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# How is capability assessment related to risk assessment? Evaluating existing research and current application from a design science perspective

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**Abstract:** Several countries use capability assessments as a part of their efforts to manage risk. However, it is unclear how such assessments are connected to other risk management activities (e.g. risk assessment). Therefore, the aim of the present paper is to present a study of how capability assessment is related to risk assessment. Capability assessment methods were identified through a scoping study and the Swedish capability assessment method was investigated through interviews with Swedish public actors and analysis of legislative documents. The data was analysed using a design science perspective. The results of the analysis show that the purposes presented for some capability assessment methods are the same or similar to purposes common to risk assessment methods, and the actual form of some of the methods is similar to existing risk assessment methods. Nevertheless, the relationship between capability assessment and risk assessment is unclear. We conclude that if capability assessments are going to continue to be an important part of risk management activities more research is needed to better establish the relationship between risk assessment and capability assessment.

**Keywords:** capability assessment, risk assessment, method, design science, scoping study

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## 1. INTRODUCTION

Societies and the risks they face are becoming more complex [1,2] and with this increasing complexity the traditional risk management approaches change. This reflects in the introduction of concepts such as societal safety [3], resilience [4,5] and the establishment of national security strategies with a whole-of-government approach [6]. Also, in order to prepare for a large variety of threats and risks, instead of preparing for specific scenarios [7], capabilities-based planning gains more ground in several countries. For example, the Netherlands, Sweden, the United Kingdom and the USA have established methods for assessing capability as part of their emergency preparedness work. Thus, the interest for capabilities-based planning seems to increase and since several countries already have implemented the concept in policy and practice its importance in future efforts to manage risk remains.

Despite the increased interest for capabilities-based planning it is unclear how capability assessment is related to other risk management activities such as risk assessment and vulnerability assessment. Questions like whether risk assessment is part of capability assessment, or vice versa are important to answer both from a scientific as well as a practical perspective. Unless the relationships between capability assessment and other risk management activities are clarified there is a risk of conceptual as well as practical confusion. The present paper attempts to investigate these relationships. We argue

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that (1) the *concept* of capability and how it relates to other important concepts such as risk, vulnerability, and resilience, needs to be investigated. Moreover, (2) we need to study how *methods* for capability assessment relate to methods for risk assessment (and other risk management activities). The present paper deals specifically with this second issue and it is worth noting that the first issue is explored elsewhere [8]. Thus, the present paper aims at investigating how capability assessment is related to risk assessment.

To clarify the relationships between methods for capability assessment and risk assessment we first need to identify capability assessment methods and their use in practice. To do this we performed a scoping study [9,10] focusing on scientific publications in international journals and conference proceedings. To gain a deeper understanding of a method used in practice we chose Sweden as a study case. Swedish authorities have used both risk assessments and capability assessments for some time now, making Sweden a suitable case for the scope of this paper. Identifying methods for capability assessment in literature and practice can be used to produce an overview of the area. However, a theoretical framework is needed to guide the comparative analysis. To that end, we chose to use design science. We consider it suitable since capability assessment methods and risk assessment methods are artefacts designed to achieve some kind of purpose(s).

Design science differs from “traditional” sciences such as natural science and social science mainly because of their different goals, according to several authors from different scientific fields (see e.g. [11-13]). While design science aims at developing “...knowledge for the design and realization of artefacts, i.e. to solve *construction problems*, or to be used in the improvement of the performance of existing entities, i.e. to solve *improvement problems*” [14, p. 224], the sciences that van Aken calls explanatory sciences, including “...the natural sciences and major sections of the social sciences”, has the goal “...to describe, explain and possibly predict observable phenomena within its field” [14, p. 224], (see also [11,15]). In other words, the key difference between design science and many other sciences is that the former aims at contributing to changing the world whereas the latter aims at understanding it. You might study an artefact and try to understand it without knowing its purpose, but it is difficult to construct or improve one without a purpose and therefore the purpose(s) of artefacts is a key aspect of design science. Even though design science focuses on constructing and improving artefacts, one can also use other ideas from it to study how existing artefacts work and evaluate them. Recent research has, for example, successfully used ideas from design science to evaluate risk and vulnerability assessments and accident investigations [16-18].

Methods for capability assessment (and risk assessment) are artefacts, i.e. created by humans for some purpose(s). Therefore, we argue that a design science perspective is suitable to use in the present context. However, design science is not a homogenous research area but made up of several disciplines. For this study we have chosen an approach presented by Brehmer [19] who suggests using Rasmussen’s [20] abstraction hierarchy to describe, design and evaluate artefacts (in this case capability and risk assessment methods). The hierarchy in Brehmer’s version has three perspectives: Purpose, Function and Form. A description of an artefact from the respective perspective corresponds to answering the questions “*Why* does the artefact exist?” (Purpose), “*What* does the artefact do to fulfil its purpose?” (Function), “*How* does it do it?” (Form). A number of researchers [16,18] provide more detail on the use of the abstraction hierarchy in the present context. Thus, we have analysed a number of papers dealing with capability assessment methods to determine if they describe *why* the suggested method should be used in practice (Purpose), *what* it does to achieve the purpose(s) (Functions), and *how* it does it (Form). Using the same approach, we analysed the empirical data from Sweden. These analyses then formed the basis for a comparison with risk assessment methods using the same set of questions.

