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## Improving emergency and disaster response management performance

### A problem-solving perspective

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# Improving emergency and disaster response management performance

## A problem-solving perspective

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FACULTY OF ENGINEERING | LUND UNIVERSITY





Lund University  
Faculty of Engineering  
Division of Risk Management and Societal Safety

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# Improving emergency and disaster response management performance

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Tove Frykmer



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<b>Abstract</b> <p>The purpose of this doctoral thesis is to investigate how collective emergency and disaster response management performance can be further improved. Based on four studies, this research contributes with knowledge in two areas.</p> <p>First, collective processes that might improve response management are investigated. In this regard, collective improvisation as a concept is found limited in its usefulness and it is suggested to adopt problem solving as a broader analytical concept. In specific, collective problem representation is argued as potentially useful for investigating how response management performance can be improved. One interview study and one document study explore collective problem representation in response management. Based on interviews with response management professionals, three factors are found to impact the process of achieving a collective problem representation: formal hierarchical structures, legislation and regulations, and, relationships. How problems are represented in common operational pictures, which are widely used for sharing information about problems and solutions in response management is investigated in an empirical study of a wildfire response. Problems were found to be mainly represented in terms of geographic references and the status of the present wildfires, statements regarding resources, and, in terms of risks or potential consequences, relating to anticipated or future problems. Understanding how problems are represented in common operational pictures enables an investigation into how these can be improved to better inform the handling of various events.</p> <p>The second area of contribution concerns how we can identify measures that actually improve response management performance. A complementary approach to traditional response management research is suggested: that of combining descriptive and experimental research. Descriptive studies constitute a basis for understanding response management problems and suggesting possible solutions. Experiments can thereafter test and evaluate the suggested solutions to see whether these should be further developed. The suggested research approach is exemplified with an experimental study testing a recommended measure in response management practice, namely goal alignment. Even though the findings indicate that goal alignment might not be an effective solution to improve response management performance, further inquiry is warranted. This thesis nevertheless calls for caution when attributing causal explanation for successful performance to concepts without thoroughly investigating cause and effect between the two, which is supported by the findings related to collective improvisation and goal alignment. A useful way forward can be that of developing articulated models, which should describe the essential performance of the concept in question and have clear, falsifiable, connections between the concept and the outcome.</p>	
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# Improving emergency and disaster response management performance

A problem-solving perspective

Tove Frykmer



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# Summary

This doctoral thesis investigates how collective emergency and disaster response management performance can be further improved. Emergencies and disasters threaten what we value in society. These unwanted events seem to increase in numbers, become more difficult to manage and require collective effort. As a result, society's capability to manage emergencies and disasters will be challenged and it will become important to continuously update and improve the response management capability. How well the response management fulfils its purpose of protecting societal values is thus important.

Exactly what improves response management performance is however hard to identify. Complex and wide-spread events such as the covid19 pandemic show that a number of factors affect how well the responding system can meet needs and minimise consequences from adverse events. How authorities coordinate activities may impact the outcome, but so may also factors that we cannot influence. Research on emergencies and disasters has traditionally developed within the social sciences, with a common focus on descriptive research. This type of research is strong in developing theory, but less so in providing solutions for addressing practical problems, such as improving response management. How response management performance can be improved is thus important both from a professional and a methodological perspective, which serves as the overall purpose of this thesis. The research contributes with knowledge in two areas.

The first area concerns collective processes, i.e., activities that produce effects in the responding system, that might improve response management. Initially, collective improvisation appeared as a potentially useful concept for investigating how response management performance can be improved. The capability to improvise is described as necessary for handling time pressure and uncertainty that is often prevalent in emergencies and disasters. However, findings from a scoping study of current scientific literature indicate that it is hard to establish the connection between the concept and the desired performance, and it is therefore considered limited in its usefulness. In this thesis, it is suggested to adopt problem solving as a broader analytical concept. In fact, response management is about solving problems in order to meet needs and minimise consequences during an adverse event. In addition, the concept highlights the desired effect of actions taken; to solve problems, which is connected to performance and thus central to this thesis.

Representing the problem before solving it is considered important in the problem-solving literature, and it has also been prescriptively validated that effective problem solving relies on this step. Therefore, collective problem representation is argued as a potentially useful concept when investigating how to improve response management performance. In the response management context, a collective problem representation can reduce the risk of problems being missed or neglected



by responding organisations, and the risk of “solving the wrong problem right”. Assuming that a collective problem representation is important for response management performance, this thesis identifies three factors that may impact this process: formal hierarchical structures, legislation and regulations, and, relationships. The two former were found to mainly impede the process, whereas the latter was found to mainly have a positive impact.

The thesis further explores the concept of collective problem representation through investigating how problems are represented in common operational pictures, which are widely used for sharing information about problems and solutions in response management. Understanding how problems are represented here enables an investigation into how these can be improved to better inform the handling of various events. In an empirical study of common operational pictures created during a wildfire response, problems were found to be mainly represented in terms of geographic references and the status of the present wildfires, statements regarding resources, and, in terms of risks or potential consequences, relating to anticipated or future problems. These representations were found to be key for managing the response through enabling dimensioning and planning of the response, setting up the response organisation and facilitating proactive strategies, respectively.

The second area of contributions concerns how we can identify measures, or interventions, that actually improve response management performance, serving to methodologically advance the field. This thesis suggests a complementary approach to traditional response management research: that of combining descriptive and experimental research. Descriptive studies constitute a basis for understanding response management problems and for suggesting possible solutions. Experiments can thereafter test and evaluate the suggested solutions to see whether these should be further developed. The suggested research approach is exemplified with an experimental study testing a recommended intervention connected to problem solving and found in response management practice, namely goal alignment. Aligning goals is considered a successful strategy within collective response management, however the literature is rather ambiguous and it has seemingly not been tested against its desired effect. In the experimental setting, aligning goals did not improve the performance of the studied groups. Either the experiment did not capture the effect of goal alignment sufficiently or the underlying hypothesis, i.e., that misaligned goals result in worse outcome, is wrong. Even though the findings indicate that goal alignment interventions might not be an effective solution to improve response management performance, further inquiry is warranted. This thesis nevertheless calls for caution when attributing causal explanations for successful performance to concepts without thoroughly investigating cause and effect, which is supported by the findings related to collective improvisation and goal alignment. A useful way forward can be that of developing articulated models, which should describe the essential performance of the concept in question and have clear, falsifiable, connections between the concept and the outcome.

# Sammanfattning

Denna avhandling undersöker hur den kollektiva krishanteringen kan förbättras, för att bättre kunna möta akuta behov och minimera konsekvenser under oönskade händelser. Olyckor och kriser hotar det vi värderar i samhället. Dessa oönskade händelser ser ut att bli allt fler, svårare att hantera och kommer att kräva kollektiva insatser. Till följd av detta kommer samhällets förmåga att hantera olyckor och kriser utmanas och det kommer bli viktigt att kontinuerligt uppdatera och förbättra krishanteringsförmågan.

Exakt vad som förbättrar hanteringen av olyckor och kriser är däremot svårt att identifiera. Komplexa och samhällsövergripande händelser som t.ex. covid19-pandemin visar att en mängd olika faktorer påverkar hur väl krishanteringssystemet kan möta de behov som uppstår. Hur myndigheter samordnar sina uppgifter kan påverka utfallet, men så kan även andra faktorer som vi inte kan påverka. Forskning inom krishanteringsområdet har främst bedrivits inom samhällsvetenskaperna, med ett traditionellt fokus på beskrivande studier, d.v.s. studier som beskriver och förklarar en kris. Denna typ av forskning är väl utvecklad inom teoribildning men mindre fokuserad på att hitta lösningar för praktiska problem, såsom hur krishanteringen kan förbättras. Hur man kan förbättra den kollektiva krishanteringen är alltså viktigt både utifrån ett praktiskt och ett metodologiskt perspektiv, och utgör syftet med denna forskning. Avhandlingen bidrar med kunskap inom två områden.

Det första området handlar om kollektiva processer, d.v.s. aktiviteter som skapar effekt i krishanteringssystemet, och som kan förbättra krishanteringen. Initialt undersöktes kollektiv improvisation som ett potentiellt användbart koncept för att förbättra krishanteringen. Förmågan att improvisera beskrivs som nödvändig för att kunna hantera den tidspress och osäkerhet som ofta förekommer under olyckor och kriser. I en litteraturstudie uppvisades däremot brister i kopplingen mellan improvisation och dess utfall, vilket gör att det i nuläget är svårt att utgå från kollektiv improvisation om man vill förbättra krishanteringen. Istället föreslår avhandlingen problemlösning, inom vilket improvisation kan ses som en del, som ett lämpligt område att utgå från för att föreslå hur krishanteringen kan förbättras. Kortfattat kan man säga att hanteringen av olyckor och kriser handlar om att lösa en mängd problem kopplat till att möta akuta behov och minimera konsekvenser. Problemlösningsspektivet bidrar även med att betona det önskade utfallet av krishantering: att ha löst problem.

Forskning visar på att effektiv problemlösning är beroende av en tydlig bild, eller representation, av vad problemet är. Därför föreslås i denna avhandling kollektiv problemrepresentation som ett potentiellt användbart koncept för att undersöka hur krishanteringen kan förbättras. I denna kontext kan en kollektiv problemrepresentation minska risken för att problem ignoreras eller faller mellan

stolarna, eller att man så att säga “löser fel problem rätt”. Med detta som ingång identifierar avhandlingen genom en intervjustudie tre faktorer som kan påverka processen att åstadkomma en kollektiv problemrepresentation: formella hierarkiska strukturer, relationer samt lagar och förordningar. Formella hierarkiska strukturer och lagar och förordningar verkar framförallt försvåra processen medan relationer verkar ha en positiv inverkan.

För att vidare utforska konceptet kollektiv problemrepresentation undersöktes hur problem representeras i så kallade samlade lägesbilder. Dessa används vanligen för att förmedla beskrivningar av problem och lösningar under en händelse mellan aktörer i krishanteringssystemet. Förståelsen för hur problem representeras i lägesbilderna kan sedan ligga till grund för en undersökning kring hur problem representeras på bästa sätt för att kunna förbättra hanteringen av oönskade händelser. I en empirisk studie över samlade lägesbilder under hanteringen av skogsbränderna i Sverige 2018 identifierades följande dominerande problemrepresentationer: geografiska referenser, ofta i kombination med status för de pågående skogsbränderna, yttranden om resurser, och som framtida risker eller konsekvenser. Beskrivningarna ses som stöd för att hantera krisen genom att dimensionera organisationen utifrån geografien eller tillgängliga resurser samt kunna anamma proaktiva strategier för att möta framtida, potentiella problem.

Det andra området inom vilket denna avhandling bidrar med kunskap är kring hur vi kan identifiera åtgärder som faktiskt förbättrar krishanteringen. Detta handlar om hur forskningsfältet kan utvecklas metodmässigt. Här föreslås en forskningsmetod som kombinerar beskrivande studier med kontrollerade experiment, som komplement till existerande metoder. Beskrivande studier behövs som utgångspunkt för att förstå problem inom krishanteringen och föreslå möjliga lösningar, och experiment kan därefter testa och utvärdera sådana lösningsförslag för att se om man ska gå vidare med dessa eller utveckla andra. Metoden exemplifieras genom en experimentstudie där “likriktade mål” testades. Att likriktade mål anses vara en framgångsfaktor inom krishantering, men litteraturen är tvetydig och åtgärden har till synes inte testats utifrån önskat utfall. Experimentstudien visade att likriktade mål inte förbättrade utfallet i de studerade grupperna. Antingen lyckades inte experimentet fånga effekten av likriktade mål eller så är den underliggande hypotesen, att icke likriktade mål leder till sämre utfall, fel. Även om resultaten indikerar att likriktade mål kanske inte är en effektiv lösning för att förbättra krishanteringen behövs vidare undersökning. Denna avhandling vill dock mana till försiktighet när specifika koncept tillskrivs kausala förklaringar för positivt utfall utan att orsak-verkan har undersökts ordentligt. Detta stöds av avhandlingens resultat kring kollektiv improvisation och likriktade mål. En väg framåt kan vara att använda modeller som tydligt beskriver konceptet och dess tänkta utfall och som har tydliga, falsifierbara, kopplingar mellan de två.

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“Finally!!”. This is the first word that comes to mind at this stage of my doctoral project. It is a relief to be here, but I am also at a stage where I can look back and reflect upon what I have learned and accomplished. My expectations at take-off have been far exceeded and I have learned more than I could imagine about all things research. Therefore, “rewarding” is the second word that comes to mind. Then, of course, there is “gratitude”.

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# Introduction

Society's capability to respond to emergencies and disasters is expected to be increasingly important given existing and future conditions and challenges. In recent years, records of climate-related negative effects and disasters have been broken repeatedly (EEA, 2015; IFRC, 2020; WEF, 2020). Scientists report that climate change is happening so fast that adaptation will be difficult, most likely resulting in large population movements as well as an increasing number of climate-related hazards and disasters (EEA, 2015). Trends in the global security situation may also add to a future landscape of unrest and instability. Changes in major global powers, a growing demand and competition for resources, demographic imbalances and fast urbanisation are factors that may give rise to political and social instability (Jordan, 2017; WEF, 2020), as well as an increased exposure to hazards (Coppola, 2015).

Furthermore, today's interconnected society has resulted in adverse events being increasingly transboundary in nature, meaning that consequences can spread over not only geographical borders, but also over administrative or sectorial boundaries (Ansell et al., 2010; Coppola, 2015; EEA, 2015; OECD, 2011). Such events tend to involve more response actors, commonly dispersed and not so familiar with each other, which will inevitably challenge the response management. For example, the migration crisis in 2015 caused widespread political and humanitarian consequences in many European countries (Boin, 2019) and, more recently, the global covid19 pandemic represents a global, transboundary disaster. The pandemic has indeed illustrated that the flow of people and commercial transactions today has increased the potential for risks to propagate. Apart from the obvious spreading of the virus due to global travel and transportation, closing down of industries in some parts of the world heavily affected industry in other continents when components could not be delivered along the supply chain. Further illustrating this interconnectedness in critical infrastructures, where a disturbance in one infrastructure spreads to the next, giving rise to a cascade of failures (de Bruijne & van Eeten, 2007; OECD, 2011; Rinaldi et al., 2001), are earlier examples of the Eyjafjallagökull eruption in 2010 that caused worldwide transportation problems and the Great East Japan earthquake in 2011 that led to the Fukushima nuclear disaster.

These societal challenges are neither new nor undescribed in literature or media. They nevertheless describe a situation of increasing risk for adverse events that threaten what we value in society, and that will become more difficult to manage. Societal values are often described in terms of human life and health and critical



societal functions (Olsen et al., 2007), as well as property and the environment (Coppola, 2015). Due to the increasing risk for adverse events, emergency and disaster response management, i.e. activities and organisational solutions aimed at protecting these societal values during an adverse event, is expected to be of increased importance.

At the same time, we can also expect that the challenges described above will continuously test society's response and demand new or improved capabilities. For example, given the interconnected society and transboundary nature of emergencies and disasters, response operations are expected to involve many different actors and will require joint activity (Frykmer, 2020; Nohrstedt et al., 2018; OECD, 2011; Uhr, 2017). As a result, the capability to collectively respond will become increasingly important. Society's rapid development, e.g., in technology and globalisation (EEA, 2015), also means that advancing response management capability needs to match the speed of development. In order to meet these demands and continuously improve response management capability, it is important that we can evaluate current capabilities, as well as future, suggested improvements, against the desired effects. Therefore, a focus on response management *performance*, i.e. how well the response management fulfils its purpose of protecting societal values, is warranted, including how this can be improved.

