical than those labeled as “important,” which is reflected in their respective scores. Moreover, in case an entity does not fall under either category, an additional question evaluates whether the entity is significant for a critical supply chain, i.e., is the entity a supplier for a critical entity (or an essential or important entity, respectively). If the answer is yes, the entity’s criticality score will increase but less significantly compared to an entity that is officially classified as “important.” The fourth step is related to the societal role of an entity and, therefore, addresses whether an organization is considered a small or medium enterprise (SME) or a large company (this is usually done taking the number of people that are employed and the annual turnover) or if the entity has programs that benefit society, such as community or charity programs. Here, the concept is that entities with more employees or social programs play a more essential societal role and ultimately will receive additional points towards their criticality scores.

By combining these criteria, the proposed decision process provides a structured framework for evaluating DSCEs and ensures that key factors, such as infrastructural relevance, disaster impact, resilience, and societal contributions, are systematically assessed.

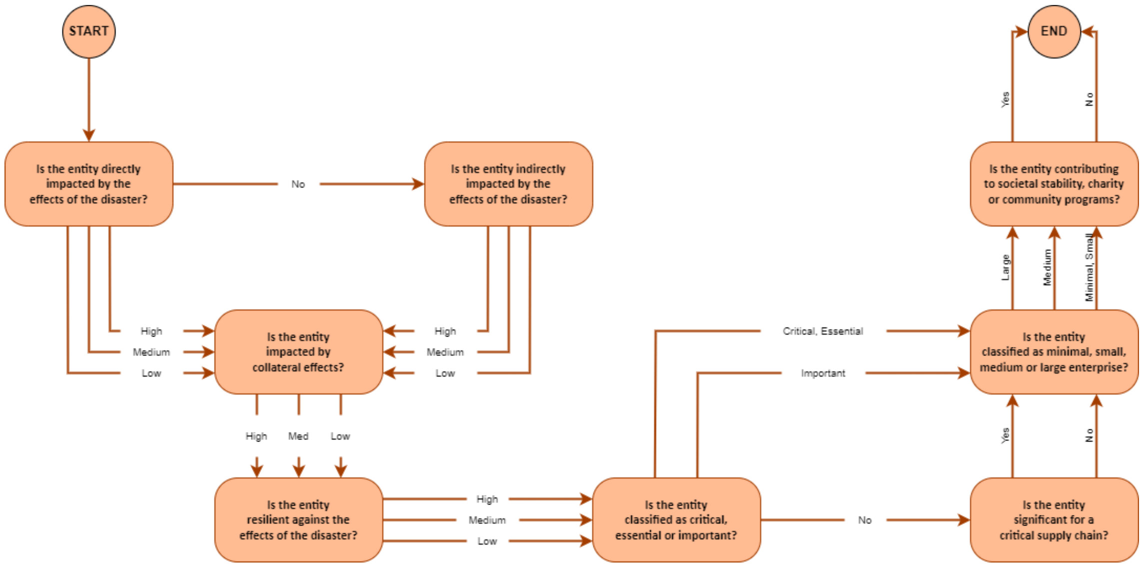

Figure 1: Schematic illustration of the generic process to identify disaster-specific critical entities (DSCEs).

Results

Following the respective steps of the decision process, an entity receives a score between 0 and 100, which will help determine the entity’s criticality during a particular disaster event. A high criticality score indicates that an entity is more significant during a disaster event than entities with lower scores. As given in **Error! Reference source not found.**, entities can be classified as non-critical entities, special considerations entities, critical entities, and high-priority critical entities according to some predefined threshold scores.

	Non-critical entity	Special considerations entity	Critical entity	High-priority critical entity
Score	0 – 35 points	36 – 60 points	61 – 75 points	76 – 100 points

Table 1: Characterization of disaster-specific critical entities according to their score

These classification types are based on an entity’s performance across the four previously described criteria. The different classification types are designed to represent the following characteristics:

Entities in the category of ***non-critical entity (0-35 points)*** fulfil at most one criterion. These entities are not significantly impacted by a disaster event or are highly resilient towards the disaster and are not considered systemic or societal relevant. Organizations determined to be non-critical entities can operate normally during a specific disaster scenario, or operational outages only have limited impacts on other individuals and organizations.