Following this introduction section, we first present both the approach and results from the scoping study, followed by the study of the Swedish capability assessment method. Finally, we discuss and present conclusions regarding capability assessment's relation to risk assessment.

## 2. SCOPING STUDY

In order to identify scientific papers presenting methods for capability assessment, we performed a scoping study [9,10]. Thus, below, we first present the method used in the scoping study. The section concludes with the findings which include the analysis of the identified papers using the abstraction hierarchy.

### 2.1. Method

We identified papers presenting capability assessment methods through searches in the databases Scopus and Web of knowledge. The term *capability assessment* and the related concepts *capacity assessment* and *ability assessment* via Boolean operators (see Table 1) were used to construct the search queries. In order to further identify relevant papers we manually hand searched reference lists and relevant journals<sup>†</sup>. Papers were included if they addressed capability assessment related to emergency, crisis, disaster, or catastrophe response management. Papers were not included if they focused on assessments of an individual's capability. Instead, the focus was on different kinds of organisations' capability. All searches and methods of data handling were recorded. Hence, the searches, performed between April and December 2013, resulted in the screening of 4544 unique titles. Papers that did not seem relevant based on the title were excluded, resulting in 62 possibly relevant papers based on the title. The references that were manually searched for, added another 11 possibly relevant papers based on the title. The abstracts of these 73 papers were read and 54 were still found relevant. We were not able to download the full-length version of 10<sup>‡</sup> of these, resulting in that 44 papers were read in full length.

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<sup>†</sup> Disaster management and response 2003-2007, Disaster prevention and management 1992-2013, Disasters 1977-2013, International journal of critical infrastructure 2004-2013, International journal of disaster risk reduction 2012-2013, International journal of disaster risk science 2010-2013, International journal of emergency management 2001-2013, Jamba 2006-2013, Journal of contingencies and crisis management 1993-2013, Journal of risk and uncertainty 1988-2013, Journal of risk research 1998-2013, Natural hazards 1988-2013, Reliability engineering and system safety 1988-2013, Risk analysis 1981-2013, Safety 1991-2013.

<sup>‡</sup> **J. Von Kanel, E. W. Cope, L. A. Deleris, N. Nayak, and R. G. Torok**, "Three key enablers to successful enterprise risk management," *IBM J. Res. Dev.*, vol. 54, no. 3, 2010.; **Unknown**, "Strengthening our emergency response systems," *Public Work.*, vol. 134, no. 6, 2003.; **J. H. Gu, X. Y. Wu, and H. Y. Wu**, "Capability assessment for earthquake emergency rescue based on the reported death toll rate," *J. Harbin Inst. Technol. (New Ser.)*, vol. 16, no. 2, pp. 145–149, 2009.; **S. Y. Wang and G. J. Tang**, "Research on evaluation of urban disaster emergency capability based on unascertained measure," *J. Harbin Inst. Technol. (New Ser.)*, vol. 16, no. 2, pp. 109–113, 2009.; **S. Y. Wang and J. Liu**, "Checking of city disaster emergency capacity evaluation," *J. Harbin Inst. Technol. (New Ser.)*, vol. 16, no. 2, pp. 119–123, 2009.; **S. J. Cannon, T. Kontuly, and H. J. Miller**, "GIS-based emergency response planning in a Mexico-US border community," *Appl. Geogr. Stud.*, vol. 23, no. 2, pp. 227–246, 1998.; **X. Jianguang and X. Ruhe**, "Research on model and method of emergency capability assessment," in *Proceedings of the 2nd International Conference on Modelling and Simulation, ICMS 2009*, 7, 2009, pp. 484–489.; **X. Sun**, "SEM-based Capability Assessment of Emergency Management Agency," in *Proceedings of ISCRAM China 2010: Fourth International Conference on Information Systems for Crisis Response and Management*, 2010, pp. 456–460.; **Z. Guo and M. Qi**, "Comprehensive Assessment Method of Urban emergency Response Capability based on FAHP," in *International Conference on Management Science and Engineering Location: Wuhan, Peoples R China, Oct 17-18, 2010*, 2010, pp. 273–276.; **S. Wang and Y. Sun**, "The Function of the Disaster Background on Urban Disaster Emergency Capability Assessment," in *International Disaster and Risk Conference (IDRC) Location: Chengdu, Peoples R China, Jul 13-15, 2009*, 2009, pp. 453–457.

**Table 1: Search strategies**

Search term	Database: Scopus	Database: Web of knowledge
Capability assessment	1. (ALL({capability assessment}) AND LANGUAGE(english))	1. Topic=("capability assessment") OR Title=("capability assessment")
	2. (ALL("capability assessment") AND LANGUAGE(english))	2. Topic=("capabilit* assessment") OR Title=("capabilit* assessment")
Capacity assessment	3. (ALL({capacity assessment}) AND LANGUAGE(english))	3. Topic=("capacity assessment") OR Title=("capacity assessment")
	4. (ALL("capacity assessment") AND LANGUAGE(english))	4. Topic=("capacit* assessment") OR Title=("capacit* assessment")
Ability assessment	5. (ALL({ability assessment}) AND LANGUAGE(english))	5. Topic=("ability assessment") OR Title=("ability assessment")
	6. (ALL("ability assessment") AND LANGUAGE(english))	6. Topic=("abilit* assessment") OR Title=("abilit* assessment")
Note: All searches in Web of knowledge were refined by: Languages=( ENGLISH ); Timespan=All years; Search language=Auto. The searches in Web of knowledge covered the years 1864-2013, in Scopus 1960-2013.		