How to improve collective response management performance is thus an essential question, but not easy to answer. First, research on emergencies and disasters has traditionally developed within the social sciences, such as in the fields of sociology and political science, with a traditional focus on descriptive research. This type of research is strong in developing theory, but less so in terms of providing solutions for improving practical problems (Watts, 2017), such as how to improve response management performance. Thus, with the exception of handbooks and guidelines (see e.g. Coppola, 2015; IASC, 2010; UNHCR, 2015), there is less focus on researching what can improve response management, at least not in a way that systematically aims at determining what works and what does not work. Therefore, it seems like research on emergency and disaster response management is much more developed in terms of its explanatory ambitions than when it comes to how to best achieve goals and improve performance in a specific professional context. Second, emergencies and disasters bring into play a multitude of factors that may impact the outcome of an adverse event. As a result, it is difficult to distinguish between the effects of factors that we can influence, such as resource management, from those that we cannot influence, such as the weather. Due to these circumstances, it has been hard to identify which measures, or interventions, that are proven to have positive effects on the response management performance.

In light of this discussion, how emergency and disaster response management performance can be improved appears to be an important area for investigation, both from a professional and a methodological perspective. Therefore, the overall purpose of this thesis is **to investigate how collective emergency and disaster response management performance can be further improved.**

## Research process and research questions

Given the broad research purpose presented above, some limitations has been made. This thesis has a functional rather than structural approach, meaning that the focus is on emergency and disaster response management *processes*, as opposed to system setup or organisational solutions. In the field of emergency and disaster response management, a common focus is on how it should be structurally organised through e.g., functions, roles, methods or supporting systems. Less attention has been devoted to processes, i.e., the activities that actually produce effects in the responding system, supported by the resources in the system setup (Brehmer, 2013; E. A. Smith, 2006). Tightly connected to effects is the focus on *performance* in this thesis. Here, performance refers to how well the response management fulfils its purpose of protecting societal values through meeting needs and minimising consequences resulting from adverse events. Performance is thus linked to how effective the response management is at achieving the response management purpose and goals. The link between processes and the effectiveness of the response management is important in this thesis. If the process in question cannot be related to the effectiveness of the response management, it is not considered relevant for investigating how the response management performance can be improved.

Furthermore, this thesis focuses on *collective* processes. *Collective* processes, as used in this thesis, is explained as follows. Processes can be classified as individual, group, team, organisational and so forth. In emergencies and disasters, at any given moment of time, the responding actors can be said to consist of individuals as well as various collective constellations, such as groups, teams or organisations. These constellations are not necessarily stable in their structures, but are rather formed and dissolved during the course of the response. Since the aim of this thesis is not to focus on specific forms of collectives at some given point in time, but rather to investigate processes that may be similar for these constellations, “collective” is adopted to denote any constellation of two individuals or more.

Initially in this research, *collective improvisation* as a tool for improving emergency and disaster response management performance provided a promising area for several reasons. First, the concept of improvisation has in the literature been described as a well-known activity in response operations (see e.g. McEntire et al., 2013; Mendonça & Wallace, 2004; Wachtendorf & Kendra, 2006). Further, the

capability to improvise is seen as crucial in order to prepare for the unexpected and to be able to adapt to new conditions, i.e., circumstances that very much prevail in emergencies and disasters (see e.g. Cutter et al., 2010; Mendonça & Wallace, 2004; Wachtendorf, 2004; Webb & Chevreaux, 2006; Weick & Sutcliffe, 2015). Given that improvisation is seemingly a well-regarded and sought-after capability in response, but much referred to at the individual level, the first study investigated the capability for improvisation at a collective level and how it affects response management performance. More specifically, the aim was to explore if the capability to collectively improvise can explain, predict and be used to assess performance in response management. This resulted in the first research question:

**RQ1: According to scientific literature, how can the concept of collective improvisation be used for investigating how emergency and disaster response management performance can be improved?**

Paper I addresses this research question. A scoping study of existing improvisation literature was conducted and a number of challenges to observing and measuring collective improvisation were identified. Without being able to observe and measure collective improvisation, it is hard, if not impossible, to evaluate or improve it. Conclusions were that current literature does not clearly demonstrate the link between improvisation and performance at a collective level, meaning that it is hard to say how improvisation affects the outcome of emergency and disaster response. In the end, Paper I suggests that, based on current literature, collective improvisation as a concept is limited in its usefulness for explaining collective performance in response management. It raises the question of whether collective improvisation provides a suitable framework for investigating performance in response management and argues that a way forward would be to adopt the broader, more comprehensive, analytical perspective of *problem solving*. Although improvisation may be one instrument that can be used when solving problems in emergencies and disasters, broader problem-solving theories may help us understand performance in response management for several reasons.

First, problem solving focuses on a goal state of having solved a problem. This highlights the desired effect and performance of taken actions, which is central to this thesis. Second, emergencies and disasters bring with them a multitude of problems, which need to be solved in order to meet the needs and minimise consequences of the adverse event. In fact, response management can be described as a control<sup>1</sup> problem, where the responding actors attempt to control the adverse event by solving problems related to both the event and to the response itself (Brehmer, 2000; as also noted by Quarantelli, 1997 in the light of agent and response generated needs). Turning to a common definition of a problem as being the difference between a goal state and the current state of a system (Mayer, 1992;

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<sup>1</sup> Here it is important to note that control is not to be seen as merely a mechanistic concept.

Newell & Simon, 1972; Simon, 1996; G. F. Smith, 1989), emergency and disaster response management can be viewed as a problem-solving activity where relevant actors during an adverse event (current state) seek to protect societal values through meeting needs and minimise consequences (goal state). For these reasons, problem solving is in the remainder of this thesis viewed as a central part of responding to emergencies and disasters and therefore serves as an analytical lens for investigating how emergency and disaster response management performance can be further improved. Here, it should be acknowledged that there are other related, and perhaps more well-known, concepts like decision making, sensemaking or situation awareness in the field. These will be further discussed but, in brief, problem solving is not seen to be in conflict with these related concepts but can rather be seen as a more inclusive concept.

Despite several previous publications on both individual or collective problem solving in emergencies and disasters (see e.g. Albanese & Paturas, 2018; Gralla et al., 2016; Quarantelli, 1995), this literature was difficult to use to address the overall purpose of this thesis for two reasons. First, the identified publications mainly approach specific parts of the problem solving process, such as identifying or defining the problem, and rarely place these specific investigations in the larger problem-solving context. This renders it difficult to understand what the overall process of problem solving in emergencies and disasters is about. Second, there are few publications on problem solving in emergencies and disasters that provide precise arguments for how to transform recommendations into response management implementations that improve performance. This means that there is limited advice for which aspects of problem solving that are promising for investigating response management performance. This connects back to the argument that research on emergency and disaster response management appears to be less developed when it comes to improving practical problems such as how response management performance can be improved.

In this thesis, these two aspects motivated a broader search for useful problem-solving literature. In general problem-solving literature, phase models are frequently used to present the problem-solving process (Lipshitz & Bar-Ilan, 1996). These models identify a logical sequence of steps to be taken in the problem-solving process and argue that the outcome will be more successful if the steps are followed. Most phase models contain a step where the problem is represented, or defined, to oneself or others. Many scholars stress the importance of completing this step before attempting to diagnose or solve a problem (see e.g. Baer et al., 2012; Büyükdamgaci, 2003; Klein, 1998; Lyles & Mitroff, 1980; Massey & Wallace, 1996; Newell & Simon, 1972; G. F. Smith, 1989) and, in fact, it has been shown that effective problem solving relies on proper execution of early steps in the process, such as problem representation (Lipshitz & Bar-Ilan, 1996). This connection to performance motivated an initial focus on the concept of problem representation in this thesis. At this stage in the research process, having a shared, or collective, problem

representation was therefore assumed to be essential for effective problem solving in emergencies and disasters. Given this assumption, a relevant question to ask is what can impede or facilitate the process of achieving a collective problem representation. Therefore, the second research question, addressed in Paper II, is as follows:

**RQ2: In the context of emergency and disaster response management, what key factors are found to impact the collective problem representation process?**

Continuing on the path of collective problem representation, and given its expected importance, this thesis further explored its role in emergency and disaster response management. Viewing the widely used practice of creating *common operational pictures* (COPs) as a means for responding actors to communicate around problems they encounter during an adverse event, these can be regarded as an important tool for effective collective problem solving. In emergency and disaster response management, COPs are commonly used for sharing information among actors to achieve situation awareness (Comfort, 2007; Endsley, 1995; O'Brien et al., 2020; Spak, 2017; Wolbers & Boersma, 2013) and thus support coordination of activities (Comfort, 2007). COPs typically include information about the adverse event and its development, what is being done and what needs to be done in order to meet the needs and minimise the consequences, and are often created by and shared among actors in the response system (Landgren & Borglund, 2016). In other words, COPs can be seen as collective representations of the problems at hand and possible solutions to those problems, which can be communicated throughout the response system. Given their potential significance to collective problem solving in response management, it was found relevant to consider how problems are represented in COPs. Understanding how problems are represented in COPs enables an investigation into how problem representations can be interpreted by various response actors, and how they may inform the handling of adverse events. This opens up for an analysis of how problem representations in COPs can be developed and improved in order to best inform responding actors about what needs to be solved during the handling of the adverse event. Therefore, the following research question was developed and addressed in Paper III:

**RQ3: How are problems represented in common operational pictures used in emergency and disaster response management?**

The research process had up to this stage been quite explorative and of descriptive nature. However, to address the overall purpose, investigating possible research approaches of a more normative character was warranted. Such research approaches may facilitate investigations of desired effects of implemented or suggested measures, or interventions, in emergency and disaster response management. Interventions are here seen as something that can be implemented in a response management context, with the intention of improving the management of either all adverse events or specific types. Interventions can be, for instance, a new method

or a recommended way of working in a specific part of the management process. In the end, more normative research approaches may provide more precise arguments for how to transform suggested measures into response management implementations that improve performance. Therefore, the fourth research question, addressed in Paper IV, is:

**RQ4: How can emergency and disaster response management interventions and their effects on performance be investigated?**

In order to suggest how interventions and their effects on performance can be investigated, it was motivated to exemplify with an actual intervention, connected to problem solving, that can be found in the field. While problem representation characterises an important initial step of the problem-solving process, identifying and working toward a desired goal state is also fundamental. In many emergencies and disasters, the context is characterised by multiple organisations, each having their own responsibilities and organisational goals. At the same time, the organisations should strive towards the common goal of meeting societal needs and minimising consequences. In these multi-organisational response operations where inter- and intra-organisational goals co-exist, goal alignment is expected to improve outcomes (Aldrich, 2019) and is a recommended intervention in national frameworks (see e.g. FEMA, 2017; MSB, 2018). However, and especially interesting in the light of unclear, ambiguous literature (see e.g. Aldrich, 2019; Rosenthal et al., 1991), it appears that the effectiveness of goal alignment has not been investigated empirically and it therefore remains unclear whether, in a response situation, misaligned goals inevitably degrade outcomes – or not. Providing a relevant example for investigating the desired effects of an intervention, the following research question was formed and addressed in Paper IV:

**RQ5: Is goal alignment a useful intervention for improving response management performance?**

# Publications

## Appended papers

- I. **Frykmer, T.,** Uhr, C. & Tehler, H. (2018). On collective improvisation - A scoping study analysis. *Safety Science, 110*, 100-109. DOI:10.1016/j.ssci.2018.02.028  

I was the main author and conducted the scoping study. I was the main responsible for analysis and writing, and other authors contributed to the writing, according to the order of authors.
- II. **Frykmer, T.** (2020). "What's the problem?" - Toward a framework for collective problem representation in emergency response management. *Journal of Emergency Management, 18*(6), 511-524. DOI:10.5055/jem.2020.0504  

I was the single author and performed all part in the study as well as writing the article.
- III. **Frykmer, T. & Svenbro, M.** (submitted). Common operational pictures as collective problem representations: The case of the 2018 wildfires in Sweden. Submitted to an international peer-reviewed journal.  

I was the main author and main responsible for writing the article. The authors jointly selected the case, analysed the documents and discussed the results.
- IV. **Frykmer, T.,** Tehler, H., Uhr, C. & Wester, M. (2020). Advancing the Field of Disaster Response Management: Toward a Design Science Approach. *International Journal of Disaster Risk Science, 12*, 220-231. DOI:10.1007/s13753-021-00330-0  

The authors jointly developed the paper structure and the ideas in the paper. I planned and conducted the experiments and thus collected the data, however the computer game was developed by the second author. The fourth author was responsible for the statistical analysis, but all authors discussed and analysed the results. I took the main responsibility for writing the paper, but the authors jointly contributed to the writing, according to the order of authors.

## Related publications

**Frykmer, T. & Uhr, C.** (2015). Improvisation som en del av problemlösningen [Improvisation as part of the problem solving]. In C. Uhr (Ed.), *Att åstadkomma inriktning & samordning—7 analyser utifrån hanteringen av skogsbranden i Västmanland 2014* [Achieving direction & coordination - 7 analyses of the handling of the wildfire in Västmanland 2014] (pp. 179-209). Lund: Media-Tryck.

Uhr, C. & **Frykmer, T.** (2015). Vad är problemet? - Problemförståelse som en del i beslutsfattandet på olika ledningsnivåer [What is the problem? - Understanding the problem as part of the decision making on different levels of command]. In C. Uhr (Ed.), *Att åstadkomma inriktning & samordning—7 analyser utifrån hanteringen av skogsbranden i Västmanland 2014* [Achieving direction & coordination - 7 analyses of the handling of the wildfire in Västmanland 2014] (pp. 121-175). Lund: Media-Tryck.

**Frykmer, T., Uhr, C., & Bergström, J.** (2015). Organised behaviour in the Swedish fire and rescue service—a case study. *Proceedings of the European Safety and Reliability Conference ESREL*. Sept 7-10, Zurich, Switzerland.

Bergström, J., Uhr, C. & **Frykmer, T.** (2016). A complexity framework for studying disaster response management. *Journal of Contingencies and Crisis Management*, 24(3), 124-135.

**Frykmer, T. & Uhr, C.** (2018). What's the problem? An empirical study on how problems are expressed during emergency and disaster response. *Proceedings of the Third Northern European Conference on Emergency and Disaster Studies NEEDS3*. Mar 21-23, Amsterdam, The Netherlands.

**Frykmer, T., Månsson, P. & Svenbro, M.** (2019). Utvärdering av hur länsstyrelserna i Dalarnas, Gävleborgs och Jämtlands län bidrog till inriktning och samordning under skogsbränderna sommaren 2018 [Evaluation of how the county boards of Dalarna, Gävleborg and Jämtland contributed to direction and coordination during the wildfires in 2018]. Avdelningen för Riskhantering och Samhällssäkerhet, Lunds Universitet.

**Frykmer, T., Hassel, H., Cedergren, A., Fredholm, L., Uhr, C. & Wester, M.** (2021). Forskningsstudie av arbetet i länsstyrelsernas samordningskansli som etablerats med anledning av covid19 [Research study of the county boards' coordination office that was established for covid19]. Avdelningen för Riskhantering och Samhällssäkerhet, Lunds Universitet.

Nesse, S. & **Frykmer, T.** (2021). Politisk-administrativ ledelse i Norge och Sverige under pandemin: forskjell i ansvarsstrategi, kapasitet og legitimitet [Political-administrative management in Norway and Sweden during the pandemic: differences in strategy, capacity and legitimacy]. *Magma*, 3, 94-103.



# Emergency and disaster response management

Research on emergencies and disasters is relatively young and founded in many areas, such as sociology (see e.g. Lindell, 2011; Neal & Phillips, 1995; Quarantelli, 1997; Rodriguez et al., 2007), political science (see e.g. Ansell et al., 2010; Boin, 2004; Kalkman et al., 2018; Nohrstedt et al., 2018), public administration (see e.g. Comfort, 2007; Waugh & Streib, 2006), organisation studies (see e.g. Schulman et al., 2004; Weick, 1993), military science (see e.g. Brehmer, 2000), risk management (see e.g. Hassel, 2010; Lindbom & Tehler, 2019; Pennings & Grossman, 2008), safety science (see e.g. Antonsen, 2009; Dekker & Pruchnicki, 2014; Leveson, 2011; Rasmussen, 1990) and humanitarian settings (see e.g. Campbell & Knox Clarke, 2018). This diverse field has led to a variety of definitions of concepts and terms, which are oftentimes not agreed upon. This chapter explains how the concept of *emergency and disaster response management* is defined and used throughout the thesis. It should be noted that “response management” is at times used without “emergency and disaster” for stylistic reasons, however still representing the same meaning.

