Learning for safety: Improvements of Swedish authorities' toolkits for societal resilience

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Learning for safety

Improvements of Swedish authorities' toolkits for societal resilience

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The universe goes on its merry, mystical, magical way until you start observing it and you, by observing it, create problems. The working of the universe has no problems.

Ramesh S. Balsekar

Summary

This thesis suggests improvements of selected parts of the Swedish authorities' toolkits for societal safety and crisis management; crisis response evaluations, crisis management exercises and organizational risk assessments. The thesis also explores how visualizations of safety culture data can be used to support safety culture development. The research was motivated by practical needs and delivers results that can be used to facilitate and improve efforts for societal safety and crisis management.

Empirical data has been collected from five Swedish public organizations (three municipalities and two county councils) through interviews, observations and questionnaires. Most of the research has been performed in close cooperation with practitioners. Methods from design science have been used to arrive at applicable solutions to the practical problems motivating the research.

The thesis shows how learning results with broader applicability can be achieved from the evaluations of singular crisis responses. Evaluations of crisis responses do not necessarily have to focus on as accurate accounts as possible of what happened. To support the development of crisis management capability they should instead revolve around alternative possibilities. From a summary of what actually happened the exploration of possible variation can bring about broadly transferrable learning results. Evaluation results and explorations of variation should be disseminated throughout the organization.

Crisis management exercises often produce vague results with unnecessarily limited applicability. This thesis presents a framework that can help to strengthen the learning effects of discussion-based crisis management exercises. In preparing exercises, aspects of reality that are considered relevant in future instances of crisis management should be identified. Some of them should then be used as parameters in a scenario description. In discussions, exercise participants should collectively alter the parameter representation of the scenario. This can establish shared mental models and provides variation for the individual participants to experience. Experiencing variation is vital for learning and developing capability.

Important principles for the design of organizational risk assessment systems for large organizations are forwarded. Large organizations are typically hierarchically layered and laterally split into thematic areas. With such structures, first order analyses pertaining to single organizational units and their areas of operations should be performed unit-

wise on all levels, and second order analyses with a systems perspective should be performed for all aggregated subsystems up through the composite organization. In second order analysis, data from the first order analyses of constituent organizational units needs to be reanalyzed, with level-appropriate questions and methods. It is not sufficient in a second order analysis to simply add or aggregate information from the first order analyses of the units in the system, and additional input may also be required.

Organizational risk assessment in large organizations faces many communicational challenges, which pose major threats to the functionality of the risk assessment systems. This thesis presents countermeasures to such communicational challenges. For example, efforts to create and use shared knowledge, the bridging of steps of formal communication, the use of dialogue, and the standardization of parts of communicational work can help to reduce the threat of miscommunication.

An organization's safety culture can be developed through emergent change, which requires that relevant information is available to the organizational members. To support such change processes presentations of collected safety culture data should preferably: Facilitate the comprehension of data; Offer suitable relevance structures to the target group; Provide possibilities to experience variation; Evoke inquiry and inspire hypothesizing; and Visualize relations between different parts of data.

Sammanfattning

Denna avhandling föreslår förbättringar av vissa verktyg som svenska myndigheter använder för samhällssäkerhet och krishantering; krishanteringsutvärderingar, krishanteringsövningar samt organisatoriska riskbedömningar. Avhandlingen undersöker även hur visualiseringar av säkerhetskulturdata kan stödja utveckling av säkerhetskultur. Forskningen motiverades av praktiska behov och resultaten kan användas för att underlätta och förbättra arbetet för samhällssäkerhet och samhällelig krishantering.

Empiriska data har hämtats från fem olika svenska offentliga organisationer (tre kommuner och två regioner) genom intervjuer, observationer och frågeformulär. Huvuddelen av forskningen har utförts i nära samarbeten med praktiker. Designvetenskapliga metoder har använts för att nå fram till tillämpbara lösningar på de praktiska problem som motiverat forskningen.