## 2.2. Findings

The information found in the papers was coded related to general information and the three perspectives discussed earlier (Purpose, Functions and Form).

### 2.2.1. General information

The majority of the papers originate from China (N=33), followed by the United States (4), Sweden (3), Australia (2) and the Netherlands (1). Researchers from both Australia and Finland authored one (1) paper. 32 papers were found in conference proceedings, 9 were articles and 3 review papers in international scientific journals. The majority (N=14) was published in 2011, followed by 8 in 2010, 6 in 2012, 6 in 2009, 3 in 2013, 2 each year in 2005, 2006 and 2007, and 1 in 2008. The databases categorised the papers and the majority of the relevant papers were found in the category "decision sciences", followed by "business, management and accounting" and "engineering". 36 of the papers suggest methods for capability assessment. The remaining papers evaluate or compare methods for capability assessment, or evaluate the capability of an organisation after an incident.

The methods identified are intended to be used on various administrative levels in society, ranging from the emergency department of a city (e.g. [21,22]) and the city as a whole (e.g. [23-28]), to regions [29] and nations [30]. Other papers present methods to be used by companies (e.g. [31-34]) or for certain infrastructures such as subway systems [35] or power systems [36]. Thus, the contexts in which the proposed methods are intended to be used cover a broad spectrum.

### 2.2.2. Purpose

Studying an artefact based on its purpose means trying to answer the question “*Why* does the artefact exist?” A purpose of the capability assessment method is presented in 19 of the 36 papers. The most common purpose is to provide support to decision-makers in some way [26,28,37-39], which is also an important purpose of risk assessments, (see e.g. [40]). Other relatively frequent purposes of the identified capability assessment methods are to either increase capability or to identify weaknesses in capability [41-47]. Thus, in the cases [26,28,37-39] there seems to be a connection between capability assessment and risk assessment; they aim to provide support to decision-makers. However, a majority of the identified methods does not explicitly describe the purpose(s) of conducting capability assessments. Therefore, it is difficult to say if the conclusion is valid for only a small part of the capability assessment methods or for a majority of them. Moreover, possible connections to risk assessment are not discussed in the studied papers. Therefore, we cannot say if it was the intention of the designer to use a purpose similar to that of a risk assessment or if it was just a coincident.

An indirect way of getting insights about the purpose of a capability assessment method is to look for evaluations of it. If a method is evaluated it seems reasonable that it should be evaluated with respect

to its intended purpose. Therefore, even though the purpose might not be explicitly stated in a description of a capability assessment method it might be possible to use an evaluation of the method to derive the purpose. Testing the method and then analysing how it performed in the test is the most likely approach to use when evaluating a method. In 25 of the 36 studied papers a real or fictional case was used to demonstrate and test the method. However, the most common way to present the cases is to describe the result of the capability estimate, for example the authors might conclude that the capability in the case used is 23.4, but not provide any further comment or evaluation of the result. We have not found an evaluation of the suggested method in relation to the stated purpose, for example by reporting if the produced capability assessment improves the support for decision-makers, in any of the papers.

To summarise, 17 of the 36 papers do not present a purpose for the suggested method at all. In the remainder of the papers (19) common purposes are to provide support to decision makers, and to improve capability or identify weaknesses in it. Moreover, none of the papers provide an evaluation of the method in question to show that it actually fulfils the purpose in question.

### 2.2.3. Functions

Trying to identify the functions of a method involves asking the question “*What* does the method do to fulfil its purpose?” (see [18] for more details on analysing functions). For example, common functions of risk assessment methods are risk identification, risk analysis, and risk evaluation [40]. These functions help fulfil one common purpose of risk assessments and that is to provide support for decision-making as is discussed in the next few lines. In producing an assessment of risk one first needs to identify the risk, which means finding and describing it in terms of the events that might lead to something undesirable. Moreover, one also needs to analyse the risk, which means determining the level of the risk in some way. Finally, one needs to evaluate the risk, which means comparing the level of the risk to some criteria. All these help decision-makers determine if the risk is acceptable/tolerable or if actions to reduce the risk are necessary [40].

