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The Use of Expert Knowledge in the Danish National Risk Profile

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Expert opinion is an engrained part of risk analysis, but there needs to be more debate on the efficacy of Strength of Knowledge (SoK) in aggregated strategic risk reports like the Danish National Risk Profile (NRP). This paper discusses the utility of expert opinions by government agencies and the uncertainties associated with this practice. The NRP is a publication issued by the Danish Emergency Management Agency (DEMA) that describes threats to Danish society in the short to medium term. The ambition is for government agencies, companies, and other organisations to use the profile as a strategic document that identifies which threats they are to include in their strategic risk assessment. The risks are determined by experts from 15 government agencies who have provided their opinions on 14 different threats, which are then analysed and ranked by DEMA. The use of experts and a qualitative methodology leads to the question of how the SoK could be a factor that influences the national risk strategy and, thereby, the mitigation initiatives taken by private, public and non-governmental organisations. The paper utilises an analytical approach based on the sensemaking of experts, resulting in proposals for risk strategies in the NRP. The paper concludes that SoK has a significant but implicit role and that uncertainties can result in over or under-representation of threats by DEMA, which in turn can lead to faulty strategic risk governance decisions by the readers of the report.

Keywords: Strength of Knowledge (SoK), National Risk Profile

1. Introduction

The National Risk Profile (NRP) report is issued every three to four years by the Danish Emergency Management Agency (DEMA) and 'recommends that authorities and other organisations use the National Risk Profile as a starting point for their work with preparedness, security, and crisis management capacity even though a concrete crisis' character, longevity, scope, and consequences are rarely known beforehand' (DEMA, 2022). The intention is for public authorities and organisations to take the profile as a reference point for their ongoing work with preparedness planning and crisis management. The NRP is, hence, a risk analysis issued by Denmark's highest authority on emergency management and is norm-setting for organisations working with risk governance across the nation. This paper explores how DEMA makes sense of expert opinions and arrives at recommendations to be used nationally to determine which threats organisations in Denmark should include in strategic risk management.

One of the central elements in risk analysis is the strength of knowledge (SoK), which underpins management decision-making (Termeer & van den Brink, 2013). However, DEMA does not reference or discuss SoK in its risk assessment, raising questions about the knowledge platform upon which the NRP stands. The question is what role a norm-setting report, such as the NRP, should take in the national discourse of risk and disaster governance in Denmark. These considerations lead to the research question: How can the SoK in the NRP be assessed? Answering this question will contribute to understanding uncertainty in risk analysis and estimating the legitimacy of risk assessments in publications like the NRP.

The paper starts with a review of the current literature on sensemaking in social systems, and SoK. Based on this theoretical foundation and methodology, the following section presents a model for a systematic approach to risk analysis applied in the subsequent analysis. The section follows a discussion of how organisations apply SoK in national risk

assessments like the NRP. The last section discusses its practical implementation of sensemaking as a tool for decision-makers and researchers to analyse and assess SoK.

2. Theory

2.1 Risk, Uncertainty and Strength of Knowledge

Karl Weick discussed unknowability as partial connections that produce multiple realities, plausibly supported by justification rather than an accurate representation (Weick, 2005). He saw a world where various realities could co-exist as semi-independent agents, reciprocal references, evolving identities forming loosely coupled systems, and self-organising fragments whose significance does not lie in the fact they were once part of a greater whole but instead held together by communication. Such social systems can evolve by enacting the information they believe is true, providing a self-organising trajectory. Unknowability is the unspoken, unenacted, and uncommunicated between the social system's fragments and the context in which it is situated, resulting in uncertainty in decision-making.

Uncertainty is essential in risk analysis but is challenging to conceptualise, assess, characterise, communicate and manage (Hoti, 2023). The dynamics of self-organising systems offer a platform from which organisations can offer perspectives, thereby providing the grounds for distributed enactment that engenders organisational aims. In this way, uncertainty should not be avoided but instead sought, as it provides insights into the unknowns that are yet to be explored and need further scrutiny. Organisations can revisit assumptions about how the world around them functions, challenge established norms and provide a reason for enacting decisions that alter the reality previously known to be true.