Emergency and disaster response management concerns responding to adverse events. These adverse events threaten what we value in society, for example human life and health and critical societal functions (Olsen et al., 2007) as well as property and the environment (Coppola, 2015). When it comes to labelling adverse events, there is a lack of agreement in naming and classifying various societal disruptions (Boin, 2004; Quarantelli, 2000). Terms such as “emergencies”, “disasters”, “crises” and “catastrophes” have different meanings for different individuals, and whether such events are ongoing or not is highly subjective (’t Hart & Boin, 2001). This thesis views adverse events as ranging from incidents and emergencies to disasters and catastrophes. Improving response management performance is nevertheless relevant for all adverse events and to reflect this broad perspective, “emergencies and disasters” will be used throughout the thesis. It should however be noted that, due to journal tradition or for the aid of using an umbrella term, different terms have been used in the appended papers.

Further, the focus of this thesis is on emergency and disaster *response*. The impact and handling of a disaster can be divided into its concentration in time (pre-impact, trans-impact and post-impact according to Lindell, 2011) or according to phases, or functions (e.g., hazard mitigation, disaster preparedness, emergency response and disaster recovery as according to the National Governors Association, 1978). Similar to classifying societal disruptions according to magnitude and scale, dividing an adverse event into phases can be controversial and lacks consensus. However, for the purpose of this thesis, emergency and disaster response is here seen as including “*actions aimed at limiting injuries, loss of life, damage to property and the environment that are taken prior to, during and immediately after a hazard event occurs*” with the time frame of “*beginning as soon as it becomes apparent*”

*that a hazard event is imminent and lasts until the emergency is declared to be over”* (Coppola, 2015, p. 321). In light of these definitions, emergency and disaster response concerns protecting what we value in society, such as human life and health, property and the environment, through actions taken to meet needs and/or minimise consequences resulting from an adverse event, concentrated in time.

Resources involved in responding to adverse events include official authorities such as the fire and rescue services, the police and the emergency medical services, as well as actors from the private sector, volunteers and non-profit organisations (Uhr et al., 2008). In this thesis, emergency and disaster response *management* is about effectively managing available resources, through transforming capability to effective action (Brehmer, 2006a; Ekman & Uhr, 2015; E. A. Smith, 2006). This perspective distinguishes between any actions taken when responding to an adverse event from those actions that actually produce effects in relation to the societal values that are threatened. Connecting back to the description of performance above, improving the performance of emergency and disaster response management is related to how well the response actors protect societal values and meet needs and minimise consequences following an adverse event.



# Conceptual framework

In this chapter, the conceptual framework used throughout the thesis is explained. The chapter first describes relevant problem solving literature and other concepts that are connected to problem solving and relates these concepts to the conducted research. The concept of improvisation was in this thesis initially perceived as useful for investigating collective response management performance, but was in Paper I found to be of limited help. Therefore, improvisation is only described in Paper I and not in this conceptual framework. Last, design science is presented to give a more comprehensive description of the research approach used in Paper IV.

## Problem solving

In this chapter, relevant problem solving literature that has helped in addressing the research questions and the overall purpose, thus guiding the research process, is presented. First, problem solving in the specific context of emergencies and disasters is addressed. Even though problem solving is relatively often described as a key feature in any managerial context (see e.g. Hicks, 1991), it should be acknowledged that there are differences between everyday administration and emergency and disaster response management that create partly different problem-solving environments. Above all, emergencies and disasters threaten what we value in society, meaning there are high stakes at play that create a sense of urgency (Quarantelli, 1995). While there are “slow-burning” (’t Hart & Boin, 2001), or slow on-set (see e.g. IFRC, 2018), emergencies and disasters, there is often a need for fast action (Quarantelli, 1995; Weick & Sutcliffe, 2015). Many adverse events are characterised by uncertainty and ambiguity (Uhr et al., 2018), and there is often a need for timely and multiorganisational response, which causes a rather unique blend of prerequisites and challenges. Acknowledging that the specific contextual conditions may vary between various types of adverse events (as argued by Quarantelli, 1995), this nevertheless illustrates important aspects of the problem-solving context in emergencies and disasters.

Both individual and collective problem solving in emergencies and disasters have been investigated in previous publications (see e.g. Albanese & Paturas, 2018; Beamon, 2004; Gralla et al., 2016; Hofinger & Buerschaper, 2009; Klein, 1998; Quarantelli, 1995; Tatham & Houghton, 2011; Vieweg et al., 2008). For example,

Quarantelli (1995) argues that using a problem solving model is more realistic for managing disasters than a command and control based model, and, Albanese and Paturas (2018) describe the importance of critical thinking skills in disaster management, including the ability to identify and define a problem. In the literature on problem solving in emergencies and disasters, however, two aspects were discovered that rendered this specific literature difficult to use for investigating how response management performance can be improved.

First, the concept of problem solving as an explicit, comprehensive, framework has not been fully explored in this particular context. In general, the identified publications rarely approach the problem solving process as a whole, but rather investigate specific parts, like identifying or defining the problem. In addition, these specific investigations are rarely related to the larger problem-solving context. Therefore, it is difficult to understand what problem solving as an overall process in emergencies and disasters is about. Second, there are few publications on problem solving in emergencies and disasters that provide precise arguments for how to transform recommendations into response management implementations that improve performance. This means that there is limited advice for which aspects of problem solving that are promising for improving emergency and disaster response management performance.

These aspects are motivated by a search in the database Scopus for relevant literature on problem solving in emergencies and disasters (and related search terms). This literature search, where over 1000 hits were scanned, indicated that there is a lack of publications that investigate problem solving in depth or give explicit directions for how to deal with proposed recommendations. Although important literature concerning problem solving in emergency and disaster response management might have been missed, due to e.g. using other terminology, this finding nevertheless indicate that there is little guidance on how to approach problem solving as a whole or how to operationalise suggested recommendations and, therefore, it is hard to investigate the potential performance of such recommendations. The latter connects back to the argument that research on emergency and disaster response management is much more developed in terms of its explanatory ambitions than when it comes to normative conclusions, meaning that arguments supporting conclusions of an explanatory nature are generally stronger and more salient compared to arguments of a normative nature.

Given this context, a broader search for relevant problem-solving literature in other research areas was motivated. Initially, it was relevant to look for literature in research domains where problem solving takes place in a similar context as mentioned above, such as in the military domain. Despite critics of military thinking in a civilian context (Quarantelli, 1995; Waugh & Streib, 2006), this field may offer valuable empirical and theoretical insights considering that the conditions for problem solving in a military context is similar to those in many civilian response operations, such as operating under time pressure and uncertainty with high stakes

at play. Acknowledging the critique of using military models for emergency and disaster response, this thesis however advocates a nuanced position realising that there may be misunderstandings about contemporary meanings of e.g. command and control (Uhr, 2009).

In the military command and control context, problem solving appears to be treated differently depending on which hierarchical level is referred to. Also, “problem solving” and “decision making” are often used interchangeably, which somewhat blurs the theoretical arguments. On an over-arching level, command and control is often described as problem solving. For instance, Brehmer (2010, p. 1) describes it as “*a human activity that aims at solving (military) problems*” and Vassiliou, Alberts and Agre (2015, p. 1) provide a definition of command and control as “*the set of organizational and technical attributes and processes by which an enterprise marshals and employs human, physical, and information resources to solve problems and accomplish missions*”. On higher levels of command, problem solving appears to be related to planning methods (see e.g. Erdeniz, 2017) and on lower levels, it seems like decision making is the dominating theoretical approach.

In military decision making at the field level, Boyd's so-called OODA (Observe - Orient - Decision - Act) loop (Boyd, 2018) represents the dominating practitioner's model (Brehmer, 2006b). The model has been developed into a function-oriented and more proactive, dynamic OODA model, or DOODA for short (Brehmer, 2005, 2006b), or, more recently and more similar to problem solving, a model where the functions are translated into processes (data providing, orientation, planning and influence) (Spak & Carlerby, 2018).

However, similar to the literature on problem solving in emergencies and disasters, the problem solving research in the military domain provided limited guidance on how to approach problem solving as a whole or how to operationalise suggested recommendations. The research is strong in motivating theories or ideas logically, however, it is not always clear what empirical conclusions the normative research builds upon. Consequently, this strand of literature was found difficult to use for investigating how response management performance can be improved. Therefore, it was deemed relevant to turn to problem solving literature from other fields to explore relevant theories.

As a theoretical concept, problem solving is part of many fields and studied in many different ways. It has played, and still plays, an important role in various fields like mathematics, psychology and computer science. Theories and ideas that develop in such diverse fields are not always in sync and quite often in conflict with each other. Here, the aim is not to present a comprehensive review on problem-solving research, but rather to introduce theories and concepts that are valuable tools to use when addressing the purpose of this thesis.

First, it is relevant to define the very basis for problem solving: there is some kind of a *problem*. In much of the problem-solving literature, there is considerable

agreement that a problem is: there is some kind of undesirable current state, it is desired to be in another state and there is no direct, obvious way to move from the given state to the goal state (Mayer, 1992). This definition resonates well with influential authors in the problem-solving domain, such as Duncker (1945) and Newell and Simon (1972), and represents the view on problems in this thesis. The definition highlights performance by focusing on reaching a goal, such as protect what we value in society. The component of an “undesirable current state” also connects well to emergencies and disasters, which indeed represent something undesirable, a disruption of some kind.

As problems represent a gap between perceived reality and something desirable, problems are intrinsically subjective and shaped by each individual’s beliefs, preferences or goals (Dery, 1983; G. F. Smith, 1989). Nevertheless, problems express beliefs about real things (G. F. Smith, 1993), such as adverse events threatening societal values. Although problems are commonly described according to their level of complexity, their subjective nature means that these descriptions are not objective and, in fact, reflect a value judgment (Dery, 1983). Nevertheless, problems can be described as *well-defined/-structured* (Reitman, 1964; Simon, 1973) or *structured-bounded* (Mitroff & Linstone, 1992), i.e., relatively easy to grasp and solve. On the other side of the scale, problems can be conceptualised as *wicked* (Rittel & Webber, 1973), *ill-defined/-structured* (Reitman, 1964; Simon, 1973) or *unstructured-unbounded* (Mitroff & Linstone, 1992). Denoting similar characteristics, the main message is that these types of problems are ambiguous, unconstrained and there are no objective solutions to be found. Current states and goal states are difficult to define, and, in fact, whether there is a problem or not is highly subjective (’t Hart & Boin, 2001; G. F. Smith, 1992), and how to reach the goal might not be agreed upon (Klein, 1998). In addition, these types of problems cannot be separated from the environment, i.e., they are difficult to place boundaries around, and they appear to have an infinite number of solutions, where a “good enough” solution often has to make do. Evaluation of implemented solutions is also challenging with these problems, due to the complex surroundings consisting of a multitude of interrelated factors and the issue of not being able to find objective solutions (Rittel & Webber, 1973). Solving such problems can be called *complex* or *dynamic* problem solving (Fischer et al., 2012, 2017; Greiff et al., 2012). Even though the perception of a problem can depend on the eye of the beholder, many problems in emergencies and disasters are nevertheless considered wicked, or ill-defined in the literature (see e.g. Boin et al., 2020; Christensen et al., 2016; Roberts, 2001).

Much of the general problem-solving research has been performed at the individual level, where problem solving is studied as a cognitive process, often connected to thinking and reasoning (Mayer, 1992, 2013; Sternberg, 1994). In this thesis, however, the focus is on collective processes, meaning that, although collective

problem solving is individual at the foundation, this thesis does not focus on cognitive processes and individual problem solving.

When it comes to research on problem solving at a collective level, there is still quite an extensive body of research (see e.g. Hargadon & Bechky, 2006; Holloman & Hendrick, 1971; Hung, 2013; Marquart, 1955; Mitroff & Linstone, 1992; Taggar & Brown, 2001). Acknowledging that relevant literature might have been missed in this vast area, it was however, similar to the case of emergency and disaster literature, problematic to find literature that explained the overall process of collective problem solving or provided advice on which aspects that are promising for investigating how response management performance can be improved. Therefore, in order to understand relevant aspects of problem solving, it was found necessary to turn to more general problem-solving research.

In the vast research domain of problem solving, phase models are frequently used to present the problem-solving process (Lipshitz & Bar-Ilan, 1996). These models identify a logical sequence of steps to be taken and argue that the outcome will be more successful if the steps are followed. Shortcomings in phase models have been observed by several researchers (Klein, 1998; Lipshitz & Bar-Ilan, 1996; Mintzberg et al., 1976; Witte et al., 1972). Notably, the descriptive validity of their linear logic has been questioned in real-world settings (Klein, 1998; Klein et al., 1993), and steps have been found to be blurred (Witte et al., 1972). To better suit the real-world context where problems may be ill-defined and where pursuing the steps in a particular order is oftentimes considered unrealistic, Klein (1998, p. 122) suggests a non-linear problem-solving model. This model allows for e.g. redefinition of the problem and re-evaluation of the course of action, important activities that are perceived as lacking in linear phase models. For both linear and non-linear problem-solving models, however, the steps can generically be summarised as: representing the problem, generating a course of action, evaluating the course of action and carrying out the course of action (Klein, 1998). In this thesis, conceptualising problem solving through these generic steps has been helpful in order to understand what problem solving in emergencies and disasters can be about.

When it comes to problem solving and performance, there is still a need for empirical studies investigating the prescriptive validity of the problem-solving process as a whole (Lipshitz & Bar-Ilan, 1996). However, it has been shown that effective problem solving relies on proper execution of early steps in the process, such as problem representation (Lipshitz & Bar-Ilan, 1996). After detecting a problem, the problem solver should represent the problem, i.e. specify the problem and represent it to oneself and others in a conceptual process (see e.g. Klein, 1998; G. F. Smith, 1989). The problem representation phase usually includes goal setting and, if necessary, diagnosis, i.e., analysing and establishing the cause of the problem.



The importance of representing the problem before solving it is commonly emphasised by researchers in the problem-solving domain (Baer et al., 2012; Büyükdamgaci, 2003; Klein, 1998; Lipshitz & Bar-Ilan, 1996; Lyles & Mitroff, 1980; Massey & Wallace, 1996; Newell & Simon, 1972; G. F. Smith, 1989). Considering that problems are subjective conceptualisations of a perceived gap in preferences and not, for example, physical entities that can be easily pointed to, it is argued that they must be described and expressed in order to have their existence communicated and to enable problem solving (Ackoff, 1978; Baer et al., 2012; G. F. Smith, 1989). Problem representation becomes even more important when faced with messes, i.e., situations consisting of complex systems of problems that are changing and interacting with each other and are difficult to define (Ackoff, 1979), such as commonly prevalent in emergencies and disasters. In these situations, it is especially important to represent the problem in order to avoid solving the wrong problem correctly (Büyükdamgaci, 2003; Mitroff & Linstone, 1992; Niederman & DeSanctis, 1995; G. F. Smith, 1989). However, whether real world problems, which are by definition ill-defined/-structured and carry no objective solutions, can be represented at all can be questioned (Dery, 1983; Klein, 1998; G. F. Smith, 1989). Nevertheless, given their assumed importance for the outcome of problem solving, problem representation is central to this thesis and investigated in Papers II and IV.

## **Related concepts**

Some concepts related to problem solving, that are perhaps more well-known in the field, needs to be acknowledged in relation to this research. In this chapter, relevant concepts are briefly described, together with explanations of how they relate to this thesis. It is important to note that problem solving is not in conflict with these related concepts but can rather be seen as a more inclusive concept.