Special considerations entities (36-60 points) meet one to two criteria. They may experience moderate disaster impacts or have lower resilience than non-critical entities. They might not be classified as systemic or societal critical; however, they can have characteristics that warrant attention, such as being suppliers in critical supply chains.

Critical entities (61-75 points) fulfill two to three criteria. A disaster event significantly impacts critical entities, but they have the resources to mitigate these impacts. Additionally, the disruption of critical entities would directly affect essential infrastructure or supply chains. As a result, these entities require substantial attention or support to maintain business operations during a disaster event.

High-priority critical entities (76-100 points) are entities that fulfil three to four criteria. They experience severe disaster impacts, have low resilience, have high systemic relevance, and play a crucial societal role. These entities demand immediate attention and resource allocation to mitigate disruptions and reduce the impact of a disaster event.

In general, we want to stress that the process as illustrated in Figure 1 together with the classification as described in Table 1 can be tailored to the requirements of a specific disaster scenario. Hence, some of the blocks in the process can be adapted or changed (as we will show in the second use case below); also the weights of the links in the process can be adapted which might also change the thresholds of the classification types.

USE CASE: PANDEMIC SCENARIO

The first use case is focused on a pandemic and the critical entities would be the organizations and infrastructures within a specific region or an entire state. The scenario is closely related to the COVID-19 pandemic and the impacts and consequences that became visible in several different countries. To use the proposed decision framework in a pandemic scenario, the four steps of the process could be applied as they are. However, the process will be easier to understand for decision makers if the individual questions are a little more tailored to the context of a pandemic.

Impact by Disaster

Regarding the first step, the main impact to a critical entity are the effects of the pandemic, where the transmission method mainly influences the direct impact (in terms of how and where the virus spreads). Depending on the transmission vector, people would avoid certain places or even certain groups of other people (e.g., if some are more vulnerable). One direct impact common to all pandemics is the absenteeism of people and the reduction of the workforce of an entity. This can also be considered as part of the indirect impact, since a reduction of the workforce at a supplier would influence their productivity, which would again influence the entity under evaluation depending on supplied goods. The mitigation measures that are set in place during a pandemic, i.e., non-pharmaceutical interventions (NPIs) like social distancing, store closures or lockdowns, would be considered as part of the third aspect, the collateral impact.

During the COVID-19 pandemic, the main direct impact for organizations was the lack of employees, as mentioned above, who were either sick or in quarantine. Additionally, the transmission method was air-borne, which had direct implications for the transport sector, as people would avoid crowded places. The indirect impacts would manifest mostly in supply shortages, either because some ports were closed and means of transportation (e.g., ships and containers) were scarce or because of an unexpected demand for certain goods (food, toilet paper, etc.). When the NPIs were set in place, social distancing again had the collateral impact on the transport sector and events; similarly, the closure of shops had direct financial impact on them.

Operational Resilience of the Entity

When considering the resilience of an entity in the second step, existing measures against the direct and indirect impacts would need to be taken into account. This would include measures to cope with a reduced workforce or an increased demand (e.g., hospitals were experiencing much more patients) but could also include the ability of companies to switch to remote work or of restaurants to change to pick-up or delivery concepts. In the course of a pandemic, rather specific mitigation measures were needed compared to technical outages or natural disasters, simply because of the nature of the pandemic. Due to the fact that pandemics were not on the top range of events considered in business continuity management (BCM), these measures often were not at hand or could not be implemented quickly.

As we have seen from COVID-19, companies that were able to adapt quickly to a remote work setting would be more resilient in providing their business services than others. Some organizations were able to compensate the reduced workforce by re-activating people from retirement, e.g., in hospitals, whereas others could not do so as they would not have access to retirees, or the retirees were not qualified (or trained) properly. In other organizations, grouping highly relevant staff (e.g., air traffic controllers) into separate teams was used to reduce the risk of infection of an entire team. However, some organizations simply did not have the means to adapt quickly, e.g., shops that had to close down would struggle if they would not have an online presence or online store.