Uncertainty in risk analysis disappears when we become convinced that our experience is plausible and authentic. The concept is elusive as we are constantly confronted with the fact that we discover new risks and uncertainties either through analysis or events that question our assumptions. In a world of incomplete information, there is a perpetual state of incomplete data to prove

something dangerous or safe (Zio, 2018). It is possible to state that the uncertainty of an event is related to entropy or the level of disorder in the system. The greater the entropy, the greater the 'surprise' and the availability of information to the event observer. The only answer we can give with any certainty depends on the question guiding the analysis limited by our cognitive capability to imagine its plausibility. If we propose this probability from the degree of knowledge of it, a relationship exists between probability and uncertainty. While it is equally clear that these concepts are the basis of some definition of risk that recognises that information about an event's characteristics, causes, and consequences are riddled with unknowns on which we apply different levels of legitimacy. Society of Risk Analysis (SRA) defines uncertainty as 'not knowing the actual value of a quantity or the future implications of an activity' or the 'imperfect or incomplete information/knowledge about a hypothesis, a quantity, or the occurrence of an event' (SRA, 2021). Both definitions relate to the SoK and the capacity to provide plausible and authentic information. Rather than focus on the probability that something will occur, the definition of risk emphasises the uncertainty of what we do not know about the threat, the probability and its consequences. Risk could, hence, be defined as uncertainty about the occurrence of a threat and its perceived implications on human activity.

SoK is related to uncertainty as it provides insights into the legitimacy that the reader can place on a particular piece of information (Antonyuk et al, 2023). The risk assessor does not have to have direct knowledge of a given threat but rather assess the information provided for analysis, either being collected directly or through experts, which allows for a judgement if the knowledge that the assessment is based on could be characterised as either strong, medium, or weak. To estimate SoK, we need to understand how the expert makes sense of a given risk and then deconstruct the process that resulted in a given assessment (Savadori et al., 2004; Taarup-Esbensen, 2019). The sensemaking process includes explicit and tacit knowledge, some of which the expert would not necessarily be able to articulate but is part of the assessment and recommendations.

2.2 Sensemaking of Experts and Uncertainty

We formulate our interpretation of what we consider plausible by confirming it through dialogue with the social environment (Gephart et al., 2009). Sensemaking is the process through which individuals attempt to explain uncertainties about events, resulting in changes in context. We make decisions based on what is believed to be accurate and what could influence our knowledge and subsequent decisions to be enacted (Mikes, 2011). Sensemaking describes how we evaluate and make decisions when confronted by a change in what is observed. Weick's (2005) framework explains the process of sensemaking as 'the ongoing retrospective development of plausible images that rationalise what people are doing'. When making sense of a given context, decision-makers undergo a mental process, which leads to a decision as to what is a legitimate assessment of the subjectively sensed reality (Maitlis & Christianson, 2014). Like everyone else, experts engage in a sensemaking process based on their meaning-creation process and have specific insights into a given topic that require time and resources to acquire. Because of this knowledge, their opinions are regarded as particularly valuable in specific situations, such as when providing risk assessments on their area of expertise.

2.3 Social Systems and Uncertainty

Organisations are communicative systems that enable the efficient flow of information to and from the individual subsystems and the coupled network in which they participate (Schoeneborn et al., 2014). As information flows through the system, the organisation senses changes in one part and evaluates their significance to others. The organisation continuously makes sense of its context, identifying cues and sorting communication as inconsequential or something that needs enactment. The applied technologies allow us to distribute the correct information input to qualify decision-making. Information about changes is central, as it can present cues that some part of the whole can be threatened and need an organised response. These sensory systems provide information that they are either accepted or rejected as providing cues of relevance. These technologies, like machinery or software, can be physical or social, such as standards, procedures, and guides constructed through organised sensemaking. The commonality between these technologies is that they are containers of previously acquired

knowledge about the social context in which they operate and how the socio-technical system has solved problems related to uncertainty in the past. They form the basis of what is believed to exist in the world and how we make sense of change as consequential or inconsequential. In essence, social systems create their own boundaries as to what information is legitimate and expert opinion plays a significant part in determining where these boundaries should be placed.

