Approaching the criticality of information for emergency response and control center operations

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ABSTRACT

Successful emergency response and control center operations rely on a great number of information sources. The importance of said information becomes immediately obvious if it is not available when required during an emergency situation. This can be described as the criticality of information, signifying a potential need for action to prepare for functional failures. The concept described in this paper approaches the criticality via an analysis that examines various combinations of information sources and situations in order to identify weaknesses and improve existing procedures. The proposed semi-quantitative assessment was developed taking several attributes and characteristics of criticality into account and afterwards conducted in close cooperation with emergency response institutions.

Keywords

Criticality analysis, information management, emergency services and procedures

INTRODUCTION

During a violent storm in the late summer, heavy rain and gale-force winds struck the city of Calau in Eastern Germany. Every available fire brigade in the area was activated to respond to a multitude of emergency calls. The local department in Calau deployed a temporary control center in order to deal with all the problems at hand and coordinate mission orders as well as the involved units. Between closing a big access road due to a broken down power line, shutting down train traffic because of a number of trees on the tracks as well as several other locations that had to be cleared of trees, fallen power lines and other debris operations continued until the early morning hours (Volunteer Fire Brigade City of Calau 2013). While firefighters were eventually able to deal with the overwhelming events of that night, the difficulty of receiving, processing and distributing or utilizing all available and necessary information was made apparent. Handling emergency situations of such high and luckily irregular magnitude poses a problem for emergency control centers, dispatchers and first responders alike. With a multitude of incidents likely occurring at the same time, the actors involved are faced with numerous problems including information overload and availability. Modern technology can offer at least partial solutions to these problems, for example through the use of decision support systems and automated data processing. In order to accomplish that however, relevant information and processes have to be identified pertaining to different types of missions or events.

Here, “criticality of information” attempts to distinguish between different corresponding aspects for the purpose of improving workflow. Commonly used terms related to this concept such as “vulnerability” or “risk” will be assessed to define the criticality of information sources that are required for certain emergency response procedures and to develop a comprehensive and coherent approach that can aid with fire brigade and control center operations by further examining the corresponding findings as well as putting them in context with existing procedures (or lack thereof) that can be encountered during everyday events.

This paper attempts to create a baseline for such an approach. Working closely with various emergency response institutions, a concept was implemented that enables users to identify the significant processes at hand and take action accordingly, e.g. by improving specific communication chains or determine a given system's weak points. Therefore, the following section analyzes related work and defines the terms that are needed to approach the criticality of information in the third section, where a process will be outlined that allows for further analysis through use of a scorecard. Afterwards, this concept will be discussed together with the first results and feedback received by the aforementioned institutions. The final section will then draw conclusions from this first approach and provide an outlook comprised of possible changes.

RELATED WORK AND TERMS

Critical infrastructures have long been the subject of diverse research. They are often subdivided into network or basic critical infrastructures (such as power supply) and socio-economic service critical infrastructures such as emergency and rescue services or disaster protection (Federal Ministry of the Interior of Germany 2009). The latter are the focus of this work. The examination of these complex systems, especially from a socio-technical point of view, has for a long time focused on the concepts of preparedness and prevention as well as vulnerability and resilience. However, criticality has established itself as a term in the context of risk research and is gaining increasing influence (Bijker et al. 2014; De Bruijne and Van Eeten 2007; Hémond and Robert 2012; Theoharidou et al. 2009).

According to the Federal Office of Civil Protection and Disaster Assistance in Germany (2017) criticality is defined as a relative measure of the importance of an infrastructure in relation to the consequences of a disruption or malfunction for society's security of supply with essential goods and services. The concept is commonly described through special characteristics or properties that vary between different authors and scenarios or specific critical infrastructures in the case of infrastructure research. Theoharidou et al. (2009) outline three characteristics of criticality to analyze the impact of a disruptive event on different sectors: Firstly, the "scope or spatial distribution", secondly the "severity or intensity or magnitude" and thirdly the "effects of time or temporal distribution" (Theoharidou et al. 2009 p. 36). By comparing criticality and risk analysis for critical infrastructures they identified that risk analysis is rather organization-centric with regard to aim and impact type and the scope focusses on internal assets and systems. Criticality analysis on the other hand is rather society-centric and its scope does not only include internal assets but also interdependencies.