Systemic Relevance of the Entity

Since we are considering the organizations, companies, and other infrastructures within a certain region in this example, it is rather straight-forward to evaluate whether they have a systemic relevance for said region. Particularly in Europe, we could fall back on the above-mentioned directives like NIS2 (European Commission, 2022b) and CER (European Commission, 2022a). They are (at least to some degree) translated into national law, defining some thresholds upon which it can be decided rather objectively, if a given entity is considered critical. It gets a little more complex when considering the upstream and downstream value chains of an individual organization. This is mostly due to the fact that the individual value chains are only known to the respective organizations and often this information will not be shared with some national authority. Additionally, value chains become extremely complex rather quickly, particularly when reaching beyond country borders or even continents.

As we have seen from COVID-19, organizations that were considered “critical” (or “essential” or “important”) due to national law also received high attention to maintain their functionality. For example, there were several exceptions for essential organizations (e.g., pharmacies, supermarkets, etc.) and critical personnel. Regarding supply chain dependency, some explicit examples could be drawn where the criticality of organizations only showed after they caused an interruption in the supply chain. For example, some certification and standardization bodies were not operational which brought the value for surgical masks to a halt (masks could be produced but not sold as they were not certified).

Societal Role of the Entity

When considering a pandemic scenario, the societal aspect of the entities under consideration becomes increasingly important as several parts of social life are directly affected. This ranges from organizations like hospitals or first responders that are crucial for the public health over providers of essential services like power, telecommunication, water, etc., that are contributing to public safety up to smaller parts like hairdressers, cinemas, bars or even parks. Although the latter group is not considered as “critical” or “essential” by any of the national laws or directives, the lack of their services affects the mood of individuals and, consequently, of the general public. Therefore, such overlooked or neglected organizations need to be considered as they might have a greater impact than initially thought.

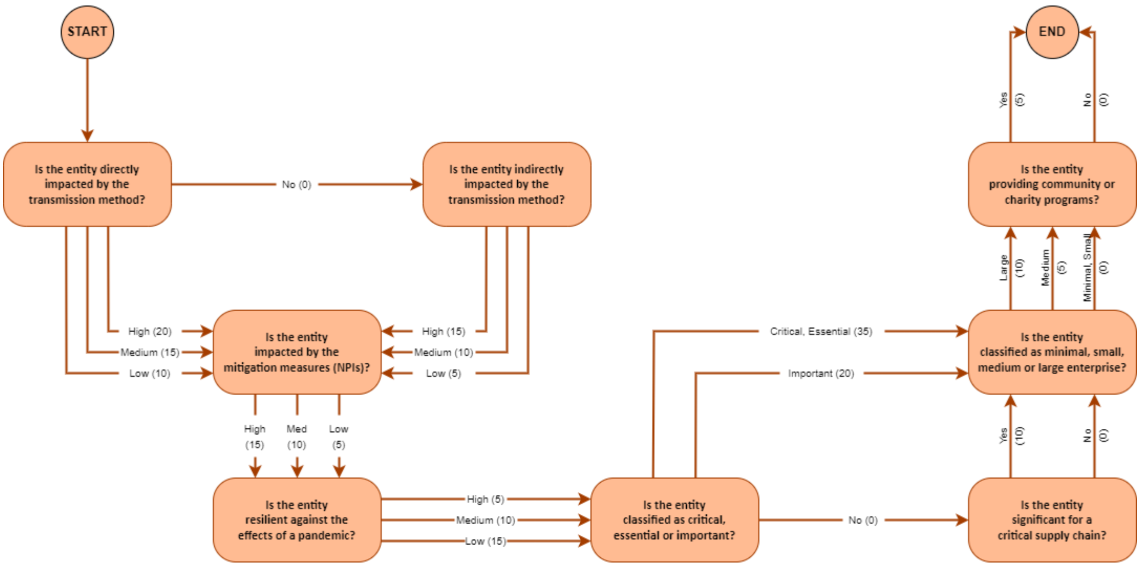

Figure 2: Adaption of the identification process for the pandemic use case. The numbers in brackets are the scores for each branch.

USE CASE: SUPPLY DISRUPTION SCENARIO

In this use case, a supply disruption is considered and the entity under evaluation is "phosphorus in agriculture," which is not an organization or system but a critical good for agricultural fertilizer. Phosphorus is listed as a critical raw material in the respective Critical Raw Materials Act, which was adopted by the European Commission in March 2023, and entered into force in May 2024 (European Commission, 2024).