A system is closed but conditionally open to distinctions of risks, as past experiences alter the trajectory of future events, determining the nature of future decisions that are yet to be known. It chooses the nature of information included and, not least, what to exclude as part of the sensemaking process. We then make distinctions about what should be included in our perception of risk. Some information will be emphasised as instrumental for making decisions, while others will not impact our decision-making process. Risk perception is not only a choice between different modes of communication, the form in which information is conveyed, but also relies on identity, past experiences, specific context, social interactions, cues, and what is regarded as plausible. Risk communication is, hence, regarded as making available the information that an audience can select from based on the degree to which this information makes sense. Information regarded as irrelevant will not be selected and, therefore, not be included or regarded as less important than others in the risk analysis.

2.5 Social Systems and Risk Analysis

Risk analysis acknowledges that it is only possible to collect fragments of the past, pieced together to create an accurate representation of the present and a potential trajectory of enactments regarded as plausible for the social system in which we are participating (Johnson et al., 2023). Through their enactments, social systems continuously test their perceptions of their context. Each test is based on the perceived reality, and each enactment is regarded as a test of the consistency of the social systems' beliefs about the world under uncertainties. Enactments determine if the knowledge is plausible because it falls within what the system has learned about the context in the past (retrospectively). An enactment engenders a response in the form of communication that the

social system can select or disregard. The selection is a double selection as the context offers information that can be selected, and the social system chooses which part to include in its meaning-creation process. Such a system of organised sensemaking operates under the influence of epistemic, aleatory and ontological uncertainties and, at times, ambiguity, which can be opaque to the system itself. It is impossible to select communication that the system cannot detect and will regard some form of information as more legitimate than others. The SoK is only as robust as its ability to engage in a sensemaking process that allows it to include and process information that will alter existing beliefs about what is true and what is unfeasible. Ascribing strong or weak knowledge to a given analysis is hence dependent on the observer rather than the evidence presented and the mental model that constitutes what is regarded as consequential. Enabling the rejection of foundational concepts of reality and what can be regarded as uncertainty about its perception.

2. Methods

DEMA issues the national risk profile, which describes and assesses the most severe threats to Danish society in the short to medium (less than five years). The methodology in this paper is based on a review of DEMA's use of experts in their NRP from 2022. The report itself includes 15 different threats, identified by experts from 14 government agencies that have contributed and how DEMA subsequently made assessments these threats relative to each other. Through a deductive approach, the paper shows how expert knowledge is interpreted by DEMA and assigned different levels of risk based on the legitimacy assigned to each threat in the report. Thematic coding is utilised to identify the sensemaking processes of DEMA experts as they analyse and make decisions on the legitimacy of the information provided by experts and clarify the uncertainties that have contributed to the report conclusions. The processes contributed to identifying threats, sources of uncertainty, and the selection criteria for the consequences and perceived uncertainty by experts that the threat potentially involves. The coding and supplementary risk assessment data were used to identify themes related to the elements in the theoretical framework. The coding scheme was compiled from the extant literature on systems theory, SoK and sensemaking, as described in the

theory section. The scheme includes keywords related to the process of sensemaking sources of uncertainty and the selection and enactment of plausible outcomes. The analysis is split into two sections, one focusing on sensemaking and another on the use of SoK at DEMA.

3. Analysis

The NRP describes a range of threats to Danish society that DEMA communicate to be salient from extreme weather to solar storms (DEMA, 2022). Each threat is described by its characteristics, occurrence, consequences, and trends, and examples of historical events where it was realised are given. DEMA has also estimated on a quantifiable scale: 'The challenges associated with the incident type' and 'Incident type's consequences' for each threat type on a scale from serious to extreme. Each section ends with a hypothetical 'What if ...' description of how a future scenario involving individual threats could unfold.