Thus, when analysing the methods for capability assessment found in the literature we looked for descriptions of what should be done in order to arrive at the end result to see if there are similarities to the functions found for risk assessment. However, none of the papers identified in the scoping study discuss what needs to be done for the purpose of the method to be fulfilled. Instead, one needs to investigate the form of the methods to derive the needed functions. For example, most of the methods for capability assessment found in the literature are so called index methods. This means that they specify various indicators that should be assessed. Each indicator is then weighed together with other indicators and the result is the overall capability index. Studying the structure of the capability index provides information of the aspects (the different indicators) that are necessary to assess in order to arrive at the final result. Thus, it provides information regarding *what* needs to be done to assess capability and therefore it can be seen as a representation of the functions that need to be fulfilled. However, the indicators used in the studied capability assessment methods (see examples of indicators under "Form" below) are very different from the key functions of risk assessment (identification, analysis, evaluation). Even some specific “products” of risk assessment (e.g. likelihood and consequence estimates) are lacking from the capability assessment methods (see the discussion below). Therefore, we conclude that capability assessment methods appear to be quite different from risk assessment methods when studying them from a function's perspective.

### 2.2.4. Form

Our analysis on the form perspective focuses on *how* capability assessment methods are constructed and *how* they produce the output of the functions. As noted above the output of every function performed by a capability assessment method, or a risk assessment method, might in practice be produced in many ways. For example, a method for risk assessment needs to identify risks in some way (a function) but *how* it does it varies much between different methods. One might, for example, use table-top exercises involving different stakeholders with relevant knowledge of the context of interest. The exercises might be of ad-hoc or “brainstorming” character or very systematic using fir

example guidewords to help identifying critical events for example such as the HAZOP procedure [40]. Thus, the form perspective deals with the concrete design of the method.

In total, we identified 36 papers suggesting capability assessment methods (see above). 5 of them suggest methods that are based on: analysing emergency response processes and their failures [39,46,48], using table-top exercises for assessing capability [47] or using a military planning framework to assess the capability to respond to a natural disaster [49]. The remaining 31 contain suggestions that can be classified as index methods. Such a method makes use of indicators of capability, and often assigns each indicator a numerical value and derives a final score that reflects the capability. Half of these 31 papers report that they improve previously established methods (e.g. by suggesting other indicators or another weighting system). Although there are risk assessment methods that are index methods, for example the Disaster Risk Index by UNDP [50], they seem less common<sup>§</sup>. Nevertheless, even though the capability assessment methods do not make use of common components in risk assessments (e.g. hazards, scenarios, vulnerability and consequences) they might still resemble the risk assessment methods if the indicators reflect such key components. For example, the Disaster Risk Index contains the indicators: hazard, population living in the exposed area, and vulnerability [50, p. 100]. If index methods for capability assessment contained such components we could conclude that some index methods for risk assessment resemble capability assessment methods seen from the form perspective. Examples of indicators in the identified capability assessment methods are resources, management and plan (see [33]). Such broad indicators are then usually broken down in more specific indicators like technological capabilities, staff quality, organisational structure and flexibility. Although the indicators are probably important for how a scenario develops and what the consequences will be, they are difficult to relate to concepts commonly used in risk assessment and therefore it is difficult to compare them to risk assessment methods.

#### 2.2.5. Conclusion

The empirical data from the scoping study provide limited opportunities to compare capability assessment methods with risk assessment methods. The primary reason for this is that the descriptions of the capability assessment methods are seldom detailed enough to allow for an in-depth comparison. However, we can conclude that the purposes presented for some of the capability assessment methods are the same or similar to purposes common to risk assessment methods. Moreover, we can conclude that the actual form of some of the methods resembles the form of some existing risk assessment methods such as the index methods. Nevertheless, from a functional perspective, when studying what the methods actually do, they appear to be very different. Moreover, the material found in the scoping study does not allow us to draw any conclusions regarding whether the capability assessment methods actually fulfil the stated purposes. In other words, we found no evaluations of the suggested methods.

### **3. THE SWEDISH METHOD FOR CAPABILITY ASSESSMENT**

Swedish legislation requires 290 local municipalities, 21 regional counties, and 23 governmental agencies to perform risk and vulnerability assessments as part of their emergency preparedness work [51-54]. According to the statutory instructions [53,54], the risk and vulnerability assessment must include a capability assessment and the actors shall assess capability according to an ordinal four-level scale: (1) Good capability, (2) Good capability in general, (3) Some, but inadequate, capability, and (4) No or very inadequate capability. To facilitate the assessment, the instructions provide indicators that the actors shall take into account (e.g. cooperation, information security, material resources, personnel resources, and practical experience). In addition, the Swedish Civil Contingencies Agency (MSB) performs a national capability assessment based on a request from the government through the

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<sup>§</sup> We have not investigated this in detail, i.e. we have not performed the same type of scoping study for risk assessment methods as we have for capability assessment methods. However, the ISO standard for risk management provides a summary of 31 tools for risk assessment and it is clear that a majority of them are built on other principles than an index method. For example, they use events, scenarios, causes, consequences and likelihood as building blocks rather than different contextual factors that are weighted together.

yearly letter of appropriation. In order to receive input to this assessment, MSB constructs scenarios, sends them to selected regional and national actors and asks them to perform a special capability assessment based on the indicators and assessment scale mentioned above.