Impact by Disaster

Considering both the European and Austrian contexts, EU imports the majority of its phosphorus from non-EU countries and thus the functionality of the supply chain is of high importance. A disruption in phosphorus supply would have significant implications for the EU, particularly in the agricultural sector. Phosphorus is an essential nutrient for plant growth, and its scarcity could lead to decreased crop yields, thereby threatening food security within the EU (van Dijk et al., 2016). However, a direct impact would also result from a disaster or a terrorist attack on fertilizer production facilities within the EU, which supply the European market.

Due to the importance if phosphorus into the EU, the indirect impacts would be more significant in this scenario. An indirect impact would be the case if key phosphorus-supplying regions, particularly in North Africa, were affected by disasters or conflicts, leading to disruptions in exports to the European Union. If natural disasters occur in mining areas or if armed conflicts arise in these regions, the affected mines could be temporarily shut down or even forced to cease production entirely. Such disruptions could also occur due to external geopolitical influence. If major phosphorus-producing countries in North Africa experience political pressure, economic sanctions, or forced export restrictions, e.g., due to geopolitical conflicts, economic instability, or strategic interventions, this could as well lead to a decline or halt in phosphorus exports to Europe. Even without direct physical disasters or conflicts, such influences could destabilize supply chains and create shortages in the EU.

A collateral impact due to regulations is more hypothetical but could occur if multiple phosphorus-producing countries that supply the EU were to immediately and unilaterally halt phosphorus exports based on newly implemented national regulations that take effect without delay. In such a case, the EU would no longer be able to source phosphorus from these countries. However, such abrupt regulatory restrictions are considered unlikely, as the economic interdependencies between these supplier countries and the EU are strong.

Operational Resilience of the Entity

In the event that phosphorus supply is restricted, disrupted, or entirely interrupted, countermeasures at the EU level would likely be implemented, impacting the entire European market. In the case of a supply shortage, efforts would likely focus on identifying and securing alternative sources as quickly as possible. Additionally, it may also be considered to transition agricultural fertilization (where feasible) from mineral phosphorus fertilizers to organic alternatives in order to mitigate the impact of the shortage.

For example, the EU is actively engaged in phosphorus recovery from organic sources such as sewage sludge, with projects like RecoPhos developing thermo-chemical processes to extract phosphorus from sewage sludge ash, thereby closing the phosphorus cycle (CORDIS, 2015). Additionally, the ASH DEC process utilizes thermal treatment with calcium chloride additives to produce a phosphorus-rich fertilizer with reduced heavy metal content, contributing to sustainable phosphorus management (Jama-Rodzeńska et al., 2021).

Systemic Relevance of the Entity

Similarly to the directives and law on EU and national level on the criticality of organizations, there are also EU directives on the criticality of goods. As mentioned above, the EU's heavy reliance on imported phosphate rock makes it vulnerable to external supply shocks. For instance, geopolitical tensions or trade restrictions in key exporting countries can lead to sudden shortages and price volatility, underscoring the need for the EU to enhance its phosphorus resilience (Baker et al., 2024). Moreover, the uneven global distribution of phosphate rock reserves exacerbates this vulnerability. Approximately 85% of these reserves are concentrated in just a few countries, including Morocco, China, Egypt, Syria and Algeria (Brownlie et al., 2023).

In 2019, approximately 2.7 million tons of phosphate fertilizers were applied across the EU's agricultural sector (Statista, 2019). Phosphorus-based fertilizers play a crucial role in agriculture, including in Austrian farming, although to a lesser extent compared to other EU countries. Additionally, phosphorus is vital for the processing industry, which manufactures mineral fertilizers from phosphate rock. Phosphorus is an essential nutrient in livestock nutrition, crucial for skeletal development, energy metabolism, and overall growth. Due to the limited bioavailability of phosphorus in plant-based feeds, supplementation with inorganic feed phosphates is necessary to prevent deficiencies and ensure optimal animal health and productivity (Li et al., 2016).