### *Decision making*

Above all, *decision making* is a closely related concept to problem solving. In the literature, some see problem solving as an umbrella term including decision making, and some see decision making as an umbrella term including problem solving (Klein, 1998). Often, problem solving and decision making are used interchangeably (Dery, 1983; G. F. Smith, 2009). Definitions of decision making are oftentimes not agreed upon, and reflect a difference in scope. For instance, decision making can be defined as “*the cognitive processing involved in choosing between two or more alternatives*” (Mayer, 2013, p. 774), clearly denoting a narrow perspective. On the other hand, decision making can be defined as “*the process of solving a particular type of problem, arriving at a good decision*” (Yates, 2001, p. 17), which is closely related to problem solving.

In this thesis, problem solving is viewed as encompassing decision making and, therefore, decision making as such is not in focus in this thesis. The reason for this

is foremost that problem solving can be used as a wider framework. As expressed by Landry (1995), problem solving encompasses the whole set of activities from problem recognition to choice and implementation of a solution, whereas decision making is oftentimes restricted to evaluation and choice. In this whole range of activities, problem solving's explicit focus on representing the problem and setting goals emphasises the focus on effect and performance. Many decision making theories, on the other hand, often assume goals as pre-existing entities, and fail to distinguish between “problems”, i.e. what is wrong, from “decision problems”, i.e. what to do (Dery, 1983). Nevertheless, decision making is central to the problem-solving process, and there are therefore relevant decision-making approaches that are useful in a problem-solving framework (Landry, 1995). In this thesis, it is acknowledged that there are several decision-making theories that may be applicable. Examples are as rational choice (see e.g. von Neumann & Morgenstern, 1944), satisficing (Simon, 1956, 1996), the Cynefin framework (Snowden & Boone, 2007), dynamic decision making (Brehmer, 2000; Brehmer & Allard, 1991), the Recognition Primed Decision model (Klein, 1993) or how heuristics and biases affect decision making (Kahneman, 2011; Kahneman & Tversky, 1979). However, as previously stated, decision making as such is outside the scope of this thesis.

### *Sensemaking*

Another related concept to problem solving is *sensemaking* (see e.g. Klein et al., 2010; Weick, 1988, 1993; Weick et al., 2005), which is widely used in emergency and disaster research and practice, both at an individual and collective level. Acknowledging that there may be other strands of sensemaking literature, it is in this thesis interpreted as largely being about acting in order to understand and influence the situation. In this case, acting precedes understanding, in so called retrospective sensemaking (see e.g. Weick, 1988, 1993), which differs from the problem solving process where one should try to understand and represent a problem before attempting to solve it. Also, whereas problem solving explicitly focuses on effect and goal setting, sensemaking does not explicitly address aspects of performance. For these reasons, the concept of sensemaking is not used for fulfilling the overall purpose of this thesis. Nonetheless, sensemaking can be of relevance to the problem solving process, particularly when solving wicked, or ill-defined, problems. Here, it can be questioned whether individuals are able to, or take their time, to represent the problem during situations of uncertainty and time pressure, which means that acting in order to make sense of the situation can be necessary.

### *Situation awareness*

Last, *situation awareness* (see e.g. Danielsson et al., 2014; Endsley, 1995, 2015; Salmon et al., 2008, 2012), either individual, shared, team or distributed, is another widely known concept that relates to problem solving. Situation awareness can be described as a process in itself (Durso & Sethumadhavan, 2008), or as a product

preceded by the process of situation assessment (Endsley, 1995, 2015). Situation awareness bears similarities with problem representation, as they both represent some sort of state of knowledge about the situation. As described in Jones (2015, p. 98), at the most basic level, situation awareness could be described simply as “*knowing what is going on around you*” or “*having the big picture*”. What distinguishes the two however, is the connection to performance.

In this thesis, the purpose of situation awareness is interpreted as to fundamentally generate a better understanding of a situation (similar to Stanton et al., 2017). According to Spak (2017), however, situation awareness needs to be connected to a specific activity or task in order to be useful, i.e. it should be connected to “awareness of what”. This is interpreted as without the “what”, it is hard to explicitly judge the effect of the achieved situation awareness. This argument is similar to that of Dekker and Hollnagel (2004), who illustrate that situation awareness, although assumed to be causally related to observable behaviour, is a non-observable construct, rendering it hard to judge the effect of e.g. “loss of situation awareness”. The authors mean that situation awareness is related to an intermediate cognitive state rather than actual performance and that it is rather in the observable behaviour, such as deficient decision making or diverted attention, that one should look for explanations for performance. Problem representation, on the other hand, is clearly connected to performance through the explicit focus on effect (solving a problem). Therefore, although situation awareness can be used to explain parts of the problem solving in response management, this concept is not used to address the overall purpose in this thesis.

## Design science

The focus on performance and solving real world problems is central to this thesis. The academic tradition of *design science* refers to this specifically, and has thus played a significant role in this thesis. The purpose of this chapter is to describe the foundations of design science and how it relates to the performed research.

There are several ways to categorise science. Paper IV in this thesis makes use of van Aken’s (2004, p. 224) distinction between:

“...three categories of scientific disciplines: (1) The formal sciences, such as philosophy and mathematics. (2) The explanatory sciences, such as the natural sciences and major sections of the social sciences. (3) The design sciences, such as the engineering sciences, medical science and modern psychotherapy.”

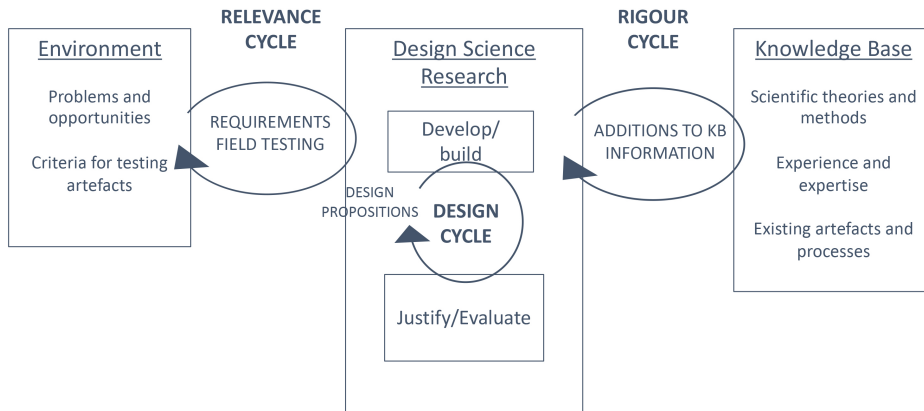
Relevant to this thesis are explanatory and design sciences. The mission of the explanatory sciences is mainly to describe, explain and possibly predict phenomena in the social world (see e.g. Simon, 1996; van Aken, 2005a, 2005b; Walls et al.,

1992). The knowledge produced in this type of research is mainly descriptive. The mission of the design sciences, on the other hand, is to develop knowledge of how to best achieve goals and improve a specific professional context, which is central to this thesis and at the basis of Paper IV. It should be noted that the term design science is hereafter used as an umbrella term covering what is considered at the basis of various design sciences (such as engineering or medicine), namely the focus on improving the performance of a particular aspect. To a great extent originating from Herbert Simon's seminal work *The sciences of the artificial* (first published in 1968), a central aspect of design science is the distinction between what is natural and what is artificial, or man-made (Simon, 1996). According to Simon, an artificial object, or artefact, is, as opposed to natural objects, created intentionally by human beings, with a purpose and designed to attain a certain goal. Design science thus concerns how things *ought to* work in order to attain goals, and the purpose of design science research is therefore to produce prescriptive knowledge. It should be noted that *normative* is commonly used to distinguish between descriptive knowledge and knowledge concerned with how things ought to be, without making the distinction between *should* and *ought to*, as can be relevant. In this thesis, the term normative is seen as a term focusing on *should* (and prescriptive focuses on *ought to*). However, as the term normative appears to be used as an umbrella term covering prescriptive knowledge, it is in this thesis therefore used for more general discussions whereas prescriptive is used particularly in relation to design science.

## **A conceptual model of design science research**

After Herbert Simon's influential work, much of the ideas on design science have been developed in the fields of Organisational research (e.g. Romme, 2003), Management studies (e.g. van Aken, 2004), Information systems research (e.g. Hevner et al., 2004; March & Smith, 1995) and Engineering (e.g. Horvath, 2004).

Based on Hevner et al. (2004, p. 80) and Hevner (2007, p. 88), but slightly adapted to this thesis, Figure 1 summarises relevant ideas from this literature. Four main aspects of design science that are central to this thesis can be illustrated using the figure: 1) the combination of descriptive and prescriptive research approaches, 2) a focus on solving real field problems, 3) emphasising a synergy of relevance and rigour and, 4) the concept of design propositions as outputs from the design science research.



**Figure 1. A conceptual model of design research in this thesis (adapted from Hevner, 2007, p. 88; Hevner et al., 2004, p. 80)**

Historically, the idea of combining descriptive and prescriptive research approaches to solve real field problems has been central in design science. For instance, March and Smith (1995) argue that information systems research, concerned with artificial objects, should be studied using both natural and design science research approaches. Being artefacts, information systems can be both created and studied, i.e. exhibiting a dual nature that relates to both prescriptive and descriptive approaches. Hevner et al. (2004) comparably argue that truth, or justified theory (the goal of natural science), and utility (the goal of design) are inseparable and should inform each other. This perspective is found in Paper IV where a combination of descriptive and experimental research is suggested to develop design knowledge in the area of response management.

The idea of combining descriptive and prescriptive research approaches to solve real field problems is further illustrated by three cycles of activities in design science research (Hevner, 2007): the *relevance cycle*, *rigour cycle* and *design cycle* (see Figure 1). The relevance cycle initiates the research with some requirements (i.e. a problem or opportunity to improve a situation) coming from the environment. The environment also defines criteria for evaluating the research results, which are used when testing the designed artefact in the field. The relevance cycle ensures that the research is relevant to the field. The rigour cycle provides the design science research with information from a vast knowledge base of scientific theories and methods, experience and expertise from relevant research domains and from existing artefacts and processes, providing the foundation for rigorous research. This input is naturally from both descriptive and prescriptive research. Grounding design propositions on existing scientific knowledge enables an efficient design by building upon past research, and at the same time explaining why the artefact gives the desired performance. Focusing on relevant, real field problems and basing

solutions on existing knowledge, means that design science research can contribute to bridge the rigour-relevance dilemma (Argyris & Schön, 1989). This dilemma means that theory (or research) is either scientifically proven but not of practical relevance, or relevant to practice but lacks in rigour. Paper IV describes an investigation into an intervention of possible practical relevance (goal alignment), using controlled experiments to increase the research rigour, so as to contribute to bridge the rigour-relevance dilemma.

In the design cycle, activities from both descriptive and design research are conducted. Theories or assumptions that may explain the problem at hand are developed and justified. Artefacts that may solve the problem are then built and evaluated against their purpose. As a result from the design science research, additions to the knowledge base can be made in the form of extensions to original theories and methods, new artefacts or processes, or experience and expertise gained from performing the research. The artefacts as outputs from the design cycles can be called *design propositions*, which is an important concept in design science (see e.g. Romme, 2003; van Aken, 2004, 2005a, 2005b), and used in Paper IV.

Van Aken (2004, p. 227) denotes design propositions as having the logical form of: “*If you want to achieve O in context C, do something like P*”. Important to note is that this general proposition (expressing “something like P”) then needs to be translated to the specific field problem at hand, which is often an activity for the professional context. There is great variation in terms of how concrete design propositions are. For example, it can be an algorithm specifying a very precise method to do something or, more likely in the context of response management, a heuristic similar to the general proposition given above (that is, it includes the notion of “...do something like...”). Importantly, the proposition does not need to be condensed into an algorithm or resemble the statement above. It reflects the intervention-outcome logic of a specific proposition, but the actual description might be contained in, for example, a guideline, book, or instruction video (van Aken, 2005a). In addition, a single design proposition may not solve a real field problem on its own, but rather several design propositions can make up a solution. In Paper IV, the concept of design propositions is used to illustrate how knowledge intended to improve professional practice can be generated in a transparent and logically consistent way.

In order to evaluate design propositions against their purposes, several methods may apply. Hevner et al. (2004) describe observational, analytical, experimental, testing or descriptive evaluation methods. Other authors in design research (see e.g. Carlsson et al., 2011; Romme, 2003; van Aken, 2004, 2005a) suggest to use an incremental test cycle called alpha, beta and gamma testing from software development as a method for testing design propositions. Hevner (2007) argue that artefacts should be tested in laboratory and experimental situations before testing in the field, which calls for iterations in the design cycle before research contributions are input to the relevance cycle. In a similar vein, updating relevant information

from the relevance and rigour cycles through several iterations may also be relevant during the design process. In Paper IV, an analogy from the development of modern medicine is used to argue for testing design propositions using controlled experiments, where each step is carefully evaluated and only promising solutions are brought forward to the next development step. The final evaluation can be seen in the closing of the relevance cycle; artefacts that are developed through the design research should be applied and tested in the environment, so that they truly solve the real field problem in question.

# Research philosophy

In the pursuit of developing knowledge, researchers, consciously or not, make a number of assumptions (Burrell and Morgan, 1979 in Saunders et al., 2009). These assumptions will inevitably shape how the particular research project is carried out; including how research questions are understood, what methods are used and how findings are interpreted (Crotty, 1998). In this chapter, the assumptions underpinning this research are presented, including assumptions on *ontology* (how we perceive reality, and consequently our research objects), *epistemology* (how we obtain knowledge about the reality) and *axiology* (the role of values and ethics within the research process).

The research area in this thesis, emergency and disaster response management, concerns protecting what we value in society through actions taken to meet needs and/or minimise consequences resulting from an adverse event. There are few who would contend that during adverse events, people really die or are injured, buildings really collapse and areas are really flooded, even if no one is there to observe it (Shrader-Frechette, 1991). Also, there is little doubt that individuals and organisations act and organise in various ways to meet the needs and handle the consequences. The belief in this thesis is that adverse events, including consequences, and emergency and disaster response management in some form really exist. This reality, however, cannot always be understood because of a lack of direct access to what is really going on. Instead, it must be understood and interpreted in the light of e.g. context, experience, knowledge, values and what is possible to observe. For instance, what is perceived as a disaster depends on the perspective taken. A car crash where three out of four family members die is a disaster for the remaining family member, but probably not considered as more than an accident on a societal level.

These ontological and epistemological assumptions resonate well with *critical realism*, which was mainly brought forward by Roy Bhaskar in the 1970s as an alternative to positivism and interpretivism in the philosophy of science (Sayer, 2000). Focusing on explaining what we see and experience, related to the underlying reality that shape the observable events (Saunders et al., 2009, p. 138), critical realism rests on an ontological realism, an epistemological relativism and a judgmental rationality (Archer et al., 2016; Bhaskar, 2008; Sayer, 2000).



*Ontological realism* means that reality exists and operates outside our knowledge of it (Archer et al., 2016; Bhaskar, 2008; Sayer, 2000). Reality is differentiated in three ontological domains: the real, the actual and the empirical (Brandén, 2015; Saunders et al., 2009; Sayer, 2000). These domains distinguish critical realism from realism, where observers are assumed to have direct access to reality through their senses. In critical realism, however, the empirical, i.e. what is observed, is only the tip of the iceberg. Here, the real domain consists of objects that exist, be it natural or social, regardless of whether we have observed them or have an understanding of them (Sayer, 2000). In order for something to be real, however, its existence must be able to cause something actual (Brandén, 2015), regardless if they do that or not. The actual domain refers to what happens if and when the objects cause something to happen, and this may or may not be observed (Saunders et al., 2009). The empirical domain therefore refers to events that we have actually observed or experienced. These empirical events may be understood quite differently by observers, meaning that there is a process of interpretation taking place between the actual and empirical domains (Easton, 2010).

Already implied by this differentiation of ontological domains, critical realism further rest on an *epistemological relativism*, which recognises that our knowledge about the reality is always historically, socially and culturally situated and thus dependent on context, concepts and human activity (Archer et al., 2016; Saunders et al., 2009).