### **3.1. Data collection**

Semi-structured interviews with representatives from 15 municipalities, 5 counties and 5 governmental agencies were conducted in a previous research project in 2011 [55]. The counties were selected to obtain a geographical spread: two in the southern part, two in the central part and one in the northern part of Sweden. Three municipalities were chosen in each county based on the size of the municipality: one small with less than 15,000 inhabitants, one medium with between 15,000 and 90,000 inhabitants and one large with more than 90,000 inhabitants. Five governmental agencies were chosen to represent five different areas of expertise. On the national level, MSB representatives responsible for performing the national capability assessment were interviewed in 2013. The interviews covered capability assessment, critical infrastructure and interdependencies. An interview guide consisting of some sixty questions (twenty related to capability assessment) was used to guide the interviews. In total, representatives from 26 actors were interviewed and 25 of the 26 interviews were recorded. Only the recorded interviews are included in this study: 15 municipalities, 4 counties, 5 governmental agencies, and MSB.

### **3.2. Method for analysis**

All the recorded interviews were transcribed into text and saved as Microsoft Word documents using intelligent verbatim transcription with the purpose to facilitate the analysis of the material. The transcribed interviews were searched in order to find sentences or text segments that could be classified according to the three perspectives Purpose, Function and Form. First, we searched the text using the Swedish word for capability. This also allowed us to find concepts such as "emergency management capability" and "capability assessment". We thereafter read the text in close proximity to the search results and marked the text segments that were related to capability. Following this stage, we coded the marked segments according to the perspectives. We finally skimmed the entire transcribed interview with the aim of finding text related to capability that had not been found through the search. This resulted in a document for each interview with highlighted text sections according to the three perspectives. A highlight meant that the text section was judged to contain information related to a perspective and one section could be categorised as several perspectives. Only text sections relevant to the different perspectives were coded, not the entire document.

In addition to the interviews we have studied the legislator's intention with the Swedish capability assessment method through legislation, guidelines, and reports. We did this using the same perspectives (Purpose, Function, Form) as when analysing the research papers and the interviews. Below we present the results from the study of the legislation, guidelines and reports, and the interviews.

### **3.3. Findings**

#### **3.3.1. Purpose**

The purpose answers the question "*Why* does the artefact exist?". From the legislator's perspective, the four purposes of the risk and vulnerability assessment, including the capability assessment, are to "provide a basis for decisions to decision makers and those in charge of operations; provide the public with an information basis of society's risks; provide basic data for community planning; and contribute to providing a risk profile for all of society" [56, p. 16]. Thus there seems to be a connection between capability assessment and risk assessment from the legislator's perspective especially since they have the exact same purpose.

The interviews did not explicitly address the practitioners' views of the purpose of capability assessments. Still, some related answers were given to for example the asked question if they have had any difficulties in assessing capability, and in their general descriptions of how they work with capability assessments. A couple of municipalities and a county administrative board wonder how they can use the result of the assessments in their own organisations and they find the process of



performing the assessment more useful than the final report. All respondents were also asked about their view on how risk assessment and capability assessment are related. The majority says that they are related but they have difficulties in explaining what the relationship is.

### 3.3.2. Functions

The functions answer the question “*What* does the method do to fulfil its purpose?”. The process for developing the Swedish method (indicators and assessment scale) is presented in a report [57] published by the Swedish Emergency Management Agency, later MSB. The report presents no functions explaining how the method helps fulfil some purpose. In the non-statutory guidelines for risk and vulnerability assessments [56], the legislator presents parts that could be included in the risk and vulnerability assessment (e.g. risk identification, risk analysis, probability and consequence assessment). These could be seen as functions of risk and vulnerability assessment, similar to the functions identify, analyse and evaluate [40]. However, according to the non-statutory guidelines capability assessment is also part (or a function) of the risk and vulnerability assessment.

The interviews did not reveal any conclusive information concerning the functions of capability assessment methods. One possible reason is that the respondents had difficulties expressing the purpose of the capability assessment method they employed. Therefore, it also became difficult for them to explain *what* the methods do to fulfil the purpose (functions). The interviews did therefore not contribute to our analysis of the connection between risk assessment and capability assessment when using the function perspective.

### 3.3.3. Form

When studying an artefact from the form perspective we are interested in *how* the actual method fulfils the functions and the purpose(s) and *how* the method is constructed. The legislator describes the Swedish method, consisting of a list of indicators and an assessment scale, in the statutory instructions [53-54]. Contrary to the index methods found in the scoping study discussed above, the Swedish method says nothing about how to translate the indicators into the assessment scale (e.g. through a weighting system). Even though the instructions present detailed information about indicators to use in the capability assessment, there are no statutory instructions on how to assess risk. However, in the non-statutory guidelines [56] several specific methods and tools for performing risk assessment are presented, for example seminar-based scenario methods, and traditional risk assessment methods. But in the descriptions of these risk assessment methods we find no similarity to the indicators and assessment scale used for assessing capability.

During the interviews, respondents from the local level expressed that the indicators and the assessment scale helped them in their work. But still the majority express that they find it difficult to assess capability and some say that they do not see how the indicators relate to capability and that they do not know how to interpret the indicators. Moreover, how the capability assessment relates to risk assessment also seems to be unclear, as mentioned above.