In comparison to the characteristics presented by Theoharidou et al., Katina and Hester (2013) also identify four generalized criticality factors in regard to critical infrastructures. They build their argumentation strongly on the fact that resources like funding, human workforce or available technologies among others are limited and a criticality assessment is needed in order to prioritize infrastructures and efforts. The criticality factors are based on a synthesis of factors from literature to create a generalized baseline for all infrastructures. They distinguish between the 'level of resiliency' with respect to the defensive properties of a system, the 'level of interdependency' where they refer to the connectedness of a system or its external relations, the 'level of dependency' posing the question of how much people's daily activities relate to a system and the more traditional 'level of infrastructure risk' which includes threats, vulnerabilities and their likelihood.

A different characterization was made by Fekete (2011). He argues that the criticality, in his context of infrastructural services, is most present in cases of failure and consequent loss of services or resources. He continues to point out that from an etymological perspective criticality relates to the concept of crisis and implies a "turning point or an impending change" (Fekete 2011 p. 16). In relation to time the criticality of an infrastructure system is constructed by reflecting on the 'normal' and the 'crisis' mode of operation. For a better criticality assessment Fekete introduces three general criticality properties based on the use of criticality in nuclear science: critical proportion, critical time and critical quality. In doing so, the proportion expresses aspects of extent, such as spatial range and scope or number of elements and services. Additionally, the number of redundancies is a crucial point in this context. Critical time is described by the author via duration and the mean times to repair, recovery and functionality but also the robustness or resilience of a system. Lastly, critical quality can be exemplified by quality of services or loss of trust.

As part of the described methodology to filter and prioritize critical assets of large organizations such as the US Army, Anderson et al. (2008) connect vulnerability and criticality. They introduce four properties of vulnerability that have an implied notion of criticality: redundancy, robustness, resilience and security. The filtering and prioritization approach presented by the authors contains seven steps ranging from scenario identification to a multi-criteria risk, criticality and vulnerability evaluation and finally operational feedback. To balance their multiple perspectives for measurements and management they use a scorecard model with a normalized score so that every characteristic of a system is equally accounted for.

As illustrated before, the characteristics of criticality contain aspects of risk and vulnerability and may connect these two concepts by adding a public interest or social pressure (especially regarding the function of a system) to the assessment. As Theoharidou et al. (2009) state, criticality can be used as a synonym for 'risk' and 'vitality'. The attributes of criticality impart a sense of urgency on the general association with "importance" that can be found within the analysis of risks and vulnerabilities of a system. Its notation thus expresses a relevance of a system or a system component and might entail an obligation to act. Based on that understanding, the criticality of information that can be found in the context of emergency and rescue services as well as disaster control and management describes the importance or relevance of an information source for a situation and the potential need for action to prepare for functional failures. As a consequence, information and its availability or lack thereof can have a direct impact on the security of society since the function of a given critical socio-economic service infrastructure may no longer be (fully) guaranteed.

APPROACHING CRITICALITY OF INFORMATION

While the last section gave an overview of the attributes of criticality and introduced the criticality of information as a relative measure in the context of emergency and rescue services, this section will introduce an approach for the assessment concerning the criticality of information. Due to the similarities to risk and vulnerability the assessment of the criticality of information is similar to the analysis of the aforementioned. First of all, the system and its boundaries need to be defined in order to create a frame of reference. Since the criticality of a system or its components can only be determined in relation to another system, a function or an attribute of a system, the criticality of information in the context of this work refers to the criticality of an information source in relation to emergency situations or processes it is associated with. The identification of all relevant processes or emergency situations as well as the information sources has to be made by the end-user. They define the depth of the analysis and filter emergency situations as well as information sources based on scope. Examples of emergency situations among others may include mass casualty incidents, ambulance transports or fire-fighting operations. Optionally, the identified processes can be grouped (e.g. according to organizations such as rescue service and fire brigade or alternatively according to frequency). Examples of information sources range from basic information, e.g. alarm data or regulations and laws, to emergency call support systems and more extensive data such as weather forecasts, information from social networks or operators of critical infrastructures. It is also interesting to receive input from commanding officers or other emergency personnel, as long as a clear flow of information can be established. To visualize the relations between information and the emergency situations and later on display the criticality of information, a situation-information-matrix is created. These matrices are somewhat comparable to threat-system-matrices which are used for vulnerability analyses as presented by Baker (2005) or Anderson et al. (2008).