The combination of ontological realism and epistemological relativism leads to the importance of *judgmental rationality*, i.e., asserting criteria for judging which accounts about the world are better or worse (Archer et al., 2016). This means that it will be possible to make claims about reality that are relatively justified, such as comparatively objective reasons for affirming one conceptual model over another. Interpretations or observations of reality rely on assumptions which, together with other assumptions, create a system of thinking that we find acceptable (Easton, 2010). In Paper IV, this is referred to as “justified beliefs”.

Last, the *axiological assumptions* concern how researchers deal with both own values and those of the research participants (Saunders et al., 2009). According to the epistemological assumptions in this research, it is impossible for a researcher to be objective and value-neutral in the pursuit of knowledge. However, the researcher should strive to be aware of how one's socio-cultural background and experiences might influence one's research, and try to minimise biases and be as objective as possible (Saunders et al., 2009). This, and the context-dependent knowledge means that the researcher must be critical of the objects or phenomena studied, hence the word “critical” in critical realism. How effects of researcher bias were mitigated and how a critical approach was pursued in this thesis is described in respective methods below.

# Methods and materials

Within critical realism, the choice of research method depends on the problem at hand and the object of study, allowing for a wide range of methods (Sayer, 2000). Consistent with critical realism, the choice of methods for this research has been informed by the relevant research problems, and a plurality of methods has been used. As a consequence, both qualitative and quantitative methods have been applied throughout the thesis. The various methods have served different purposes. For example, interviews and qualitative content analysis were used for descriptive purposes whereas controlled experiments were used to investigate cause and effect of a response management intervention.

This section provides an overview of the methods and materials used, as summarised in Table 1. More detailed descriptions can be found in respective paper.

**Table 1. Methods and materials**

	<b>METHOD</b>	<b>MATERIAL</b>
<b>Paper I</b>	Scoping study Qualitative content analysis Conceptual research	Title and abstract analysis of 2053 articles in Scopus database, snowballing of references in relevant articles  In-depth analysis of 66 articles.
<b>Paper II</b>	Semi-structured interviews Qualitative content analysis Conceptual research	21 disaster response management professionals in the USA and Sweden
<b>Paper III</b>	Qualitative content analysis	41 documents (common operational pictures)
<b>Paper IV</b>	Controlled experiments Statistical analysis Conceptual research	111 participants (students and fire and rescue service professionals)

## Scoping study

There are many types of literature reviews and associated methodologies. For example, Grant and Booth (2009) have identified 14 different review types, and Arksey and O'Malley (2005) mention 8 different types. There appears, however, to be a lack of consistent definitions and agreement among these types of reviews (Arksey & O'Malley, 2005; Grant & Booth, 2009), leaving it up to the researcher to judge whether a specific methodology is suitable or not.

In Paper I, a *scoping study* was performed, which is an approach for systematically mapping the literature, or “scoping the field”, on a specific topic (Arksey & O'Malley, 2005). The reason for performing a scoping study was, contrary to many literature reviews, neither to develop or evaluate a theory, nor to identify a particular problem (Baumeister & Leary, 1997). Rather, applying a scoping study method allowed for mapping a field of study (improvisation) where it is difficult to visualise the range of available material; and then identifying gaps in the literature. Since improvisation is a concept found in many research areas, the intent was to address a broad research question and apply it to many areas of research, which a scoping study allows for (Poth & Ross, 2009). Grant and Booth (2009) describe a potential risk for bias when conducting scoping reviews, as they do not include a quality assessment of the identified material but rather focus on the existence of studies. In Paper I however, this risk was mitigated by taking the scoping study a step further to analyse the results with the paper's research questions in mind.

In Paper I, following the steps of a scoping study (Arksey & O'Malley, 2005; Daudt et al., 2013; Levac et al., 2010), a broad research question (*What is known in the scientific literature about improvisation at various levels of analysis?*) determined the keywords that were applied in a search in the database Scopus. The database search resulted in a title/abstract screening of 2053 unique titles. In addition, references were added through snowballing from found literature, a Google search and advice from scholars. In the end, 66 articles were included in the analysis.

One possible concern with scoping studies, or similar literature reviews, can be that of lack of transparency in the process, which relates to its reliability. In Paper I, transparency was preserved by thoroughly documenting and displaying all steps, which means that they could be repeated. Also, there is a risk that certain steps in a scoping study are prone to bias, which may weaken validity. Issues include the selection of the literature to incorporate and the process of judging the quality and relevance of theories and methods, which can be affected by the background and values of the researchers. Furthermore, in this particular study, only the first author selected the relevant papers and carried out the in-depth analysis. Acknowledging that these issues may weaken the study's validity, the risk was mitigated by critically examining and discussing the process and documents with colleagues at numerous times.

## Interviews

Paper II investigates collective problem representation and identifies key factors that may affect the process. Considering the explorative approach, it was designed as a qualitative interview study conducted through *semi-structured interviews*. The purpose was to investigate what key factors influence the discussion of individual problem representations, and interviewing was therefore deemed a relevant method. The study was designed around eliciting these possible factors and therefore, semi-structured interviews, rather than an unstructured approach, were chosen to collect data. Further, the purpose was to learn about these factors through the interviewees' own perspectives, and therefore structured interviews with set questions (Bryman, 2008) were deemed less useful. Semi-structured interviews allow for fairly specific topics to be discussed, using an interview guide, but where the interviewee has a great deal of flexibility in how to reply, and the interviewer may ask questions that are not included in the guide (Bryman, 2008, p. 438). In Paper II, interviews were conducted using the Critical Decision Method (Hoffman et al., 1998; Klein et al., 1989). The method is developed to extract information about cognitive functions such as problem solving, in challenging events characterised by time pressure (Crandall et al., 2006), which was found suitable for the specific study. Using an interview method investigating individual cognitive functions may seem unsuitable for investigating a collective process such as collective problem representation. However, as the study focused on individuals' experience of sharing problem representations, which ultimately affects the possibility to achieve a collective problem representation, this motivated the use of the Critical Decision Method.

It should be acknowledged that respondent bias, i.e. the possibility that respondents might see the researcher as a threat and therefore withhold information or answer in a way they believe will satisfy the researcher, is a possible problem related to the validity of interview studies (Robson, 2002). Two aspects are seen to mitigate this potential risk in the present interview study. First, the fact that the author has no professional experience in the field, and thus could take an outsider role in the interviews, can limit the notion of the researcher as a threat. Second, the goal was to reduce the sense of threat by establishing trust early in the interviews and avoiding unnecessary use of complicated language.

In Paper II, 21 interviews were performed in the USA and Sweden and interviewees were selected according to a snowball approach (Bryman, 2008, p. 184), where initial contacts with response management professionals were used to establish contact with others. Snowball sampling is often used when there is no accessible sampling frame for the population (Bryman, 2008, p. 458), such as in this case with the quite indistinctive study population of “response management professionals”, representing a very broad and dispersed group. Using snowball sampling means that it is very unlikely that the sample will be representative of the population (Bryman, 2008, p. 185), however, in the study, the purpose was not to generalise but to

exemplify. This, in addition to pragmatic reasons such as getting access to informants, rendered snowball sampling suitable for the study. Interviews were either recorded and transcribed or extensive notes were taken.

## **Controlled experiments**

The data collection methods described so far were used for descriptive purposes. In contrast, to address research questions 4 and 5 in this thesis, *controlled experiments* were discussed and used for prescriptive purposes. Paper IV suggests to integrate design research with explanatory research to support the general development of design knowledge in response management. The suggested approach includes using controlled experiments as method to improve research rigour and draw robust conclusions regarding the effectiveness and relevance of various interventions, which is fundamental to design science and described above.

Experiments are a way to control conditions and study cause-effect relationships (Andersson, 2012; Cunningham & Wallraven, 2011), and are therefore suitable for investigating response management interventions. The experimenter is an active participant in the research by changing the state of a system and investigating the effects, as opposed to a passive observer that investigates a pre-existing state. In Paper IV, the suggested experimental approach concerns laboratory experiments, as opposed to field experiments, due to the difficulty in controlling the adverse event and the response management to study effects of interventions.

In Paper IV, an experimental study was designed to test goal alignment as an effective response management intervention. The experiment was conducted through a computer game, which was developed by one of the authors. Four salient features of the response management context were identified and represented in the computer game, namely: there are threats that need to be managed, there is time pressure, there is potential to collaborate and share resources, and, there is potential to positively influence the outcome of the situation. The purpose of the game was to use these features to test an intervention aimed at increasing goal alignment. The independent variable was goals (aligned or misaligned), and the dependent variable was the outcome of the game, specifically, the number of consequences. Three main sets of participants (in total, 111 participants) were used to test the experimental hypothesis, one set of fire and rescue service commanders and two sets of student groups. The sampling strategy is best described as *convenience sampling* (Bryman, 2008, p. 183), where it was possible to get access to both professionals through a regional course on response management and to students enrolled in university courses. A drawback with such a sampling strategy is that it is not possible to generalise the findings (Bryman, 2008, p. 183). However, since the aim of the study was to support incremental development decisions concerning a specific intervention, rather than generalising, this is not perceived as a problem. In each set, participants were randomly assigned to groups of three and the groups were then

randomly ascribed to either a condition representing aligned goals or one representing misaligned goals. After running the experiments, an analysis of variance (ANOVA) was conducted to investigate the effects of goal alignment.

There are concerns regarding performing laboratory experiments to simulate and test real-life problems, such as in Paper IV, that should be acknowledged. For example, their inability “*to incorporate factors that are crucial to much real-life decision-making*” (Eiser et al., 2012, p. 14). Similar opinions have also been described more generally in other areas of research (Berkowitz & Donnerstein, 1982). These concerns relate to the external validity of experiments, notably, the extent to which results can be generalised to other contexts and, specifically, the extent to which they can be generalised to a real-world context (sometimes referred to as ecological validity). Such concerns are relevant if the purpose of the experiment is to explain or predict some phenomenon in response management, but, if the purpose is to support the development of an artefact, here an intervention, the situation is different. In this case, whether an experiment is valid or not should be judged according to if we have reasons to believe that the effect of the intervention is correlated with its effect in the real context. Although an experiment may have little external validity (that is, the experimental context is unlike the practical context and results cannot be generalised), this does not discount the experimental method. Instead, the key question in the case of developing design knowledge, such as for interventions in response management, is whether the experimental context represents a valid model of the real context it aims to represent. When it comes to experimental models reflecting the context of response management, there is unfortunately little guidance. Therefore, there is uncertainty regarding the validity of the features selected to resemble the practical context in the experiment in Paper IV. For example, there could be other contextual factors that were overlooked, or a computer game may have failed to create the sense of urgency that is often present in emergencies and disasters.

## **Qualitative content analysis**

*Qualitative content analysis* was used as a data analysis method in Papers I, II and III. In its most simple form, a content analysis can be the search for certain words, items or categories in a text (Prior, 2003). Further elaborated, a qualitative content analysis involves searching for underlying themes in the material being used (Bryman, 2008, p. 529). This kind of analysis follows an iterative and reflexive process, with some categories and variables initially guiding the analysis, but allowing for others to emerge during the study (Altheide & Schneider, 2013).

In Paper I, this approach was found useful in order to investigate the connection between collective improvisation and performance and how collective improvisation can be measured and improved. Typically, the scoping study method does not include an analysis of the literature, but rather assembles and disseminates

the findings without evaluating their quality. However, as the aim was to go beyond describing the literature, the results were analysed with the paper's research questions in mind, resembling a pre-determined coding scheme, albeit allowing for other categories to emerge.

In Paper II, the interview data was imported into the Nvivo software package, which was used to structure the data for the qualitative content analysis. Categories were identified based on key factors that emerged as having an impact on the discussion of individual problem representations; these categories were common to several interviewees and judged to describe a central, common concept. After initial coding, transcripts were revised once again, in an iterative process, and categories were narrowed down by coding and uncoding interview segments. In order to achieve analytic consistency, the coding was discussed with a second researcher, who also coded two interviews based on the initial coding.

In Paper III, a qualitative content analysis of 41 common operational pictures (COPs) was used to identify how problems are represented in these. In the literature, there is limited guidance to how problems can be expressed, and therefore the iterative and reflexive nature of a qualitative content analysis was found helpful in fulfilling the purpose of the paper. In this case, some problem representation categories were initially applied to sort the data and provide a first, deductive step of the coding process. During the coding process, however, these categories proved to be difficult to use as a basis for the content analysis, and, therefore, it was decided to investigate problem representations according to their linguistic variation. This means that the analysis looked beyond the categories and into the content of the problem representations. Key themes were identified, suggesting examples of dominant problem representation categories in the COPs. It should be acknowledged that documents are always created for a particular purpose, shaped by the particular setting to serve some sort of function (Coffey, 2014). This means that they are produced for some other purpose than research (Gross, 2018), and consequently not produced to match, in our case, how problems are represented. As a result, during the analysis process, it was important to not try to force passages of information into the selected coding categories, but rather leave that particular information uncoded.

## **Conceptual research**

The research methods presented so far are connected to performing empirical research to generate knowledge related to real-world activities. In Papers I, II and IV, *conceptual research* was, in combination with the empirical research, also used in order to summarise and question a concept (collective improvisation), delineate a new concept in the particular context (collective problem representation) and to provide guidance on how to research a specific phenomenon (a combination of explanatory and experimental research). It should be noted that conceptualisation,

as used here, might not be a research method *per se* but may rather represent a research activity. Concepts means “*ideas, perceived facts, beliefs, mental pictures, perceptions, and theories*” (Rallis, 2018, p. 2) and, in turn, conceptualisation is “*a process of abstract thinking involving the mental representation of an idea*” (MacInnis, 2011, p. 140), and may involve visual outputs in the form of e.g. process models or figures. Even though conceptualisation is at the heart of any research endeavour, such as when identifying research problems or developing hypotheses, the conceptual research in this thesis is referred to as an explicit investigation of concepts, including creating and exploring conceptual models or frameworks.

The scoping study in Paper I summarises the concept of improvisation, i.e. it takes stock of what is empirically known from many disparate instances to a manageable set of key take-aways (MacInnis, 2011). Through aiming at providing conclusions that are clear, accurate and consistent with the data, and identifying knowledge gaps and laying out research priorities, the paper meets several of MacInnis' (2011) criteria for a “good conceptualisation paper”. In the end, Paper I can be seen to question, or refute, the concept of collective improvisation as a useful concept for explaining performance in response management.

The conceptual frameworks developed in Papers II and IV serve as “*organizing structure[s] or scaffold[s] that integrates related ideas, mental images, other research, and theories to provide focus and direction to the inquiry*” (Rallis, 2018, p. 2). First, the conceptual framework for collective problem representation in emergency and disaster response management in Paper II illustrates core assumptions and consolidates problem solving concepts and response management aspects. The framework delineates the collective problem representation process and illustrates the focus of the study: the boundary at which individual problem representations may be discussed and contribute to a collective problem representation. The conceptualisation serves as a roadmap for understanding collective problem representation and what the study is about, contributing to good quality according to MacInnis (2011). The paper also advocates for using the model as a complementary perspective for evaluating disaster response management, at a level of detail that is currently missing in many evaluations.

Second, the suggested research approach and included conceptual framework for how explanatory and design research can be integrated in response management presented in Paper IV can be seen as identifying procedures from other research areas and introducing these as a new perspective into the field, as well as advocating, or speaking in support of, a particular view (MacInnis, 2011). It needs to be acknowledged however, that the suggested approach does not contrast with existing research approaches, but rather serves as a complement. By revealing what new insights can be gained from introducing the suggested approach and providing clear definitions of the parts of the model, the belief is that Paper IV provides a foundation for good conceptualisation quality (MacInnis, 2011).





# Findings and analysis

This chapter describes how the research questions in this thesis were addressed in the appended papers. In doing so, the papers are summarised, including purpose, design and main findings.