Avhandlingen visar hur brett tillämpbara lärresultat kan uppnås från utvärderingar av enskilda episoder av krishantering. Utvärderingar av krishanteringsinsatser behöver inte nödvändigtvis fokusera på så korrekta beskrivningar som möjligt av vad som skedde. För att stödja utveckling av krishanteringsförmåga bör de i stället kretsa kring alternativa möjligheter. Från en sammanställning av vad som faktiskt hänt kan ett utforskande av möjlig variation medföra brett överförbara lärresultat. Utvärderingsresultat och undersökningar av variation bör spridas till hela organisationen.

Krishanteringsövningar genererar ofta resultat med onödigt smal tillämpbarhet. Den här avhandlingen presenterar ett ramverk som kan hjälpa till att stärka diskussionsbaserade krishanteringsövningars lärandeeffekt. I förberedandet av en övning bör aspekter av verkligheten som antas vara relevanta i framtida instanser av krishantering identifieras. Några av dem bör sedan användas som parametrar i en scenariobeskrivning. Genom diskussioner bör övningsdeltagarna kollektivt ändra parameterbeskrivningen av scenariot. Detta kan medföra delade mentala modeller, och erbjuder variation för de enskilda deltagarna att uppleva. Erfarandet av variation är nödvändigt för lärande och utveckling av förmåga.

Viktiga principer för utformningen av organisatoriska riskbedömningssystem i stora organisationer framförs. Stora organisationer är typiskt hierarkiskt nivåindelade och lateralt delade i tematiska områden. Med sådana strukturer bör första ordningens

analyser rörande enskilda organisatoriska enheter utföras enhetsvis på alla nivåer, och andra ordningens analyser med ett systemperspektiv bör utföras för alla aggregerade subsystem upp genom den sammansatta organisationen. I andra ordningens analys behöver data från första ordningens analyser av ingående organisatoriska enheter omanalyseras, med nivåanpassade frågor och metoder. I andra ordningens analys är det inte tillräckligt att bara addera eller slå samman information från första ordningens analyser inom systemet, och kompletterande underlag kan också behövas.

Organisatorisk riskbedömning i stora organisationer möter många kommunikationsutmaningar, som utgör allvarliga hot mot riskbedömningssystemens funktionalitet. Den här avhandlingen presenterar medel mot sådana kommunikationsutmaningar. Till exempel kan skapandet och användandet av delad kunskap, överbrygganden av formella kommunikationsled, användandet av dialog, eller standardisering av delar av kommunikationsarbetet bidra till att reducera hotet från misslyckad kommunikation.

En organisations säkerhetskultur kan utvecklas genom lokalt uppstående förändring, vilket förutsätter att relevant information är tillgänglig för organisationsmedlemmarna. För att stödja sådana förändringsprocesser bör presentationer av insamlad säkerhetskulturdata helst: Underlätta förståelsen av data; Erbjuda relevansstrukturer som passar målgruppen; Tillhandahålla möjligheter att erfara variation; Väcka frågor och inspirera hypotesgenerering; samt Visualisera relationerna mellan olika delar av data.

Acknowledgements

In the midst of the innumerable publications produced in these times of ever-expanding research, I hope you will find reading this thesis worthwhile.

The research reported here wouldn't have come about without the funding provided by the Swedish Civil Contingencies Agency, for which I am very grateful.

The lion's share of the work presented in this thesis concerns applied research. One of the driving forces has been to support the development of societal crisis preparedness and resilience. If it has succeeded in doing that, it would be great. In the process I have experienced interesting interactions with practitioners from various organizations. Thank you Valter, Erik, Bengt, Kjell, Jan, Ann-Christin, Lisa, Eva, Lennart, Jan-Peter, Pär-Ola, Åsa, Håkan and Eva!

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Charlotta, Ylva and Felix – you know that I love you.

Lund, August 2013

Jonas Borell

Appended papers

This thesis is based on the following papers, which will be referred to by their Roman numerals in the body of the text:

I. Jonas Borell & Kerstin Eriksson (2008). Improving emergency response capability: an approach for strengthening learning from emergency response evaluations. *International Journal of Emergency Management, 5*, 324-337.

The authors together designed the study, collected and analyzed the data, and drew conclusions. I was the main author.

II. Jonas Borell & Kerstin Eriksson (2013). Learning effectiveness of discussion-based crisis management exercises. *International Journal of Disaster Risk Reduction.* DOI: 10.1016/j.ijdrr.2013.05.001.