After the initial identification the criticality assessment can be carried out. By understanding the criticality of information, processes and sources can be identified that are particularly relevant to the function of the system or in this case critical service infrastructure. Based on the analysis short-, medium- or long-term strategies for strengthening and optimizing the individual system components can be made. The analysis can be divided into four steps: (1) identification of the process relevance; (2) criticality scoring; (3) considerations of usage and prioritization; (4) criticality evaluation. Figure 1 provides a graphical overview of the analysis. In order to obtain the most accurate estimate possible, each source of information must be considered for each emergency situation. To this end, all sources of information relating to a situation are first examined one after the other and then repeated for all other situations.

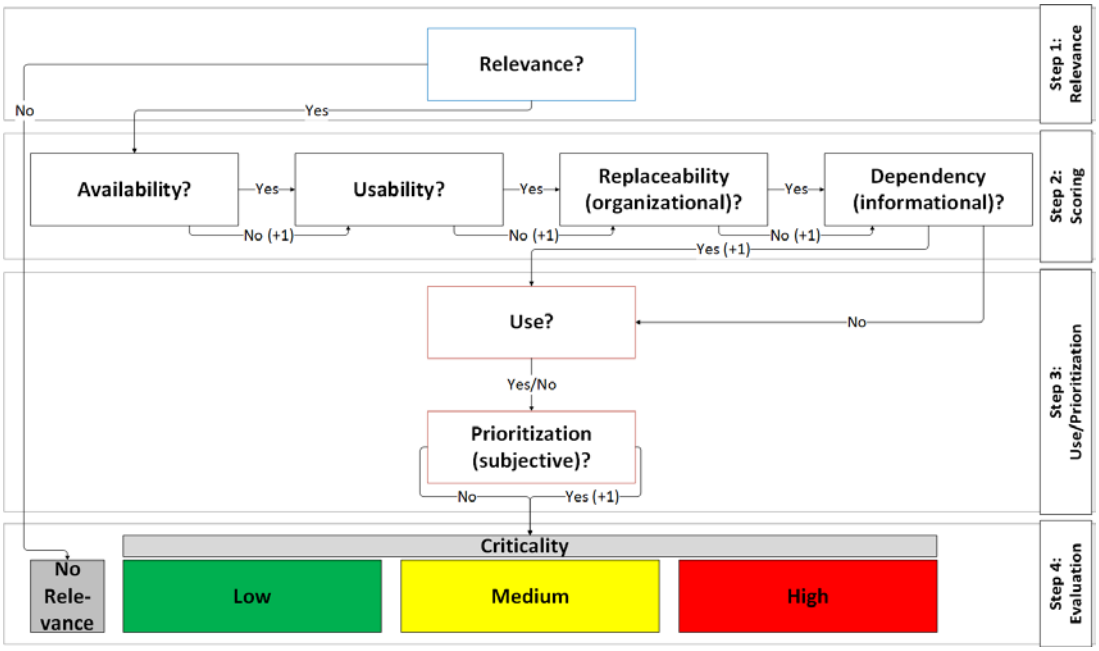


Figure 1. Overview of the criticality assessment

Step 1: Relevance

The first step of the analysis is concerned with the question of relevance. Before individual classification may begin, it has to be determined whether or not an information source is relevant to a certain process or mission type. At this point, the attributes or characteristics mentioned above may mostly be neglected as they become important at a later stage, for example definitions relating to vulnerability. The first step is much more basic and can be interpreted similar to the notion of "exposure" regarding the vulnerability assessment of critical infrastructure (Wienand and Hasch 2016) that examines whether or not a given system is actually exposed to a certain risk or danger. Propagating this idea to information processing or analysis results in the very first question one should ask before going into detail: Is the source of information even relevant to the process (s. Figure 2)? Only then could an information source or knowledge related to it yield additional benefit for the observed situation, making further analysis worthwhile. In case the source of information is beyond the effective system boundaries it may be dismissed entirely.