## Research question 1

### **Paper I: On collective improvisation in crisis<sup>2</sup> management – A scoping study analysis**

Paper I addresses research question 1: *According to scientific literature, how can the concept of collective improvisation be used for investigating how emergency and disaster response management performance can be improved?*

This paper presents the findings and implications from a scoping study analysis on collective improvisation in crisis management. The study was motivated by an increasing need for improving collective capability in crisis response management, where collective improvisation can be seen as an important tool. At the same time, research on *collective* improvisation is limited and dispersed over disciplines and, therefore, the aim of this paper was to explore the capability to improvise collectively in crisis management, and how it affects performance, through a scoping study of current literature. More specifically, the aim of the study was to explore if the capability to collectively improvise can explain, predict and be used to assess overall performance in crisis management. Three questions specifically guided the analysis: a) How does the capability to improvise at the collective level affect crisis management performance? b) How can collective improvisation be measured? c) How can collective improvisation be improved?

The scoping study's initial search resulted in over 2000 papers. After narrowing down on scope and relevance, 66 papers were analysed in detail in order to obtain an overview of current research on improvisation. The findings showed that, in current research, the concept of individual improvisation seems to be aggregated to

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<sup>2</sup> Note that "crisis" was used in this paper to denote an umbrella term covering the various magnitudes of perturbations that threaten core societal values such as life and functionality of critical societal functions.

a collective level without modification, and existing methods lack in precision and transparency. Furthermore, empirical methods do not provide the tools that are required to observe and measure collective improvisation, and, therefore, lack in support for how to improve it. Finally, the connection between improvisation and performance needs to be further explored in order to understand how the capability to improvise affects collective performance in crisis management. The role of collective improvisation in successful response operations is unclear, and the findings indicate that there is a risk that improvisation is intuitively associated with positive outcomes and assumed to have the same meaning for everyone, despite the lack of precise definitions. Given the lack of evidence regarding the connection between improvisation and performance, using “successful improvisation” as a causal explanation for positive performance may be misleading. Another implication is that research on collective improvisation that is based on existing definitions and methods risks solving the “wrong” problem correctly, meaning that general or individual improvisation, rather than collective improvisation is measured.

As a result, one should be careful when using the concept of improvisation as a causal explanation for successful performance, or when suggesting improvisation measures aimed at improving the capability to perform collectively. It appears that, based on current literature, collective improvisation as a concept is limited in its usefulness for investigating how performance in emergency and disaster response management can be improved. To move forward, the paper suggests adopting *collective problem solving* as a broader analytical frame. Although improvisation may be one instrument that can be used when solving problems under time constraints and uncertainty, which often prevail in crises, broader problem-solving theories may help us to better understand performance in crisis management.

## Research question 2

### **Paper II: “What’s the problem?”—Toward a framework for collective problem representation in emergency<sup>3</sup> response management**

The findings in Paper I suggested that collective problem solving would be a constructive way forward to investigate performance in response management. Acknowledging that collective problem representation is seemingly an essential part of problem solving, a relevant question to ask is what can impede or facilitate the process of achieving a collective problem representation in emergencies and

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<sup>3</sup> Note that “emergency” was used in this paper to denote an umbrella term covering the various magnitudes of perturbations that threaten core societal values such as life and functionality of critical societal functions, and to mirror the focus of the journal.

disasters. Consequently, this paper addresses research question 2 in this thesis: *In the context of emergency and disaster response management, what key factors are found to impact the collective problem representation process?*

In collective problem solving, representing the problem is crucial, especially in messy situations, where problems are changing and interacting with each other and are difficult to define, such as in emergencies. There is however a lack of problem representation research in general and in emergency situations specifically. Given this context, the purpose of this paper is to contribute to emergency response management in two ways.

First, the purpose is to introduce a new way of investigating emergency response management, that is through the lens of problem solving and problem representation in a collective context. A conceptual framework for collective problem representation is presented, which offers a complementary perspective for evaluating emergency response management, and does so at a level of detail that is currently missing in many evaluations. Second, the conceptual framework is used to investigate the process of achieving a collective problem representation in emergency response management through an empirical study, drawing on 21 interviews with response management professionals. Connected to what can be considered the basis of forming a collective problem representation; the discussion of individual problem representations, the objective is to empirically investigate what key factors emerge as having an impact on this process. The paper acknowledges that the identified factors do not make up an exhaustive list of key impact factors but rather serve as a starting point. Three factors are identified in this study: formal hierarchical structures, relationships, and legislation and regulations. Formal hierarchical structures and legislation and regulations were found to mainly impede the process of discussing individual problem representations, whereas relationships were found to mainly have a positive impact. These factors are discussed and related to literature on e.g., power structures, the privilege of formulating the problem, trust and defensive decision making. Last, possible implications for practice when the process of discussing individual problem representations fails are discussed. When emergency response management actors do not share problem representations and consequently work in stovepipes, the risk of having misaligned response goals is high, which may lead to suboptimal handling of the emergency. Further, the contribution of multiple perspectives may be prevented, limiting the ability to achieve a comprehensive overview and increasing the risk of solving the wrong problem right. Finally, there is a risk of a mismatch between stipulated, or encouraged, collaboration in emergency response management and the actual capability for it in a given situation.

## Research question 3

### **Paper III: Common operational pictures as collective problem representations: The case of the 2018 wildfires in Sweden**

This paper addresses research question 3: *How are problems represented in common operational pictures used in emergency and disaster response management?*

The paper argues that the widely used practice of creating and sharing common operational pictures (COPs) is a means for facilitating collective problem solving in response management. COPs typically include information about the adverse event and its development, what is being done and what needs to be done in order to meet the needs and minimise consequences, and are often shared among actors in the response system. In other words, COPs can be seen as collective problem representations of the problems at hand and possible solutions to those problems, which can be communicated and inform the problem solving of individuals and collectives throughout the response system. Thus, COPs have the potential to contribute to effective collective problem solving in response management as this relies on a collective problem representation, as argued in Paper II.

Therefore, understanding *how* problems are represented in COPs is warranted, as this enables an investigation into how problem representations can be interpreted by various response management actors, and how they may inform the handling of adverse events. This opens up for an analysis of how problem representations in COPs can be developed and improved in order to best inform responding actors about what needs to be solved during the handling of the adverse event. Consequently, the purpose of the paper is to investigate how problems are represented in COPs and discuss how such problem representations may inform the ongoing response operations.

To address research question 3 and fulfil the purpose of Paper III, the Swedish county administrative board of Gävleborg's handling of the wildfires in 2018 is used as a case. Here, the county administrative board assumed responsibility of the response operations and created COPs to be used throughout the response system. A qualitative content analysis of 41 COPs was performed to identify problem representations. Problems were found to be mainly represented in terms of geographic references and the status of the fires, statements regarding resources, and, in terms of risks or potential consequences, relating to anticipated or future problems. The three categories of problem representations identified here should be seen as a contribution to the fields of problem solving and response management and as a starting point for further studies. When solving problems in various adverse events, it is relatively easy to imagine other problem representations and, therefore, this study does not represent an exhaustive list of problem representations in COPs.

The paper includes a discussion around the possible reasons for why these representations were used and how they might have informed the response efforts. Geographic references are found to be key for managing the response as these were important for, e.g., planning the response organisation or allocating resources. Statements regarding the status of the fires and level of control seem to be central in communicating general development and are often used in combination with geographic references. Statements regarding resources are seen as a means to manage the response through acquiring and distributing resources for setting up and downscaling the response organisation. Creating the response organisation becomes a strategy in itself for solving response problems. Representing problems in terms of risks of or consequences related to future, potential problems, relate to foreseeing and mitigating unwanted events, which is a central part of a response organisation's work. Identifying risks and potential consequences becomes a foundation for proactive strategies to avoid future problems and for long term planning.

## Research questions 4 and 5

### **Paper IV: Advancing the Field of Disaster<sup>4</sup> Response Management: Toward a Design Science Approach**

This paper aims to address research questions 4 and 5:

*How can emergency and disaster response management interventions and their effects on performance be investigated?*

*Is goal alignment a useful intervention for improving response management performance?*

To address research question 4, this paper suggests a complementary approach to traditional response management research; that of combining experimental and explanatory research. Traditionally, response management research has focused on describing and explaining various phenomena, and less attention has been given to normative research with a focus on providing evidence for how to improve professional practice. Drawing upon research from fields that are more developed in normative research, this paper describes how “design knowledge”, i.e., knowledge intended to be used to improve professional practice, can be generated in a transparent and logically consistent way. The paper suggests that controlled experiments become an essential part of response management research in order to develop useful design knowledge. Studying effects from so called field experiments

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<sup>4</sup> Note that "disaster" was used in this paper to denote an umbrella term covering the various magnitudes of perturbations that threaten core societal values such as life and functionality of critical societal functions, and to mirror the focus of the journal.

during real events is however hard, and, therefore, this paper concerns experiments run in the laboratory. Important concerns related to the external validity of such experiments must be taken into consideration. Notably, concerns regarding the extent to which results can be generalised to other contexts and, specifically, the extent to which they can be generalised to a real-world context, are important. In this case, however, the purpose is to support the development of an intervention rather than to explain a certain phenomenon. Therefore, whether an experiment is valid or not should be judged by the extent to which we have reasons to believe that the effect of the intervention in the experimental context is correlated with its effect in practice. An experiment can be used as a basis to determine if, and if so how, the development process should continue.

In order to exemplify these ideas and address research question 5, this paper includes an experimental study investigating goal alignment interventions in response management. Despite a lack of clear and non-ambiguous literature concerning the effectiveness of goal alignment, it is nevertheless encouraged in national response management frameworks. Providing information to support development decisions regarding goal alignment as an intervention is therefore valuable and, in this study, the aim was to provide such information. An experiment was conducted with 111 participants, who, in groups of three, played a computer game under either one of two conditions (goal alignment or not). The results show that aligning goals did not improve the outcome in the game. Two possible reasons for these results are proposed; either the experiment did not capture the effect of goal alignment sufficiently or the underlying hypothesis, i.e., that misaligned goals result in worse outcome, is wrong. Even though the findings indicate that goal alignment interventions might not be an effective solution to improve collective performance in disaster response management, both of these reasons might be valid, suggesting that further inquiry is warranted. For instance, much more work is needed to develop valid experimental models that can be used to test interventions. From a design science perspective, this study supports the argument that explanatory statements should not be developed into normative interventions without testing and evaluating them against the desired objective. In the case of goal alignment, the findings indicate that focusing on goal alignment interventions in practice may lead to inefficient use of resources when activities are focused on aligning goals rather than on activities that potentially may result in better response management outcomes.

# Summary

**Table 2. Summary of research questions**

RESEARCH QUESTION	ANSWER
<p><b>RQ1: According to scientific literature, how can the concept of collective improvisation be used for investigating how emergency and disaster response management performance can be improved?</b></p>	<p>In current research, the concept of individual improvisation seems to be aggregated to a collective level without modification, and existing methods lack in precision and transparency. Empirical methods do not provide the tools that are required to observe and measure collective improvisation. Therefore, the connection between improvisation and performance needs to be further explored in order to understand how improvisation affects collective performance in crisis management. Thus, it appears that, based on existing literature, collective improvisation as a concept is limited in its usefulness for investigating how emergency and disaster response management performance can be improved.</p>
<p><b>RQ2: In the context of emergency and disaster response management, what key factors are found to impact the collective problem representation process?</b></p>	<p>Three factors are identified in the specific study as having an impact on the collective problem representation process: formal hierarchical structures, relationships, and legislation and regulations. Formal hierarchical structures and legislation and regulations were found to mainly impede the process, whereas relationships were found to mainly have a positive impact.</p>
<p><b>RQ3: How are problems represented in common operational pictures used in emergency and disaster response management?</b></p>	<p>How problems are represented in common operational pictures is exemplified with an empirical case of the Gävleborg county handling of wildfires in 2018. In the study, problems were found to be mainly represented in terms of geographic references and the status of the fires, statements regarding resources, and, in terms of risks or potential consequences, relating to anticipated or future problems. These representations were found to be key for managing the response through enabling dimensioning and planning of the response, setting up the response organisation and facilitating proactive strategies, respectively.</p>
<p><b>RQ4: How can emergency and disaster response management interventions and their effects on performance be investigated?</b></p>	<p>A complementary approach to traditional response management research is suggested: that of combining experimental and explanatory research. Through controlled experiments, “design knowledge”, i.e., knowledge intended to be used to improve professional practice, can be generated in a transparent and logically consistent way. The purpose is to support development decisions of an intervention aimed at improving professional practice. Explanatory statements of cause and effect, and suggested interventions based on this, can thereby be investigated.</p>
<p><b>RQ5: Is goal alignment a useful intervention for improving response management performance?</b></p>	<p>The results in Paper IV show that aligning goals did not improve the performance in the experimental setting. Two possible reasons for these results are proposed: either the experiment did not capture the effect of goal alignment sufficiently or the underlying hypothesis, i.e., that misaligned goals result in worse outcome, is wrong. Even though the findings indicate that goal alignment interventions might not be an effective solution to improve collective performance in response management, both of these reasons might be valid, suggesting that further inquiry is warranted.</p>





# Discussion

This chapter addresses the overall purpose and discusses research contributions and the research process.

## Addressing the overall purpose

The overall purpose, to investigate how collective emergency and disaster response management performance can be further improved, is here addressed through elaborating on the conceptual, methodological and empirical contributions. The conceptual contributions address both concepts that are potentially useful and concepts that are of limited use to improving response management performance. The methodological contributions address how we can investigate whether response management interventions actually improves performance, or not. Last, the empirical contributions represent empirical findings that support the conceptual and methodological contributions. Each chapter starts with a summary of the contributions in question and their implications.

## Discussing the conceptual contributions

**Table 3. Summary of conceptual contributions and implications.**

**Relating concepts in response management to performance: a call for caution**

Relating concepts to desired performance is necessary for investigating how they can be used to improve response management performance. The conceptual research in Papers I and IV indicate a call for caution when attributing causal explanations for successful performance to concepts, without thoroughly investigating cause and effect. Apart from practical implications where the desired effect of implemented interventions may not be realised, concepts that lack justified effects might have a negative impact on future empirical research, especially research with a normative underpinning. A useful way forward can be that of developing so called articulated models, describing the essential performance of a concept and clear, falsifiable, connections between the concept and the outcome.

**Collective problem representation as a potentially useful concept**

This thesis has contributed with knowledge concerning the potential usefulness of collective problem representation in response management, serving to identify a concept that can be related to, and thus potentially improve, response management performance. Collective problem representation can, due to its well-documented importance and prescriptive validity, be such a concept. Benefits with problem representation are connected to the context of response management. The potential usefulness of collective problem representation is argued in relation to the multi-organisational context of response management. Here, response actors cannot simply assume that everyone holds the same view of what problems there are, or how these should be prioritised and solved. Related to this context, positive effects of a collective problem representation are presented in the thesis.

This thesis has contributed with explicit conceptual research in Papers I, II and IV. These contributions and how they address the overall purpose are discussed here.

*Relating concepts in response management to performance: a call for caution*

One of the main implications of the conceptual contributions in this thesis is a call for caution when relating concepts in response management to performance, without thoroughly investigating cause and effect between the two. This argument is supported by the findings in Papers I and IV, where the concepts of collective improvisation and goal alignment and their connection to performance in response management was investigated.

First, the findings in Paper I suggest that current literature does not clearly demonstrate the link between improvisation and performance in response management at a collective level. This means that collective improvisation as a concept is limited in its usefulness for investigating performance in response management, at least until further research may shed light on this issue. In the meantime, Paper I argues that one should be careful when using the concept of improvisation as a causal explanation for successful performance, or when suggesting measures aimed at improving the capability to improvise collectively.

Considering the attributed significance of improvisation in response management in both research and practice, the outcome of Paper I was rather puzzling. Given that improvisation seems to be a well-regarded and desirable tool in response management, it is quite surprising that its explicit effects on performance seem to be quite unexplored. One reason might be that improvisation in itself carry many meanings, resulting in many definitions and assumptions. In the interview study for Paper II, a question on what improvisation was for the interviewee was included, out of curiosity. The very diverse answers indicate that improvisation as a concept is quite loosely defined for professionals.