3.1 Sensemaking of DEMA Experts

The role of the NRP is to provide social systems with a trajectory for risk analysis by drawing upon past experiences from a range of specific cases. The range of retrospective knowledge included a description of events dating back from 1859 (solar flares on the 2nd of September) to 2022 (SARS-CoV-2 deaths and infections in Denmark as of the 11th of January). The main criterion is that the incident must 'have an element of "plausibility" based on experts' assessments of the possibility that incidents of each type could occur within the next five years'. In the report, these assessments vary greatly from weather and climate-related to nuclear accidents and space weather. The final decision to include a threat and how to assess it is based on the decisions made by DEMA.

DEMA uses past consequences to indicate what threats should be included in the NRP. These indicators are important as they constitute what is known about the change from the contextual norm and, in this case, a threat. In themselves, they are a reduction of complexity as they are events that DEMA ascribe importance to. The rationale is that the assessment becomes reliable by collecting multiple cues, and the confidence in predicting the consequence becomes increasingly certain as

DEMA gains more diverse and detailed insights in individual cases. The interpretation of incident types as having significant societal impacts and the immediate enactment of social systems is used as an indicator for threat identification. For example, when describing coastal flooding, which DEMA has a lot of experience with, it states: 'Another factor that can increase the risk of coastal flooding even with low wind speeds is the amount of rain that has fallen during the preceding period'. Other cues are based on analysis based on a lower number of events, as when a warning for drought is issued: 'The calculations are based on three parameters: access to water (precipitation), evaporation from soil and plants, and seepage from underlying ground layers'.

Whether the analysis of possible national risks can materialise within the following period involves case examples of each identified threat type. DEMA recommends that government agencies, companies, and non-governmental organisations adopt the NRP in their risk analysis and 'include their own selection of risks assessed to be most relevant to the organisation's area of responsibility'. (DEMA, 2022). Information is made available through the profile so other organisations can select based on their sensemaking process regarding plausible threats. The enactment of the DEMA risk analysis is for the observer to 'formulate strategic goals or points to note for specific incident types for use in internal or cross-sectoral crisis staffs'. The report itself is a tool for 'working with continuity planning and increasing the robustness of the organisation's segments that can be affected by crises', 'planning exercises', 'education and training', and 'preparation of teaching programmes', pointing towards a selection of threats by the second-order observer.

The evaluation of plausibility is the final test of the SoK, as individuals and organisations include uncertainties in our presumption of what is regarded as an accurate representation of reality. Plausibility comes as we consider all the information available and the degree it is regarded as legitimate. DEMA has a natural legitimacy as a state actor, which, on behalf of the Danish government, assesses the possible threats, which it extends to the experts that contribute to the NRP. DEMAs sensemaking process hence legitimises

any information that is communicated to the readers of the report.

3.3 Use of SoK by DEMA

DEMA states that the NRP 'is the result of a collaboration with a wide array of experts from sector-responsible authorities and other actors. DEMA, however, is solely responsible for the cumulative content of the National Risk Profile'. There is no qualitative assessment of SoK in the NRP related to the individual threats identified by the experts. The final report and ranking of risks are an interpretation of expert opinions from DEMA and are described as follows:

'The incident types must also have an element of 'plausibility' based on experts' assessments of the possibility that incidents of each type could occur within the next five years. This does not mean, however, that similar incidents must have occurred or caused consequences for Denmark in the past.'

The selection of communication is based on cues that experts provide regarding the risks that society faces in the coming period and the evaluation from DEMA if they should be included in the NRP. Based on this analysis, there is a decision (enactment) as to whether this information should be made available for selection by a wider group of social systems. Within the report, these are described as 'trends', which are possible future trajectories in which the threat can materialise, and as 'what if ...', a thought experiment that describes a fictional event. The plausibility is, in this way, synonymous with the legitimacy of the information provider.

These differences also reflect the certainties as to how experts evaluate the different types of threats. In the cases where there is a significant volume of events within five years, such as weather, animal and highly virulent diseases, the expert opinions tend to be more accurate, while in the cases where there are only cases from abroad or no events in the five years, the expert opinions tend to be more speculative; for example, in scenarios involving space weather, terrorist incidents, and nuclear accidents. Uncertainties also transpire into the 'what if ...' scenarios, where information on known events enables more direct action related to the specific threat, while concrete options become more speculative when uncertainty increases.