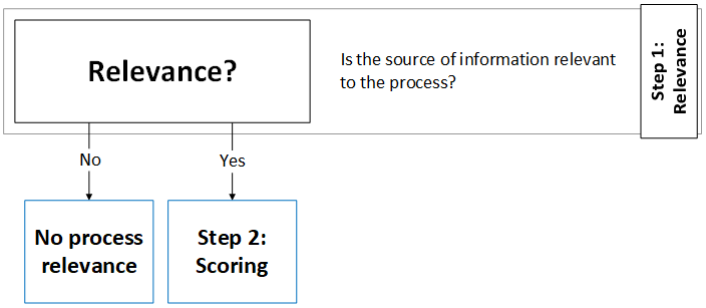


Figure 2. Detailed view of the first step (relevance)

Consider the following examples:

a) Does the information on available emergency capacities of the regional power network offer added value regarding regular ambulance transport situations? No, as a general rule of thumb this source of information will most likely not be relevant for the situation in question. As such, no further analysis is needed for this pairing of information source and situation, concluding the considerations right away.

b) Are the available emergency power capacities of interest for emergency procedures during heavy storms? Yes, as exemplified in the first section this information is required when dealing with power line disruptions as well managing the infrastructure that is still up and running, e.g. restoring power to hospitals and other important buildings or parts of a city first while making sure that backup power bridges gaps where needed. Such events may occur during a storm situation. Thus, the analysis is continued in step 2: Scoring.

Step 2: Scoring

In the second step of the analysis, the criticality is rationally assessed. For that purpose, different criteria are defined in order to assess the criticality of an information source for a given process. Based on the related work and terms outlined in the second section, availability, usability, (organizational) replaceability as well as (informational) dependency will be utilized for scoring. Each category will be further explained below, increasing the criticality score depending on the answer (s. Figure 3). As it can be very difficult to justify a certain ordering or emphasis, the approach of a scorecard was chosen to determine the criticality via the four criteria. Here, all parts of a scoring step or algorithm are viewed as equally important (Kaplan and Norton 2007) and thus can equally increase the criticality score. This is done when it is otherwise not possible to answer questions regarding the hierarchical structuring: Is having an old and possibly outdated version of an information source better or worse than having none at all? How would this rank in comparison to eligible substitutions where one might have to accept certain restrictions? From a researcher's standpoint this is especially difficult when dealing with terms and concepts that are at times open to interpretation or personal opinion as will be explained in step 3. This results in the scorecard approach presenting itself as an apt procedure to consolidate the relevant criteria. In regards to criticality, the idea of utilizing a scorecard as described by Kaplan and Norton has for example been applied in relation to the criticality analysis of the US Army in Anderson et al. (2008). While the ordering of the criteria mentioned above is not of significance, it is very important that all four are always checked during this step in order to obtain a criticality score. Using the attributes and characteristics identified in the previous section the line of reasoning with regard to terms like quality, redundancy and similar can be put to use concerning the criticality of information (sources). There is however no single correct way to accomplish this step as a lot of the terms are used interchangeably, for example in Katina and Hester (2013 p. 221) where the level of dependency is measured via usability and categorized through the associated scope while other authors use the same terminology to describe different concepts. Additionally, most if not all of those concepts intersect in multiple ways. This shows that finding a cohesive unified approach is rather complicated. However, applying the aforementioned attributes and characteristics to the criticality of information might still help to understand those ideas and make drawing conclusions easier. The criteria of the scoring procedure were defined via potential associations and are explained in the following paragraph.