Paper I indicates that the *assumption* that improvisation is beneficial to response management is dominating, despite a seemingly lack of evidence for such assumptions. Considering that literature on emergency and disaster response management appears to be much more developed in terms of its explanatory ambitions than when it comes to how to improve practical problems in professional contexts, establishing cause and effect of current and future, possible practices has probably received little attention. Therefore, there may be other concepts within the field that also render effects on performance unexplored. In light of this context, the study on goal alignment in Paper IV provides another example of a possibly weak link between a concept and its connection to performance in response management. Despite somewhat contradictory literature and seemingly a lack of justification of its desired effects, goal alignment is nevertheless a recommended intervention in national response management frameworks. This motivated the experimental study in Paper IV and, although more research is needed to strengthen, or refute, the

findings, the paper nevertheless suggests that goal alignment might not be an effective form of intervention to improve performance in response management.

This conceptual research in Papers I and IV indicate that there are reasons for being cautious when attributing causal explanations for successful performance to specific concepts. Of course, it has to be acknowledged that not all concepts are developed for explaining performance, but rather have other purposes. Here, however, those concepts that are connected to performance in some way are in focus. Apart from possible practical implications where the desired effect of implemented interventions may not be realised, concepts lacking justified effects might have a negative impact on future empirical research, especially research with a normative underpinning.

A useful way forward can be to develop *articulated* models as a basis for investigations of cause and effect. In Paper I, improvisation is connected to the risk of becoming quite the opposite; that of a folk model: a concept that professionals intuitively associate with something positive, tacitly assuming that it has the same meaning for everyone, making it difficult to disagree with (Dekker & Hollnagel, 2004). In the field of human factors and systems safety, the debate on concepts' susceptibility to become folk models is rampant and rather fiery, in particular related to situation awareness, complacency and mental workload (see e.g. Dekker & Hollnagel, 2004; Dekker & Woods, 2002; Endsley, 2015; Parasuraman et al., 2008). This debate shows that there are different views on the usefulness of certain concepts, and different views on how these can and should be applied in research and practice. It is not the intention of this thesis to take sides, but in this context it can be relevant to problematise the idea of folk models, as opposed to what Dekker and Hollnagel (2004) refer to as articulated models. In particular, the issue of identifying measurements to investigate performance is of relevance to this thesis. The measurement depends on the model, which should describe the essential performance of the phenomenon in question, have clear connections between the phenomenon and the outcome, connections that are falsifiable (Dekker & Hollnagel, 2004). These characteristics are associated with articulated models, which stand in contrast to folk models, according to the authors. In fact, the idea of articulated models certainly highlights aspects associated with addressing the overall purpose in this thesis: How can concepts or ideas that are believed to improve response management be operationalised into suggested interventions? How can effects of interventions aimed at improving response management be measured? How can such interventions be investigated?

In this thesis, the idea of articulated models is visible in several papers. First, the scoping study in Paper I suggests that time, or rather the definition of improvisation as "*the conception of action as it unfolds*" (Cunha et al., 1999, p. 302), might be a promising explanation for improvisation. However, questions on how to operationalise this definition are discussed in the paper, such as how narrow the time gap should be for it to be called improvisation, or what the timescales are between

acting and planning on each strategic level of response management. The paper concludes with that further research is needed to develop what can be seen as an articulated model concerning time and improvisation.

Second, the conceptual framework of collective problem representation presented in Paper II can be seen as an attempt to illustrate an articulated model. The collective problem representation process, which, based on literature, is assumed to have a positive impact on response management performance, is operationalised into steps. Here, discussing individual problem representations is seen as a step that impacts the possible formation of a collective problem representation and the paper then investigates what impacts whether such discussions take place or not. Although the paper does not investigate specific cases where the discussions take place or not, whether discussions occur or not should be rather straight-forward to measure, i.e. the measurement in this case is quite clear. Thus, the model can offer a concrete way to measure effects of the collective problem solving process, which is assumed to be of importance for the overall response management performance.

Third, the conceptual model in Paper IV illustrates how connections between an observed phenomenon and the outcome of it can be measured and investigated, i.e. it provides an approach for how an articulated model can be built and tested. In Paper IV, the experiment utilises a model of the system that includes salient features of a response management context, and investigates the connection between goal alignment and the outcome of the game.

To connect back to the overall purpose of this thesis, relating concepts to the desired performance is a necessary requirement for investigating how the concept in question can be used to improve response management performance. This thesis suggests that there are reasons for being cautious when attributing causal explanations for successful performance to specific concepts, without thoroughly investigating cause and effect between the two. A useful way forward can be that of developing articulated models, which should describe the essential performance of the concept in question and have clear, falsifiable, connections between the concept and the outcome.

#### *Collective problem representation as a potentially useful concept*

This thesis has contributed with knowledge concerning the potential usefulness of collective problem representation in response management. Connected to the overall purpose, this conceptual contribution serves to identify a useful concept that can be related to, and thus potentially improve, response management performance.

The starting point for investigating problem representation was its well-documented importance in problem-solving literature and its prescriptive validity in the problem-solving process. This means that the concept can be connected to performance, here facilitating effective problem solving. Related to the response management context

specifically, collective problem representation is in this thesis described as important for several reasons.

First, emergency and disaster response management is often performed in a multi-organisational context. In such a context, each actor's mandate, responsibility and agenda may result in different views on what problems there are and how they should be prioritised and solved. These potential differences illustrate that actors in response management cannot simply assume that everyone holds the same view of how to manage an emergency or disaster. Second, the nature of problems may also contribute to different views on what problems there are and how they should be prioritised or solved. As described previously, many problems in emergencies and disasters are considered wicked, or ill-defined. Such problems are characterised by a difficulty in defining current states and goal states and how to reach the goal might not be agreed upon. Especially so called “creeping crises” require a collective perception of the threat for people to be convinced about the presence of an adverse event that threatens core societal values (Boin et al., 2020). In a response management context, therefore, discussing different views on problems and solutions in order to achieve a collective problem representation is, as argued in Paper II, crucial for effective problem solving.

Positive effects of achieving a collective problem representation, which can potentially contribute to improving response management performance, is presented in this thesis. First, a collective problem representation reduces the risk of organisations working in stove-pipes, and, thereby, the risk of problems being neglected or missed by any organisation. Further, it reduces the risk of solving the wrong problems correctly (Büyükdamgaci, 2003; Mitroff & Linstone, 1992; Niederman & DeSanctis, 1995; G. F. Smith, 1989), where failing to explore problems holistically may cause response organisations to act upon the wrong problems, i.e, problems that should not be prioritised—or even solved at all. Here, it has to be acknowledged that achieving a collective problem representation does not necessarily mean that all involved organisations automatically hold the exact same view of a situation. Cognitively, different individuals will interpret and understand a situation in different ways. What is important here, however, is that individual problem representations are discussed, which opens up for a collective understanding. It should also be acknowledged that it may not be possible, or even desirable, to achieve a collective problem representation due to several factors, of which some are identified in Paper II.

Based on these arguments, Paper II brings forward what is described above as an articulated model of collective problem representation in response management. In the paper, the model is used to investigate key factors that may have an impact on the process. In future research, however, the model could also be used to test the prescriptive validity of collective problem representation in response management. One potential study could be to expand on the findings in Paper III. Here, common operational pictures are seen as a platform for discussing individual problem

representations and creating a collective problem representation. A natural step after investigating how problems are represented in common operational pictures, would be to investigate how problems are *best* represented, i.e. how they should be represented in order to improve problem solving, and thus performance, in response management. Using the research approach presented in Paper IV, this could mean creating experiments where common operational pictures of various designs are presented to response management professionals and judged according to its potential usefulness. Here, it can be useful to glance at the research area of *framing*, which discusses how individuals' judgments often depend on how an issue or problem is framed (Druckman, 2001). There are many meanings of frame and framing but in relation to response management, the concept of framing is for instance discussed in the closely related field of risk management where the way risks are framed is seen as highly influential in shaping the outcome of the risk governance process and how risks are managed (see e.g. Cedergren, 2013; Klinke & Renn, 2012; Renn et al., 2011). In a context of multiple stakeholders who have different, but equally legitimate, standpoints, diverse framings of risk are found to give rise to challenges such as controversies and deadlocks in risk-related decision making (see e.g. Cedergren, 2013; Klinke & Renn, 2012; van Asselt & Renn, 2011), which is similar to those discussed in this thesis. Further, media framing, i.e. how media present and define an issue, can be another promising area to look into, as demonstrated in a study on a major wildfire in Sweden in 2014 (Nilsson & Enander, 2020). Similar to framing, Paper II brings up the so-called *privilege of formulating the problem*. Described as who has the right, or privilege, to represent the problem (Eriksson, 2004; Gustafsson, 1989), this means that individuals or organisations defining the problem has a significant influence on what the solution should be (Büyükdamgaci, 2003; Rittel & Webber, 1973), opening up for issues of power and agenda-setting.

Last, the assumption that effective collective problem solving in response management depends on a collective problem representation, could perhaps be questioned. One could argue that working in stovepipes may be a functioning strategy in “simple” incidents. In many of today's emergencies and disasters, it is however unlikely that one individual or organisation can solve all problems alone. In addition, the importance of adopting a comprehensive approach and the value of collaboration in these contexts are often mentioned in the literature (see e.g. Nohrstedt et al., 2018; Uhr, 2017). Having a shared view of what is happening and what needs to be done in an adverse event, i.e., having a collective problem representation, may enable actors in the response collective to realise such a comprehensive approach and to collaborate in an effective manner.

## Discussing the methodological contributions

**Table 4. Summary of methodological contributions and implications.**

The methodological contributions in this thesis address how we can investigate whether response management interventions actually improves performance. These contributions are consequently aimed at how to investigate “what works or not” in response management. In relation to this, the thesis suggests a research approach of combining explanatory and experimental research, as a complementary approach to existing research. This research approach may increase research rigour and practical relevance through combining the two types of research. Also, borrowing the idea of a hierarchy of evidence as used in evidence-based medicine, experiments provide a strength of evidence that is worth pursuing.

The methodological contributions in this thesis address how we can investigate whether response management interventions actually improves performance, or not. These contributions are consequently aimed at how to investigate “what works or not” in response management.

In Paper IV, the ambition is to contribute to the development of response management research by describing how “design knowledge” (knowledge intended to improve professional practice) can be generated in a transparent and logically consistent way. Arguments for why this can be important are brought forward, arguments that are mainly concerned with the research tradition in emergencies and disasters. This research is traditionally strong in developing theory but less so in terms of providing strong normative claims, that is, evidence, with respect to what works in practice. Considering that literature on emergency and disaster response management appears to be less developed when it comes to design and on how to achieve performance goals, establishing cause and effect of current and future practices has probably received little attention. As such, there is a risk that real effects of implementing a certain tool or method are unknown, and the decision to implement such recommendations, or interventions, lacks rigorous scientific support. In this thesis, this can be noticed in Papers I and IV, connected to collective improvisation and goal alignment respectively, as discussed previously.

Similar problems have been noticed in the closely related fields of humanitarian assistance (Bradt, 2009), safety science (Rae et al., 2020) and public health (E. Smith et al., 2018). Bradt (2009) argues that in humanitarian assistance, providing evidence appears to be limited by political and organisational will rather than a lack of knowledge on how to gather evidence. Especially connected to coordination of international humanitarian assistance, the author describes that the scientific literature is meagre, and there is little evidence-based science to inform coordination efforts. Rae et al. (2020) claim that the field of safety science suffers from a shortage of evidence production and lacks an empirical basis on which to prefer one way of managing safety over another. E. Smith et al. (2018) review research on public health in disasters and conclude that the overwhelming majority is largely descriptive and anecdotal in nature and lack in high-level evidence. In these publications, as well as in Paper IV, it is suggested to bring in knowledge and experience from evidence-based medicine to overcome these problems. This field



has especially resolved issues concerning the acquiring of data to support normative claims. In evidence-based medicine, a hierarchy of evidence has been brought forward, based on the method of data acquisition and graded from expert opinion, as the weakest evidence base, to a systematic review of randomised controlled trials, representing the “gold standard” (Bradt, 2009). While the expert has an important role in understanding patient values and circumstances around medical cases, when assessing evidence from systematic research, evidence-based medicine values this in ascending hierarchical order. The hierarchy provides a methodology for assessing the value of evidence, a methodology that can be useful in other fields, such as response management. Acknowledging that the fields are different, it can nevertheless serve as a model to think with in order to judge the strength of acquired data and evaluate it against the claims made. However, methodological difficulties with conducting controlled research within response management, where much of the generated evidence is of descriptive nature and there is a lack of frequent, predictable, or controllable real-world opportunities to study different aspects of response management must be acknowledged (Challen et al., 2012; E. Smith et al., 2018). To overcome some of the difficulties, E. Smith et al. (2018) suggest, similar to the approach in Paper IV, that both quantitative and qualitative methodological approaches are valuable in generating knowledge to understand the complexities associated with managing emergencies and disasters.

In Paper IV, it is argued that, although medicine and response management are different, the use of controlled experiments to develop design knowledge and increase research rigour should be equally important in the two fields. Therefore, using insights from design science where normative research is more common, a complementary approach to response management research is suggested; that of combining explanatory and experimental research. There could be other methods than experiments for testing and evaluating interventions, such as process tracing (see e.g. Collier, 2011) or using expert opinion. However, experiments, considering the hierarchy of evidence, provide a strength of evidence that is worth pursuing.

As described in the methods section, experiments, especially those performed in the laboratory, as in Paper IV, come with certain limitations. First, there are concerns related to the extent to which results can be generalised to other contexts, and specifically to a real-world context. For example, Dekker and Hollnagel (2004) bring up the risk of overgeneralising when taking narrow experimental findings and applying them uncritically to any broad situation which bears some resemblance to the context that was investigated under controlled circumstances. The purpose of the suggested approach in Paper IV, however, is to support development decisions regarding whether to adopt an intervention or investigating it further. With this purpose in mind, the claim is not to provide an experimental model of reality and testing some intervention's “true” effects, but to provide support for incremental development decisions whether to focus on this particular intervention or on some other intervention. In this case, whether an experiment is valid or not should be

judged according to if we have reasons to believe that the effect of the intervention is correlated with its effect in the real context. Although an experiment may have little external validity, this does not discount the experimental method. Instead, the key question in the case of developing design knowledge, such as for interventions in response management, is whether the experimental context represents a valid model of some parts of the real context it aims to represent.

To further mitigate the criticism of experiments lacking in relevance, the suggested research approach in Paper IV, based on design science research, combines experimental with explanatory research. Explanatory research can produce statements that suggest a cause and effect relationship in a specific context. This will also provide better understanding of current practice, creating opportunities for intervention research (Rae et al., 2020), such as controlled experiments. Focusing on relevant problems found in the field and basing solutions on existing knowledge, means that the suggested research approach, can contribute to bridge the rigour-relevance dilemma (Argyris & Schön, 1989), as described in the chapter on design science. This dilemma means that theory (or research) is either scientifically proven but not of practical relevance, or relevant to practice but lack in rigour. Basing research activities on the perceived field problems is an attempt to bridge this gap and to ensure research relevance. Further, to address the rigour part of the dilemma, research rigour is achieved when applying the foundations and methodologies in the appropriate way to the design research, such as through controlled experiments.

## Discussing the empirical contributions

**Table 5. Summary of empirical contributions and implications.**

The empirical contributions in this thesis relate to both descriptive and prescriptive purposes. Primary data has been collected and analysed to investigate and support arguments made in the papers. Findings from descriptive studies on collective problem representation can be used to further investigate how response management can be improved. One example is to use findings on how problems are expressed in common operational pictures to explore how these can be improved and facilitate effective response management. Empirical data was collected and used to exemplify the suggested methodological approach of integrating explanatory and experimental research. The data was further used to question the use of goal alignment in national response management frameworks, despite a lack of justified connection to performance and contradictory literature.
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In this thesis, several empirical contributions are made, meaning where primary data has been collected and analysed to investigate and support arguments made in the papers. Before describing how these empirical contributions are used to address the overall purpose, it is relevant to discuss how data that is commonly collected in emergencies and disasters is used and how this may affect the field.