All the threats DEMA describes are affected by uncertainties that, to different degrees, will impact the quality of decision-making. First, the expert chooses the type of threats to include and the type of communication to offer. The choices are influenced by varying degrees of uncertainty that limit the validity and reliability of the information offered to DEMA, which again assesses if the analysis is legitimate.

In this case, the expert offers communication that includes uncertainty, as Denmark has had no significant recorded tsunami incidents within the past five years and never over one meter in height. Secondly, DEMA makes sense of the expert communication and enacts this information through its 'What if ...' scenarios.

Denmark's landmass lies an average of only 31 metres above the ocean's surface and is surrounded by approximately 7,300 kilometres of coast. Many large Danish cities are located near coasts, making them potentially vulnerable to coastal flooding.

The selection of plausible outcomes is a choice between likely consequences of an activity believed to be valuable. DEMA decides to include threats in the NRP based on cues provided by selected experts and these experts' interpretations of a specific threat. Some cases can be directly related to known events in expert analysis and opinions and, therefore, have a high level of legitimacy, while others are selections made by DEMA with little expert input. There is, hence, a two-fold process where existing bias is enacted and tested in the context, which yields a communication return from which the organisation selects the information it chooses to include in the report. In this choice, there exists a bias as to what type of communication to enact and what uncertainties surround the choice. These selections are influenced by different forms of uncertainty that, to some unknown degree to the reader, will impact the validity and reliability of individually identified threats and the NRP as a norm-setting agency.

4. Discussion

Expert knowledge forms the backbone of the NRP and many other publications that are important in the risk decision-making process in organisations.

The sensemaking approach reveals a certain perspective on how experts create meaning of and communicate their knowledge of risk, which can be used as an approach to evaluate SoK in qualitative risk assessments. Alternatively, it provides insight into the string of arguments that need to be present to convince stakeholders that behind a risk assessment, there exists a robust methodology—given that the report is to be regarded as an important tool for executives and preparedness planners in central, regional, and municipal authorities, public and private companies with responsibility for vital societal functions, the cross-sectoral fora of Denmark's national crisis management system, emergency management actors in the volunteer sector, teachers and students within emergency management-related education tracks, and the general population. Such an audience relies on their subsequent strategic decisions to be based on a solid science-based approach to risk analysis.

Firstly, the described qualitative method does not hinder DEMA from making quantitative claims about the scope and consequences of the identified threats. Through the sensemaking, first by the experts and later by DEMA, there exists a discursive struggle between different agendas that is not transparent to the reader. The disposition to prioritise some risks over others depends on the legitimacy of the information presented about the assessed threat and the experts' ability to create a consistent argument that makes sense to DEMA but not necessarily to the organisations reading the report. The bias is visible in the analysis when DEMA, during the COVID-19 pandemic, described the threat of highly virulent diseases as having the most extreme consequences on society and by far the most influential of the 14 described threats in the coming period between reports. The pandemic certainly impacted Danish society, but it is more uncertain whether there will be a similar event within the next five years, which the report covers. In other cases, new threats emerge, and a given priority like 'Space incidents' first appears as 'space weather' in 2017 and later updated with its current name. While these incidents pose a threat, as there are consequences to society, there has yet to be an incident that involved space incidents in Denmark. With the lack of a transparent methodology, these types of cases can impact the analysis and the conclusions that are biased against

the threats that are the most salient at a given time. The interpretation of consequences has more to do with the retrospective experiences or novelty of an event as interpreted by DEMA than any relationship with uncertainty, frequency, or potential impact.

Secondly, using experts when there is weak evidence of probabilities or uncertainties are high can influence SoK. The NRP does not discuss the degree to which its SoK is strong, moderate or weak. The uncertainties can result in a bias towards specific threats that are more salient at the time, while other, more systemic threats are overlooked. This assessment is not transparent to the reader and can, therefore, result in the over or underrepresentation of risks in the subsequent analysis. As such, the NRP is an excellent example of how selection criteria and methodologies induce uncertainties in risk analysis and the role of SoK in its main arguments. It should be noted that this is not to say that the 14 identified threats do not represent the most salient threats to Danish society; it is just that the reader has no opportunity to estimate the SoK that is the foundation of these assessments.