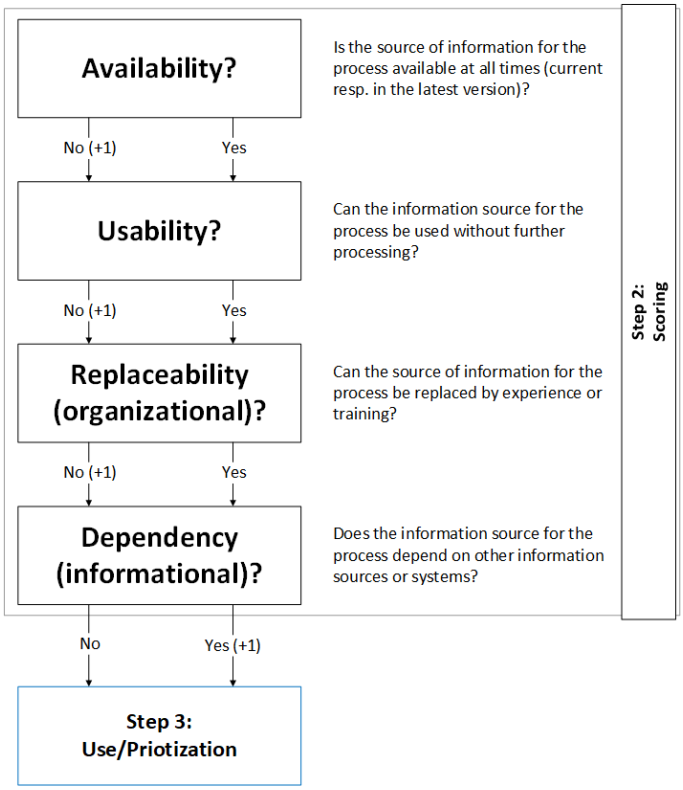


Figure 3. Detailed view of the second step (scoring)

Availability

The notion of availability is often mentioned when critical infrastructures are assessed, for example in Fekete (2011) who describes the critical time availability together with resiliency, i.e. a system's ability to resist a

disruption or recover afterwards. It is also related to the concept of redundancy (Anderson et al. 2008) since having adequate backups available for when a source of information cannot be accessed due to unforeseen circumstances. Availability thus retains the meaning it is regularly associated with and in regards to criticality of information simply poses the question of whether or not an information is available for the situation in question at all times. This is further exemplified with the following scenarios:

a) Information on the current temperature and climate conditions for the location of a rescue operation can always be attained, e.g. through the German Weather Service. As such, the score is not increased before moving on to *Usability*.

b) The information on the designated use of man power and other resources for disaster management exercises, e.g. a mass casualty incident, is always available in the currently valid version of the action plan as a PDF file or printed out documents. Unless this information is lost, the score is not increased.

c) The information on the available emergency power capacities for a storm situation cannot be retrieved at any time in most cases but must be provided by the network operator. Using an external source also increases the chance of receiving incorrect, incomplete or outdated information. Since the availability cannot be ensured, the criticality score is increased by 1 before continuing to *Usability*.

Usability

The scope of the term usability is very broad. Due to that it is difficult to associate it with a specific attribute. In regard to critical infrastructures, Fekete (2011) puts the factor of critical quality into context, determining under what circumstances and how an infrastructure deals with a situation. For the criticality of information this leads to the interpretation of whether or not the source can be used without further processing or if the quality is insufficient, thus having to adjust the information to the situation at hand. Continuing the first two examples from before, this could result in the following scenarios:

a) The German Weather Service provides information on the current temperature for the location of a rescue operation in an easily interpretable number format. It can be made available, e.g. to a dispatcher, by practically every software system in control center operations. It is thus not deemed critical and *Replaceability* can be evaluated without increasing the score beforehand.

b) The information on the tasks of the administrative staff for a mass casualty incident is described in the civil protection concept (several pages of full text). This text document is classified as an unstructured piece of information and requires further action such as filtering depending on situational specifics for efficient use. Therefore, the information source has to be processed and the criticality score is increased by 1 before continuing.

Replaceability (organizational)

The connotation of replaceability, both in the technical and organizational sense, is mentioned in association with critical infrastructures in several ways, for example in a risk analysis on systems based vulnerability carried out on behalf of the Federal Office of Civil Protection and Disaster Assistance (Wienand and Hasch 2016). Applied to the concept of criticality of information it is considered if a source of information could be entirely replaced by experience or training of the employees for the situation in question. This is exemplified as follows:

a) The instruction manual on the advised steps to perform cardiopulmonary resuscitation (CPR) from the emergency call support system can be replaced by knowledge gained through regular first aid courses. The score is not increased.

b) The information about a building's wall or insulation materials often depends on various factors such as year of construction, regional differences and whether or not it was actually built according to plan. In the event of a fire personal knowledge is too unreliable and thus dismissed. The criticality score is increased by 1.