Empirical data is collected in many emergencies and disasters. As described previously, research on emergencies and disasters is largely descriptive and focusing on understanding and explaining various phenomena, and less attention is devoted to acquiring data to support normative claims. This means that we most likely need a better empirical basis to decide which ways to manage emergencies

and disasters are better than others. Further, many response management evaluations repeatedly bring up similar, or the same, observations. For example, observations like “lack of communication” and “lack of collaboration” are frequent evaluation conclusions (see e.g. Sjökvist, 2015; U.S. House of Representatives, 2006). These recurring observations may reflect that we are poor learners, but could also indicate that we repeatedly collect the same data and draw the same conclusions, rather than collect data that can be used to overcome these challenges. For example, data that can be used to investigate questions like how we can become better at communicating or collaborating. To answer these types of questions, more empirical data that can be used to support or falsify recommended interventions is needed. In this thesis, this is argued as important for advancing the field of emergency and disaster response management. It has to be acknowledged, however, that descriptive empirical data is still valuable in itself and needed as a basis for more normative investigations, as argued in Paper IV.

In this thesis, empirical data has been collected for both descriptive and prescriptive purposes. Papers II and III contribute with descriptive findings related to collective problem representation. These findings can be used for studies of prescriptive kind.

Empirical data for investigating goal alignment as a potentially useful intervention in response management was collected in the experimental study in Paper IV. As mentioned previously, this empirical data contributes to the call for caution when relating concepts in response management to performance. The data was used to investigate the use of goal alignment in national response management frameworks, despite a lack of justified connection to performance and contradictory literature. The experimental data was further used to exemplify the suggested methodological approach of integrating explanatory and experimental research in Paper IV and the results support the argument that explanatory statements should not be developed into normative interventions without testing and evaluating them against the desired objective, which is at the basis of the suggested methodological approach.

## Reflecting on the problem-solving perspective

This thesis has focused on processes, and predominantly the problem-solving process. This doctoral project has however not been able to investigate all parts of such a broad concept in relation to improving response management performance and the studies have only explored selected parts, such as problem representation and goal alignment. Therefore, this thesis has not managed to establish a connection between the overall process of problem solving and performance in response management. However, during this research, many ideas related to problem solving in relation to response management have come up, ideas that are at a development stage. It may nevertheless be worth sharing some of these, to suggest future research

and explain portions of the doctoral project that do not explicitly relate to the research questions but have served as important input to the thought processes and development of studies.

### *Problem solving as a comprehensive framework*

As described previously, problem solving as a comprehensive framework has not yet been fully explored in the context of emergency and disaster response management. This means that there is potential to merge theoretical ideas into a coherent and explicitly articulated analytical framework. This is an interesting idea for future research, of which the findings from this thesis may play a role.

This framework, and how the problem-solving process connects to performance in response management, could then be further investigated, and preferably linked to empirical studies. Problem solving is not here seen as being in contrast with related concepts, such as sensemaking or decision making, but rather as an inclusive concept. Related concepts can be seen as important tools for succeeding with solving problems and may be relevant for parts, or all, of the problem-solving process. What theories that may assist problem solving depends on e.g. the current activities needed in the relevant situation (e.g. understanding a situation or making a decision). However, focusing on problems rather than e.g. isolated decisions to be made, highlights, as previously mentioned, the desired effect and what it is really about—solving some kind of problem.

Using problem solving as analytical lens to investigate response management performance means that there is a vast body of literature to tap into, creating new opportunities for research and learning from other fields. In combination with problem solving being an inclusive concept, this means that it can provide a larger “toolbox” for how to improve response management performance.

### *A dynamic system of problems, organised in a hierarchy*

During the research process, much thought was given to what a problem is in the context of response management and how various problems during the handling of an adverse event are connected. One suggestion is to investigate this aspect using a perspective of a *dynamic system of problems*, where problems are connected in a hierarchy. During an adverse event, at a given moment in time, some problems are known and some are deemed as possible future problems. New problems, foreseen or unforeseen, appear over time. The situation resembles a dynamic system of problems, similar to Ackoff's (1979, p. 99) *messes*, or “*complex systems of changing problems that interact with each other*”.

In this system of problems, a hierarchy of problems can be distinguished. The adverse event represents the main problem, which is the reason for the response system to be active in the first place. This is connected to a current and a goal state, which may change throughout the course. Connected to the main problem are other

problems, which are seen as problems on lower hierarchical levels. Some are sub-problems resulting from the main problem's solution steps, and some are future, potential problems that may appear from the problem solving itself or from some other factor, such as the evolving situation or the weather. Sub-problems and future, potential problems must often be solved before progress can be made toward the main problem's goal state. Both the problem-solving progress and future, potential problems may change throughout the course of the problem solving and thus alter the path towards the goal state. Viewing problems in an adverse event in this way enables a holistic overview by visualising connections between problems, thus revealing potential "showstopper problems" and establishing an order of priority and solution. This way of viewing problems can also facilitate a forward-looking, proactive, approach as it visualises future, potential problems.

### *Conditions for problem solving*

The key factors identified in Paper II that impact the process of achieving collective problem representations can be seen as examples of conditions for problem solving. Future research can explore more such conditions. For example, how contextual conditions inherent to response management, such as time pressure or uncertainty, or how the availability of resources and skills affect problem solving can be interesting to investigate.

## Reflecting on the research process

The purpose of a doctoral project is for the student to learn the researcher trade. The doctoral student should exit as an independent researcher, ready to take on research projects and the challenges associated with research. The intention is not to be a "complete" researcher but to be competent during upcoming research projects and continue to learn the trade. In this doctoral project, three aspects have been paramount to the research process and learning the researcher trade: understanding the research field, understanding practice, and, understanding how to research. These are discussed below. Last, the connection between design science and the overall research process is reflected upon.

### *Understanding the research field*

As mentioned previously, research on emergencies and disasters is relatively young and founded in many areas. This has led to a variety of definitions of concepts and terms, such as naming and classifying adverse events or how to distinguish different phases of an adverse event, which all come with benefits and challenges. Navigating the research field has been quite challenging and time consuming. The feeling of opening a Pandora's box each time when approaching different strands of literature or concepts which are discussed in many areas has been present.

Taking part in various research contexts has helped in advancing and speeding up the understanding of the research field. For example, the thesis started from a joint research project between several Swedish research bodies of different backgrounds. Further, six months were spent as a guest researcher at the Center for Catastrophic Risk Management at UC Berkeley in California, and, research has been presented at conferences based on different research fields.

What has also been helpful in this research process has been that of focusing on solving real world problems. Departing from this perspective means that theories or approaches that can explain and be used to investigate a certain problem are relevant to explore, but may differ between research projects and come from different disciplines. Another way would be for researchers, as argued by Watts (2017) to be the common tradition within social sciences, to take the particular theoretical and methodological framework that one has been immersed in and apply this to every research problem one works with. A trade-off between these approaches is that of being a generalist or a specialist. Rather than becoming a specialist in one area, the former approach leads to the skills of a generalist, which can have its drawbacks when it comes to, for instance, publishing articles and advancing one's research career. However, the latter approach often results in, according to Watts (2017), a patchwork of collectively incompatible theories, that often explain the same phenomenon. Focusing on solving real world problems can therefore be a way to create a more coherent field and contribute to scientific advancement, which this thesis has strived for.

Similar to Watts (2017), the argument in this thesis is however not that all research on emergencies and disasters should focus on solving real world problems. Neither should all research concern controlled experiments in order to achieve the highest level of evidence. All types of research is needed, for different purposes. Especially considering the rapid development in society and the fast-changing pace of technology, descriptive research is needed to understand changing or new phenomena and prescriptive approaches are needed to investigate this knowledge and to avoid creating obsolete and ineffective interventions. In order for the field of emergency and disaster response management to mature and become more coherent, the belief is however that it would benefit from introducing more prescriptive approaches, such as the combination of explanatory and experimental approaches in this thesis. This would mean an opportunity to increase the overall level of evidence.

### *Understanding practice*

Following from a research focus on solving real world problems comes a necessity to understand practice. Therefore, getting to know the field, what problems there are and how these can possibly be investigated and improved has been a priority. This has resulted in various engagement with professionals working in response management, both connected to the studies in this thesis and outside of these.

Activities include interviewing and talking to professionals in various contexts, observing during exercises and real events, presenting research findings in professional contexts and participating in evaluations or research tasks commissioned by response organisations. Apart from engaging with professionals in specific studies, it has been especially rewarding to take part in research projects concerning the Swedish wildfires in 2014 and 2018, and the covid19 pandemic. These research projects were not explicitly connected to this thesis, but they have been immensely useful for understanding how response management works in practice and for giving inspiration to further studies.

These activities have contributed with invaluable experience and knowledge that have been applied throughout the research process. In addition, it has resulted in a solid network of connections into various organisations active in emergency and disaster response management, both nationally and internationally. Taken together, these aspects have been, and will continue to be, valuable for performing research in the field, by, e.g., having access to real world problems and their contextual conditions, access to data, and, access to a “test environment” where ideas and recommendations can be tried. It has to be acknowledged that getting to know the field is quite time consuming, but, bearing in mind the attributed value, this is considered time well spent!

### *How to research*

How to research has naturally been an important topic to explore during this doctoral project. Research is about obtaining new knowledge, and it is important for a researcher to have an open mind and the right to question anything, examine data critically to obtain systematic, reliable and valid data, and, last, if possible, generalise and specify the limits of their generalisations (Andersson, 2012). What makes research transparent and what makes a solid evidence base for what a researcher wants to say has from early on accompanied this research process.

Gradually, it became evident that there are many ways to perform research. Seemingly, this depends on, among else, the research object in question, the research discipline, including traditions and beliefs, and, the researcher's own background, knowledge and preference. This thesis has been conducted at an engineering faculty, by a doctoral student of the same background, however concerning the multi-disciplinary research object of emergency and disaster response management. This has been both challenging as well as opening up for many exciting research opportunities. From time to time, the feeling has been that of a bull in a china shop, when approaching other disciplines, exploring various methods or grasping research philosophy. However, more often the “engineering heritage” of focusing on solving real world problems and improving artefacts was prevalent and found rewarding. In the end, being able to navigate between different research disciplines, and starting to understand various research traditions and methods is seen as an important outcome of this research process. However, similar to navigating the research field,

this too is related to the trade-off between being a generalist or a specialist. In this thesis, the feeling of only having “scratched the surface” of some methods is present, however, deepening methodological knowledge can be a task for future research.

One of the main takeaways from learning how to research is the awareness of and strive for transparency and evidence in research. The understanding that was developed through this research process is that all types of research are important, but serve different purposes and can be related to different steps in a hierarchy of evidence. For example, performing a descriptive study where professionals are interviewed may give valuable insights into how things are or work, but is situated at the lower end of the hierarchy of evidence. Therefore, normative claims based on such studies should be created with caution. In this doctoral project, both descriptive and prescriptive research was performed. In relation to the hierarchy of evidence, it was especially interesting to explore the usefulness of design science and using controlled experiments as part of emergency and disaster response management.

#### *The overall connection to design science*

Last, understanding the research field, understanding practice and how to research is here related to design science and its overall connection to this thesis. Ideas from the academic tradition of design science has been central to this thesis. Above all, Paper IV is founded on developing design knowledge for improving real world problems through combining explanatory and experimental research. However, a connection between design science and the overall research process can also be distinguished. Drawing upon the conceptual model of design research as presented in the conceptual framework, this connection is made visible through the three aspects mentioned there. Knowing and understanding practice is key in the relevance cycle of design research, which initiates research and evaluates whether the research has improved the particular problem. Understanding how to research and understanding the research field concern the rigour cycle, which provides the design cycle with information on relevant theories, methods etc, from a vast knowledge base. The rigour and relevance cycles provide the design cycle with relevant information to be used when developing and evaluating artefacts for improving response management performance. Not to be forgotten, the design cycle itself can extend original theories, methods etc., thus adding to the knowledge base.

Given this context, this research process can be framed in the light of a design science approach. However, it is important to acknowledge that this is the result of reflections and knowledge gained *during* the research process rather than serving as plan at the outset of this thesis. Nevertheless, the design science approach is at the end of this doctoral project regarded as a promising way to continue to perform research in the future.





# Conclusion

This thesis aims to investigate how collective emergency and disaster response management performance can be further improved. The main conclusions are summarised here.

This thesis suggests that, based on current literature, the concept of collective improvisation is limited in its usefulness for investigating how emergency and disaster response management performance can be improved. A scoping study shows that the concept of individual improvisation seems to be aggregated to a collective level without modification, and existing methods lack in precision and transparency. In addition, empirical methods do not provide tools required for observing and measuring collective improvisation. Thus, it is hard to establish the connection between collective improvisation and performance. Until further research may shed light on this issue, this thesis suggests adopting problem solving as a broader analytical frame to investigate performance in response management.

Collective problem representation is argued as a potentially useful concept when investigating how response management performance can be improved. The importance of problem representation is well-documented in problem-solving literature and has been prescriptively validated, meaning that the concept can be connected to performance, here facilitating effective problem solving. In the response management context, a collective problem representation can reduce the risk of problems being missed or neglected by responding organisations, and the risk of solving the wrong problem right.

Assuming that a collective problem representation is important for response management performance, this thesis investigates key factors that may impact this process. Three factors are identified: formal hierarchical structures, relationships, and legislation and regulations. Formal hierarchical structures and legislation and regulations were found to mainly impede the process of achieving a collective problem representation, whereas relationships were found to mainly have a positive impact. These factors should not be seen as an exhaustive list of key impact factors, but rather serve as a starting point for further investigations.

This thesis further explores the concept of collective problem representation through an empirical study of how problems are represented in common operational pictures used in response management. These can be seen as collective problem representations that can facilitate collective problem solving. Understanding how

problems are represented in common operational pictures enables an investigation into how these are interpreted by various actors and how they may inform the handling of various adverse events, which, in turn, opens up for an analysis of how problems are best represented in order to improve response management. In the empirical study, problems were found to be mainly represented in terms of geographic references and the status of the present wildfires, statements regarding resources, and, in terms of risks or potential consequences, relating to anticipated or future problems. These representations were found to be key for managing the response through enabling dimensioning and planning of the response, setting up the response organisation and facilitating proactive strategies, respectively.

In order to investigate how response management performance can be improved, i.e. what works or not, this thesis suggests a complementary approach to traditional response management research: that of combining experimental and explanatory research. Through controlled experiments, “design knowledge”, i.e., knowledge intended to be used to improve professional practice, can be generated in a transparent and logically consistent way. The purpose is to support development decisions of interventions, i.e., measures such as methods or recommended ways of working that can be implemented in a response management context with the intention of improving the management of either all adverse events or specific types. Explanatory statements of cause and effect, and suggested interventions based on this, can thereby be investigated.

The suggested research approach is exemplified with an experimental study testing an intervention connected to problem solving and found in response management practice, namely goal alignment. In the experimental setting, aligning goals did not improve the performance of the studied groups. Two possible reasons are proposed: either the experiment did not capture the effect of goal alignment sufficiently or the underlying hypothesis, i.e., that misaligned goals result in worse outcome, is wrong. Even though the findings indicate that goal alignment interventions might not be an effective solution to improve response management performance, both of these reasons might be valid, suggesting that further inquiry is warranted.

This research introduces a call for caution when attributing causal explanation for successful performance to concepts without thoroughly investigating cause and effect between the two. This argument is supported by the findings related to collective improvisation and goal alignment. A useful way forward can be that of developing articulated models, which should describe the essential performance of the concept in question and have clear, falsifiable, connections between the concept and the outcome.

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