Societal Role of the Entity

A disruption in phosphorus imports within the EU would have profound consequences for the agricultural and food supply sectors. Given that the fertilizer industry is highly dependent on external phosphorus sources, a restriction would lead to a decline in fertilizer production, resulting in supply shortages and increased costs for agricultural producers.

Since phosphorus is an essential nutrient for plant growth, a deficiency would significantly reduce crop yields, thereby constraining food supply chains. The subsequent rise in production costs for farmers would translate into higher consumer food prices (Pawłowski & Sołtysiak, 2024).

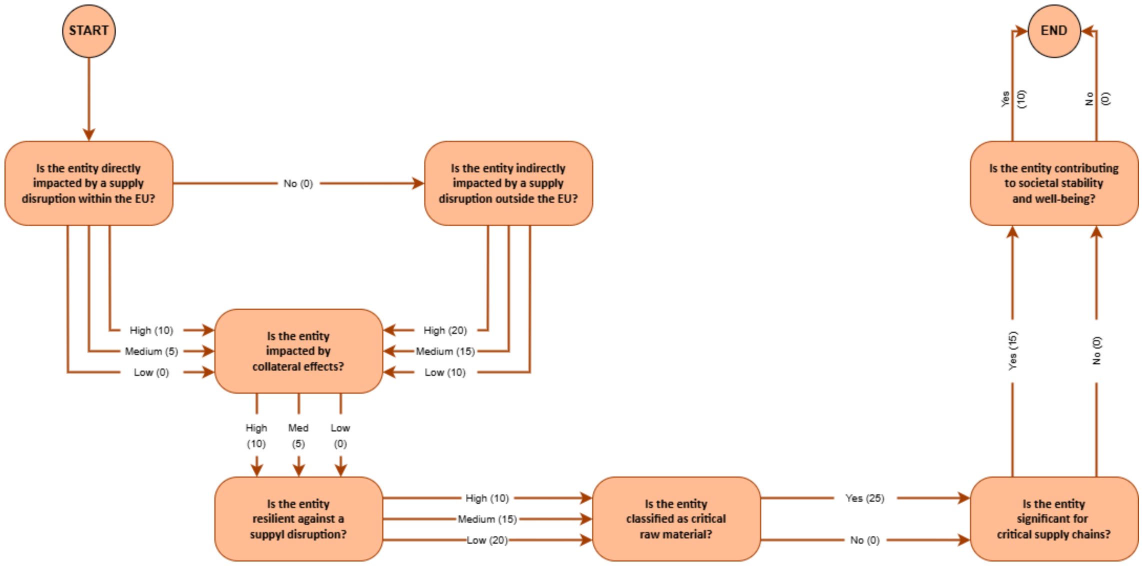

Figure 3: Adaption of the identification process for the phosphorus use case. Note that the block regarding the size of organization has been omitted since this question would not be relevant for a critical material.

CONCLUSION

The fundamental problem with preparing for possible events that could have a significant impact on CIs is their unpredictability. This concerns not only the nature of the event itself (e.g. pandemics, economic shortages, etc.), but also – depending on the nature and circumstances that led to the event – the internal differentiation of the individual CIs, their individual interdependencies and the cascading effects in response to the individual event. Another decisive factor in the situation is the assessment of resilience, i.e. the ability of an entity and their core elements, business units, processes and components to withstand the impact. This unpredictability translates into a specific degree of uncertainty in which entities might be most affected and which mitigation measures would be the best fit, i.e., which entities are the most "critical" during a certain event and require the most protection.

In this paper, we presented an identification scheme and decision framework that can be used to determine the extent to which entities are affected (their "criticality"). We suggested the following four main criteria to be analyzed in a structured manner and evaluated according to a scoring system:

1. What is the concrete impact of the disaster on the CI - direct, indirect, collateral?
2. How much operational output is still possible for the CI - extent of reduction?
3. What is the systemic relevance of the CI - criticality for systemic structures?
4. What is the social role of CI - criticality for the population?

Following a set of structured questions, we presented a simplified process to determine a criticality score, which allows to identify the most critical entities according to a specific scenario. Applying two exemplary use cases, we were able to show that this structured approach with specific questions and an underlying scoring metric can be used very flexibly for entire organizations, parts thereof or even for specific resources and material.

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