Dependency (informational)

Katina and Hester (2013) explain (inter-)dependencies in the context of infrastructures where for example a system's connectedness is measured in order to assess the criticality. With regard to information it should therefore be evaluated whether a source for the situation at hand depends on other sources of information or systems and if it can be obtained directly. Consider the following scenarios:

a) Information on the current temperature for the location of a rescue operation can be retrieved directly from the German Weather service as described above, there are no dependencies and the score is not increased.

b) The information on the individual steps for performing CPR is stored in a given emergency call support system,

e. g. NOAS, and can only be called up via this system which in turn might depend on other aspects. Thus, the criticality score is increased by 1 and the analysis is continued in step 3.

Step 3: Use/Prioritization

In the third step, the actual use of an information source for a given situation is considered. This takes into account the subjective perception of its importance by prioritizing various aspects. Through records of usage it is possible to distinguish between new sources of information and existing ones that are already in use. Since the former were not included in the processes up until this point it can be assumed that the criticality assessment is more influenced by subjective perception rather than practical experience. For instance, if a person or an institution only recently integrated a dataset into their processes the assertions made by them is likely to differ from those that have been using the data for a long time. Even if the drawn conclusions are similar, the adequacy has to be carefully evaluated depending on whether or not they stem from a gut feeling or longtime experience. However, this step can still yield useful results when the relevant aspects are taken into consideration and rated accordingly. This includes the optional prioritization that follows the usage (s. Figure 4), increasing the criticality score when the information source is deemed particularly important, no matter if old or new. This way, information that is personally perceived as essential is assigned a higher criticality. In an effort to maintain continuity and user-friendliness, prioritization is also carried out with a simple Yes/No response scheme and a potential increase of the criticality score by 1. Handling prioritization in such a way is sufficient for the vast majority of cases. However, there may be situations for which a specific source of information is subjectively irreplaceable, so the score increase would have to be adjusted. For these individual instances, an appropriate prioritization score could be defined in consultation with the end user on a case-by-case basis.

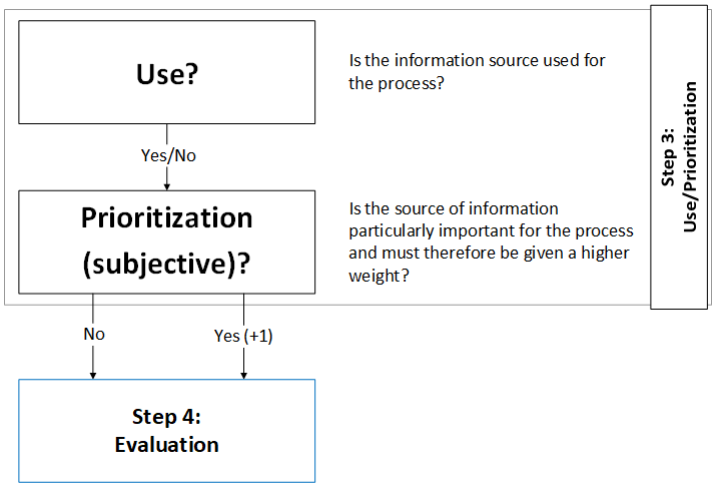


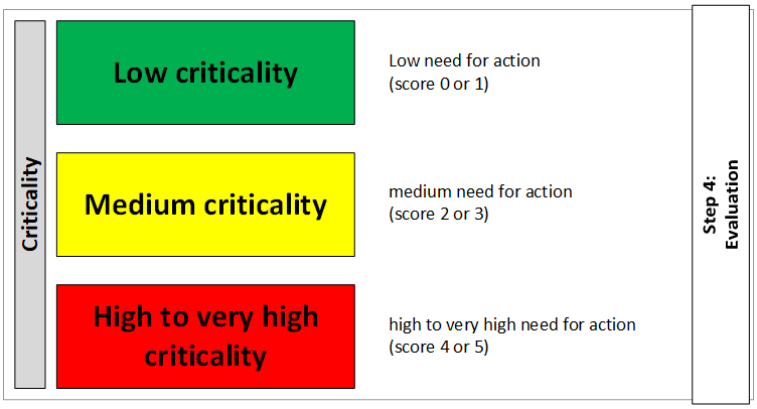
Figure 4. Detailed view of the third step (use/prioritization)