### 3.3.4. Conclusion

The empirical data from the study of the Swedish capability assessment method depicted that from the legislators' perspective the overarching purposes of both risk assessment and the capability assessment are the same. Moreover, they see the capability assessment as a function of the risk assessment (i.e. a capability assessment is needed to produce a risk assessment). On the form level, we only found differences between the stipulated capability assessment method and the suggested risk assessment methods. The respondents say that there is some connection between risk and capability but they have difficulties in explaining the connection. Apart from this, we cannot say more about how risk assessment relates to capability assessment based on the empirical data studied.

## **4. DISCUSSION**

This paper aims at investigating how capability assessment is related to risk assessment. However, we found that we cannot say much more about the relationship than that the purposes presented for some

of the capability assessment methods are the same or similar to purposes common for risk assessment methods, and that the actual form of some of the methods is similar to some existing risk assessment methods (i.e. index methods). One important reason for us not finding out more about the relationship is that possible connections between capability assessment and risk assessment are not discussed extensively in the identified papers. However, if the strategy of capabilities-based planning is to prepare for a large variety of threats and risks instead of a single risk [7] it seems reasonable to expect a clear relationship between the two, especially when the two assessments are used together, similar to the Swedish case where the capability assessment is part of the risk assessment. An explicit relationship would probably lead to less confusion, better use of resources when it comes to performing the assessments, and a clearer goal when designing the methods.

The scoping study was limited to only include scientific papers. Our study could have also included grey literature and comparisons between other countries' methods for risk assessment and capability assessment. However, we chose to limit our study to Sweden since the Swedish capability assessment method is part of the risk assessment method, and has been so for some years, and this could allow us to study the relationship in detail. But even in this particular case we did not find a clear relationship. Another limitation of the scoping study is that we did not perform similar searches in order to identify risk assessment methods for which we could identify purposes, functions and forms. This means that we only compared the identified capability assessment methods with the corresponding perspectives presented in the ISO standard [40]. However, since we had difficulties in finding information regarding the perspectives for the studied capability assessment methods, the results from such an extended comparison would most likely be similar to those presented here. Furthermore, the case study is limited to 25 Swedish public actors of some total 300. Despite the limited number of respondents, we covered different parts of Sweden when it came to geography, sectors and size of municipalities. It is worth noting that views other than the ones we reported regarding the Swedish capability assessment method are likely to exist.

## 5. CONCLUSION

We studied how capability assessment is related to risk assessment, using a design science approach to compare purposes, functions and forms of the two types of methods. The results show that in general it is unclear how capability assessment and risk assessment are related to each other. Nevertheless, we can conclude that the purposes presented for some of the capability assessment methods are the same or similar to purposes common to risk assessment methods. Moreover, the actual form of some of the capability assessment methods is similar to existing risk assessment methods (i.e. index methods). However, from a functional perspective (i.e. when studying what the different methods do or produce), they appear to be very different. The fact that it is difficult to establish a clear comparison, and that the available empirical data points in different directions depending on which perspective one assumes in the analysis we believe that the relationships between the methods for capability assessment and risk assessment deserve further attention, especially since capabilities-based planning gains more ground within the risk management work all over the world.

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## References

- [1] C. N. Calvano and P. John. “*Systems engineering in an age of complexity*”, Systems Engineering, 7(1), pp. 25–34, (2004).