Thirdly, the NRP is an example of observations made under three levels of enactment and selection, which induces uncertainty in the sensemaking processes from the expert to the agencies, companies and organisations that are the intended audience (see Figure 1). First, experts make sense of the observed context by enacting their retrospective knowledge and subsequently select what they believe to be plausible evidence of specific threats. The experts enact the information they believe represents a plausible outcome and are biased in their selection of cues. The uncertainty can be related to their methods, their selection of variables, the structures in this context, and how to interpret ambiguous communication. The expert offers their interpretation of what they believe to be a true representation of the identified threats but provide no clues as to the SoK in their assessment. DEMA enacts this information by selecting what they, as emergency response professionals, think would be a likely scenario when the specific threat presents itself. From this perspective, it is thus not the 'uncertainty about and severity of the consequences of an activity with respect to something that humans value' but the consequence that is regarded as plausible. The same type of

uncertainties as the ones experienced by the experts also impact the sensemaking process of DEMA, but as a second-order observer, it is impossible for them to know the SoK on which they are basing their assessments. The accumulated uncertainties are subsequently transferred to the agencies, companies, and organisations inclined to use the NRP as a strategic tool for threat identification.

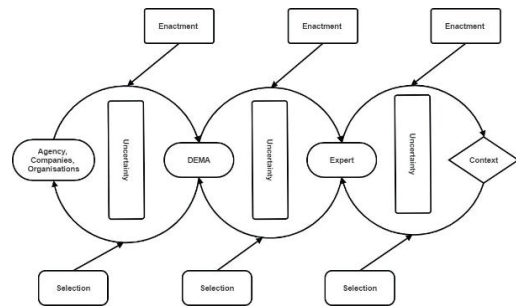


Fig. 1 Selections of the National Risk Profile

5. Conclusions

This paper discusses how SoK impacts the NRP and, ultimately, strategic decision-making by public, private and non-governmental organisations. A series of uncertainties associated with SoK, has been identified, influencing the credibility of the report's findings and its usability to risk governance. The analysis of the sensemaking process of DEMA and how it is communicated through the NRP provides a usable framework for analysis of the uncertainties and the degree to which it is possible to apply its findings. Using sensemaking analysis to SoK engenders a series of selections by individual experts and later DEMA to create meaning and construct a consistent argument as to what is regarded as legitimate about a given threat. Systems theory makes it possible to gain insights into the processes that have contributed to the description of this reality by identifying the sensemaking process resulting from it and the selection of information offered. The process uncovers the uncertainties in the analytical framework and the ability of an organisation to identify salient risks that will require future enactments. The paper shows that the NRP offers communication to the third-order observer based on the selection of first experts, then DEMA, and finally, the observers themselves. Each of these processes is influenced by uncertainties linked to how the actors make sense

through enactments and the choice to select specific information over others based on what are plausible outcomes. The NRP offers little insight into the selection or enactment criteria that DEMA has applied, which weakens the SoK and the legitimacy of the NRP recommendations.

Expert opinion plays an instrumental role in risk assessments, and uncertainties associated with the analysis mean that there is an uncertainty that some of the threats can be over or under-represented. This is especially salient when these opinions are reanalysed in a possible different domain than originally intended, for example, changes to climate, solar storms, heatwaves and drought seen through the lens of emergency preparedness. The process can lead to faulty strategic risk governance decisions by its readers and, thereby, management practices that do not mitigate risks or adapt their organisations to the threats they face. It is impossible to assess the degree to which these uncertainties are consequential in the decision-making processes or to what extent resources have been allocated to mitigate risks that might or might not be salient. The findings show that SoK needs to be explicitly addressed in reports like the NRP and expert opinions cannot stand alone and must be supported by other sources, such as generic risk analysis, to engender legitimacy.

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