An apt example for this is described as follows:

The data generated by social networks is a source that few have utilized so far, at least for the purposes discussed in this paper. Therefore, the scoring is likely to be influenced by ones like or dislike for those platforms as well as personal social media usage. Those proficient in dealing with social networks will likely exhibit a different attitude towards the newly established information sources than those that have little to no experience at all. Additionally, some might only associate the term “social media” with specific platforms like *Twitter*, *Facebook* or *Instagram* while others might evaluate social networks altogether. This could lead to results that are potentially skewed due to misunderstanding or over- or underrating certain implications when having to assess lesser known processes and information sources.

Step 4: Evaluation

During the fourth and final step of the criticality analysis the evaluation and visualization takes place. A distinction is made between the mostly objective part (results from step 2) and the extended part of the evaluation which is subjectively prioritized. Afterwards, the results are categorized visualized by means of a comparison of inputs and information as shown in Figure 5. The developed matrix can also be expanded upon by optional additions, e. g. frequency of use or data type of an information source. In addition to that, certain groupings or conditions can be employed that allow for further refinement of the results.



(a)

Information	Emergency Situation: Situation 1	Situation 2	Situation 3	Situation 4	Situation 5
Information 1	1	1	1	0	1
Information 2		3		2	1
Information 3		4		3	2
Information 4	2	1	2	1	2
Information 5	0	1	1	1	0

(b)

Figure 5. (a) Detailed view of the fourth step (evaluation) and (b) exemplary matrix

German fire brigades use a specific database that holds all relevant information regarding hazardous materials. While it is a very important source of information in itself, it is not necessarily critical for all considered processes. This can be exemplified through the following scenarios:

a) When called to the scene of a disaster such as a shipwreck, the database will only be relevant if the vessel was carrying hazardous goods. As such, the information could be relevant to the process, but since it is available, usable and independent the criticality remains low. Due to only needing this specific information source in some cases it is not prioritized, however, the database is irreplaceable, leading to a total score of 1. As long as the circumstances remain unchanged, no further action has to be taken.

b) Changing the situation to an emergency relating to hazardous materials such as spillage of a dangerous chemical also leads to a different outcome of the criticality analysis. Since the database will likely always be consulted in a case like this, prioritizing it leads to an increased score and medium criticality. This does not necessarily imply the need for further action but rather signifies an important source of information for the given conditions. The associated aspects such as availability should always be watched with due process.

c) This can be demonstrated by further altering the scenario. If the database is not available, for example due to an error with the server it is stored on, and can thus not be used for its intended purpose the score changes result in high criticality. During an evaluation, this would indicate the need for immediate rectification like making sure the server is restored to normal operation or having a backup solution available.

The example described above is based on first feedback received from fire brigades. At first glance, few situations were identified as highly critical which is plausible when taking into account that available information sources for a given mission, i.e. the obvious answers, are considered first and foremost. The following section focuses on putting these preliminary results into context and discussing them further.

FIRST RESULTS AND DISCUSSION

The approach presented here was handed out to a number of professional fire brigades in Germany including a short definition of the terms and concepts of ‘criticality’ and ‘criticality of information’ based on the scientific discussion. Also, some examples for potential emergency situations and sources of information were mentioned in order to put the concept in a more feasible context. Although the responses have not all arrived, important conclusions can already be drawn from initial oral and written feedback. First of all, the notion of criticality: even though first responders were not familiar with the concept itself and the notion was, if at all, only known from terms like ‘critical infrastructure’ or ‘critical component’, the general feedback for using criticality or criticality of information as well as the chosen characteristics in the context of emergency services was very positive. It was stated that the approach supports the creation of priorities for example by visualizing the relation between information sources and situations. By defining corresponding criticalities, it is furthermore acknowledged that some system components or some information are simply not replaceable. This can be shown via the emergency call data: If no one makes an emergency call and thus there is no call information for the dispatcher, no intervention will be initiated and no resources are deployed. In order to establish an even greater account of such systems and information, some practitioners have suggested adding further classification of importance to the approach that supplements prioritization.