- [2] OECD. *"Emerging Risks in the 21st Century: An agenda for action"*, Organisation for Economic Co-Operation and Development, OECD, 2003, Paris.
- [3] O. E. Olsen, B. I. Kruke, and J. Hovden. *"Societal Safety: Concept, Borders and Dilemmas"*, Journal of Contingencies and Crisis Management, 15(2), pp. 69–79, (2007).
- [4] A. Boin and A. McConnell. *"Preparing for Critical Infrastructure Breakdowns: The Limits of Crisis Management and the Need for Resilience"*, Journal of Contingencies and Crisis Management, 15(1), pp. 50–59, (2007).
- [5] S. Somers. *"Measuring Resilience Potential: An Adaptive Strategy for Organizational Crisis Planning"*, Journal of Contingencies and Crisis Management, 17(1), pp. 12–23, (2009).
- [6] S. L. Caudle and S. De Spiegeleire. *"A New Generation of National Security Strategies: Early Findings from the Netherlands and the United Kingdom"*, Journal of Homeland Security and Emergency Management, 7(1), article 35, (2010).
- [7] Programme National Security. *"National Security, Strategy and Work programme 2007-2008"*, Programme National Security, Ministry of the Interior and Kingdom Relations, 2007, Breda.
- [8] H. Palmqvist, H. Tehler, K. Eriksson, and T. Aven. *"Untitled work: Definition of capability"*, Manuscript in progress.
- [9] H. Arksey and L. O'Malley. *"Scoping studies: towards a methodological framework"*, International Journal of Social Research Methodology, 8(1), pp. 19–32, (2005).
- [10] K. Davis, N. Drey, and D. Gould. *"What are scoping studies? A review of the nursing literature"*, International Journal of Nursing Studies, 46(10), pp. 1386–400, (2009).
- [11] A. G. L. Romme. *"Making a Difference: Organization as Design"*, Organization Science, 14(5), pp. 558–573, (2003).
- [12] K. Peffers, T. Tuunanen, M. A. Rothenberger, and S. Chatterjee. *"A Design Science Research Methodology for Information Systems Research"*, Journal of Management Information Systems, 24(3), pp. 45–77, (2007).
- [13] I. Horva. *"A treatise on order in engineering design research"*, Research in Engineering Design, 15(3), pp. 155–181, (2004).
- [14] J. E. van Aken. *"Management Research Based on the Paradigm of the Design Sciences : The Quest for Field-Tested and Grounded Technological Rules"*, Journal of Management Studies, 41(2), pp. 219–246, (2004).
- [15] J. E. van Aken. *"Management Research as a Design Science: Articulating the Research Products of Mode 2 Knowledge Production in Management"*, British Journal of Management, 16(1), pp. 19–36, (2005).
- [16] M. Abrahamsson and H. Tehler. *"Evaluating risk and vulnerability assessments : a study of the regional level in Sweden"*, International Journal of Emergency Management, 9(1), pp. 76–92, (2013).
- [17] H. Tehler, B. Brehmer, and E. Jensen. *"Designing societal safety: A study of the Swedish crisis management system"*, 11th International Probabilistic Safety Assessment and Management Conference And The Annual European Safety and Reliability Conference 2012, PSAM 11 ESREL 2012 Volume: 5, 25-29 June 2012, pp. 4239-4248 (2012).
- [18] A. Cedergren and H. Tehler. *"Studying risk governance using a design perspective"*, submitted to Safety Science.
- [19] B. Brehmer. *"Understanding the Functions of C2 Is the Key to Progress"*, The International C2 Journal, 1(1), pp. 211–232, (2007).
- [20] J. Rasmussen. *"The role of hierarchical knowledge representation in decisionmaking and system management"*, IEEE Transactions on Systems, Man, & Cybernetics, 15(2), pp. 234–243, (1985).
- [21] X. Liu, Y. Ju, and A. Wang. *"A Dynamic Vague Multiple Attribute Decision-Making Method for Emergency Capability Assessment"*, Journal of Convergence Information Technology, 6(11), pp. 86–94, (2011).
- [22] Y. Ju, A. Wang, and X. Liu. *"Evaluating emergency response capacity by fuzzy AHP and 2-tuple fuzzy linguistic approach"*, Expert Systems with Applications, 39(8), pp. 6972–6981, (2012).

- [23] Y. Song, and J. Han. "*A Comprehensive Evaluation of City Emergency Management Capacity based on Analytic Hierarchy Process and Fuzzy Mathematics Method*", 2011 International Conference on Management and Service Science (MASS), 12-14 August 2011, (2011).
- [24] J. Liu, J. Y. Su, W. Wang, and D. H. Ma. "*Information Entropy Method for Evaluating Regional Earthquake Relative Disaster-Carrying Capability*", Applied Mechanics and Materials, 166–169, pp. 2070–2073, (2012).
- [25] G. Xiong and X. Yan. "*Research on the Synthetic Evaluation Indicators System of City Public Department Emergency Management Capability*", International Conference on Management Science & Engineering (ICMSE), 20-22 August 2007, pp. 2499–2504, (2007).
- [26] C. Juan. "*Disaster Emergency Capability Evaluation for Readiness of Urban Community - Based on Multi-level Fuzzy Comprehensive Evaluation Model*", 2011 2nd IEEE International Conference on Emergency Management and Management Sciences (ICEMMS), 8-10 August 2011, pp. 400–403, (2011).
- [27] L. Zhao, M. Tang, and M. Chen. "*The Fuzzy Synthetic Assessment on the City Disaster Emergency Capability Based on Fuzzy Pattern Recognition*", International Conference on Management and Service Science (MASS '09), 20-22 September 2009, pp. 1-4, (2009).
- [28] D. M. Simpson. "*Disaster preparedness measures: a test case development and application*", Disaster Prevention and Management, 17(5), pp. 645–661, (2008).
- [29] W. Cao, H. Xiao, and Q. Zhao. "*The comprehensive evaluation system for meteorological disasters emergency management capability based on the entropy-weighting TOPSIS method*", International Conference on Information Systems for Crisis Response and Management (ISCRAM), 25-27 November 2011, pp. 434–439, (2011).
- [30] Z. Jiang and L. Yu. "*Application of TOPSIS in Evaluating Public Crisis*", International Conference on Management Science & Engineering (ICMSE), 20-22 September 2012, pp. 1953–1957, (2012).
- [31] Y. Yi-lin and L. Guang-li. "*Study on evaluation of the city gas emergency response capability*", International Conference on Logistics Systems and Intelligent Management (Volume 3), 9-10 January 2010, pp. 1683–1686, (2010).
- [32] H. Shang, X. Wang, and X. Liu. "*Application of Fuzzy Assessment Method to Emergency Response Capability in Hazardous Materials Transportation*", Second International Conference on Innovative Computing, Information and Control (ICICIC '07), 5-7 September 2007, pp. 413–413, (2007).
- [33] X. Tan and Y. Ren. "*Comprehensive Evaluation of Enterprise Emergency Response Capability Based on Grey-AHP Method*", International Conference on Management and Service Science (MASS), 24-26 August 2010, pp. 1–4, (2010).
- [34] D. Lin, M. Kong, L. Zhou, and Y. Changsheng. "*Research on the evaluation of the enterprise emergency capability with the butterfly catastrophe theory*", 2011 2nd IEEE International Conference on Emergency Management and Management Sciences, 8-10 August 2011, pp. 29–32, (2011).
- [35] G. Yang and X. Xu. "*Assessment of emergency capacity to major public incidents on urban subway*", 2011 International Conference on Information Systems for Crisis Response and Management (ISCRAM), 25-27 November 2011, pp. 34–39, (2011).
- [36] M. Fan, S. Liu, and Z. Zhang. "*The capability assessment of emergency power supply in urban power network*", 20th International Conference on Exhibition on Electricity Distribution - Part 1, 8-11 June 2009, pp. 1–4, (2009).
- [37] L. Zhang and W. Chen. "*Studies on the emergency response ability evaluation of gas pipeline leakage accident based on GI*", 16th International Conference on Industrial Engineering and Engineering Management (IE&EM '09), 21-23 October 2009, pp. 1294–1298, (2009).
- [38] Y. Wenan and Z. Qingzhu. "*Evaluation of Emergency Maintenance Capability for Expressway Based on Triangle Whitening Weight Function*", International Journal of Advancements in Computing Technology, 5(4), pp. 914–921, (2013).
- [39] H. Zhengqiang and J. Deng. "*Emergency process Capability Assessment based on Stochastic Petri nets*", 2010 IEEE International Conference on Emergency Management and Management Sciences (ICEMMS), 8-10 August 2010, pp. 367–370, (2010).
- [40] "*Risk management - Principles and guidelines*", ISO Standard 31000:2009.