It appears there are differences between fire brigades regarding the depth of the analysis conducted. Where information sources and emergency situations were chosen rather general, fewer combinations had a high or very

high criticality score. In these cases, it was emphasized further that a lot of the success of emergency response was due to education and training of emergency personnel. The information that is needed in that case is rather specific such as knowledge about chemical reactions. Here, the presented approach may also be used for educational purposes or in combination with trainings to sensitize the people. When the analysis was carried out in a very in-depth manner, including all technical systems and information flow in order to identify specific possibilities to improve the systems at hand, the criticality score was more diverse. Here, the approach was utilized to improve technical systems and help identifying so far unknown relations between different processes or sources of information.

Summing up, the analysis of the criticality of information helps evaluating information sources and their dependencies. Questions like 'What is the most critical information or situation?' can now be answered. By further analyzing relevant information and processes with regard to e.g. the information type or the frequency of the process, strategies for an improved information management can be devised. The consideration of potentially new and/or prioritized information sources also appears to be of great feasibility. One could also contemplate the need for effective provision of said critical information in the given context and whether it is critical because it needs to be handled with urgency, because it affects the area of functional failures mentioned above or a combination of these factors. Additionally, by engaging multiple end-users in the discussion on what information sources are of personal importance or might help dealing with a situation, alternative ways for future emergency response operations can be created while incorporating new technologies and information sources. Even though the approach was designed focusing on fire brigades and control center operations and so far was evaluated by different fire brigades only, it is applicable to other emergency and rescue services or disaster relief organizations. This could also include disaster management teams and operations in networked critical infrastructures such as power supply or communication lines. Here, analyzing the criticality of information can help in comparing and understanding difficulties of different organizations and hierarchies.

CONCLUSION AND OUTLOOK

By transposing the characteristics and attributes mostly used in the context of critical infrastructure research, this paper introduced the notion of criticality of information for emergency and rescue services as well as disaster control and management. It further presented an approach for assessing the aforementioned in relation to specific emergency situations. The concept with its four-step criticality analysis procedure was conducted in coordination with a number of German fire brigades. First results and preliminary process evaluation already showed the usefulness of the approach and the applicability of the selected attributes and characteristics. In order to ensure smooth existing practices as well as identify constellations regarding certain situations and their relevant information that are being dealt with either insufficiently or incorrectly, the concept also accounts for proper interpretation and emphasis, for example through visualization for the semi-quantitative analysis via a scorecard. Furthermore, the outlined approach offers the potential to uncover new information sources and incorporate them for the purpose of rectifying current shortcomings and improve emergency response and control center operations.

While the preliminary feedback received from the fire brigades showed promising results, there were also some uncertainties regarding a few aspects of the concept. As such, once the full results of the analysis are obtained all answers will be evaluated further in order to achieve a more unified and representative survey. This will allow for proper quantitative analysis and empirical research. In order to support the partners in practice, an information concept based on the theoretical approach presented here is planned, which is to serve as the basis for a semi-automatic or fully automatic software tool and to support the acquisition, analysis and visualization of the data. Results of the analysis could then for example be reviewed for similar pairings of information sources and situations found throughout different scorecards or grouped by region as well as characteristics such as organization size or type. The same could be done for various mission types for the purpose of identifying comparable approaches and gain added value for the institutions involved. Altering the approach this way would also enable the aforementioned incorporation of new information sources. Similarly, an in-depth view at properties like data type or spatial allocation might aid with overcoming problems by composing an improved overall system and giving recommendations for training. One example could be combining different results regarding related processes to identify corresponding information sources and create redundancies that will help with critical attributes such as availability. If this can be achieved the proposed approach for the criticality analysis of information sources can help prepare emergency response and control center institutions as a critical socio-economic service infrastructure for upcoming challenges and ensure appropriate functionality.

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