- [41] S. Hao. "Research on capability evaluation indicators of government emergency management in the public emergency", 2011 International Conference on E-Business and E-Government (ICEE), 6-8 May 2011, pp. 1–5, (2011).
- [42] H. Zhang, Y. Xiao, B. Yu, and X. Jang. "Comprehensive Evaluation of Maritime Emergency Capability", 2010 Second International Conference on Computer and Network Technology (ICCNT), 23-25 April 2010, pp. 452–456, (2010).
- [43] Y. Yi-dan. "Study of the evaluation index system of the emergency capability of mass incident based on management through overall process", 2011 2nd IEEE International Conference on Emergency Management and Management Sciences (ICEMSS), 8-10 August 2011, pp. 224-227, (2011).
- [44] Y. Han and Y. Yu. "Study on Emergency Response Capability Assessment of Urban Disaster", 2009 International Conference on Public Administration (ICPA 5th), pp. 399–404, (2009).
- [45] M. Hu and Y. Lu. "Priliminary research on emergency response capacity evaluation system", 2011 2nd IEEE International Conference on Emergency Management and Management Sciences (ICEMSS), 8-10 August 2011, pp. 439-442, (2011).
- [46] Z. Han and J. Deng. "Process oriented emergency capability assessment", 2010 IEEE International Conference on Emergency Management and Management Sciences (ICEMMS), 8-10 August 2010, pp. 496–499, (2010).
- [47] J. Nilsson. "What's the Problem? Local Officials' Conceptions of Weaknesses in their Municipalities' Crisis Management Capabilities", Journal of Contingencies and Crisis Management, 18(2), pp. 83–95, (2010).
- [48] B. A. Jackson, K. Sullivan Faith, and H. H. Willis. "Are We Prepared? Using Reliability Analysis to Evaluate Emergency Response Systems", Journal of Contingencies and Crisis Management, 19(3), pp. 147–157, (2011).
- [49] P. Tatham, R. Oloruntoba, and K. Spens. "Cyclone preparedness and response: an analysis of lessons identified using an adapted military planning framework", Disasters, 36(1), pp. 54–82, (2012).
- [50] UNDP. "Reducing disaster risk - A challenge for development", United Nations Development Programme, 2004, New York.
- [51] SFS 2006:942. "Emergency Management and Heightened Alert Ordinance", Sweden.
- [52] SFS 2006:544. "Act on municipal and county council measures prior to and during extraordinary events in peacetime and during periods of heightened alert", Sweden.
- [53] MSBFS 2010:7. "The Swedish Civil Contingencies Agency's instructions on governmental authorities' risk and vulnerability analyses", Sweden.
- [54] MSBFS 2010:6. "The Swedish Civil Contingencies Agency's instructions on municipalities' and county councils' risk and vulnerability analyses", Sweden.
- [55] M. Abrahamsson, K. Eriksson, H. Hassel, K. Petersen, and H. Tehler. "Kritiska beroenden, förmågebedömning och identifiering av samhällsviktig verksamhet [Critical interdependencies, capability assessment and identifying critical infrastructure]", Lund University Centre for Risk Assessment and Management (LUCRAM), 2011, Lund.
- [56] Swedish Civil Contingencies Agency (MSB). "Guide to risk and vulnerability analyses". Swedish Civil Contingencies Agency (MSB), 2012, Karlstad.
- [57] Swedish Emergency Management Agency (SEMA). "Indikatorer på krisberedskapsförmåga [Indicators of emergency management capability]", Swedish Emergency Management Agency (SEMA), 2007, Stockholm.