I made major contributions to the study design, literature search and analysis. The authors together designed, performed and analyzed the empirical study used as an example. I was the main author.

III. Jonas Borell & Kerstin Eriksson. Generic design considerations for organizational risk assessment systems in large organizations. (Submitted to an international scientific journal.)

The authors together designed the study, performed the literature search, collected data, performed data analysis and reflected over the results. I was the main author.

IV. Kerstin Eriksson & Jonas Borell. Countering communicational challenges in hierarchical risk assessment systems. (Submitted to an international scientific journal.)

The authors together designed the study, performed the literature search, collected data, performed data analysis and reflected over the results. I participated in writing the manuscript.

V. Jonas Borell, Åsa Ek & Marcus Runefors. Development-oriented visualizations of safety culture data. (Manuscript.)

I designed the study, performed the data collection, participated in the data processing, and I am the main author.

Contents

1 Introduction

The Swedish government identified that improved crisis preparedness principally can be seen as consisting of two things: *increased crisis management capability* and *vulnerability-reducing measures* (Proposition 2005/06:133). The government also stated that the goals for the Swedish society's safety and security management should be to defend:

- The lives and health of the population
- Society's functionality
- The ability to maintain basic values such as democracy, law and order, human freedom and human rights

> The democratic state governed by law, as well as health care, information and communication systems, energy supply, the flows of goods and services, and other society-critical activities are prerequisites for a functional society and must not break down (Proposition 2005/06:133, p.45).

Society is vulnerable. To protect itself and what it can do for its citizens, it needs to build and maintain safety. Sweden uses a national system for this. Partly defined through laws such as the Act on Municipal and County Council Measures Prior to and During Extra-ordinary Events in Peacetime and During Periods of Heightened Alert[1] (SFS 2006:544), the Swedish system distributes tasks and responsibilities for safety management to public organizations.

According to Olsen, Kruke and Hovden (2007), *societal safety* concerns the ability to maintain critical social functions, the protection of the lives and health of the citizens, and meeting the citizens' basic requirements. Other sources sometimes use different terminology, stressing alternative yet complementing aspects of the central object of study of this thesis, which I have chosen to refer to as *the system for societal safety and crisis management*.

The thesis research work was part of the Framework Program for Risk and Vulnerability Analyses (FRIVA), funded by The Swedish Emergency Management Agency

[1] In Swedish: Lagen (2006:544) om kommuners och landstings åtgärder inför och vid extraordinära händelser i fredstid och höjd beredskap

(SEMA)/Krisberedskapsmyndigheten (KBM), which became The Swedish Civil Contingencies Agency/Myndigheten för samhällsskydd och beredskap (MSB) 1 January 2009. The stated objectives and constraints of the research were to develop applicable, cost effective methods for proactive crisis management, including safety culture, taking into account the increasing complexity and interdependencies in society. The target group is authorities and their areas of operations, which include municipalities, county administrative boards, county councils, and central authorities.

Sweden's system for societal safety and crisis management went through major changes and development in the early years of the third millennium. With the intention to adopt an 'all hazards approach', formal responsibility for the local efforts was allocated to the municipalities (local authorities), who became responsible for such activities as risk and vulnerability analyses and crisis preparedness planning. Similar responsibilities were allocated to the county councils regarding their societal tasks.

There are three principles among the leading ideas behind the structure of Sweden's system for societal safety and crisis management: *the responsibility principle, the similarity principle* and *the proximity principle.* The responsibility principle means that the one responsible for an operation under normal conditions remains responsible during emergencies. The similarity principle means that the organization and localization of an operation shall remain as similar as possible during peacetime, emergencies and war. The proximity principle means that emergencies should be dealt with at as low a level as possible (i.e., locally) within the public sector (Harbom, 2010).

This means that societal safety and crisis management is up to the regular organizations that provide us with various services on a day-to-day basis. Crisis management shall be performed alongside their core businesses.

Legislation (e.g., SFS 2006:544) requires that authorities and public organizations in Sweden perform risk and vulnerability analyses of their own operations and areas of societal responsibilities. The legislation is generic, leaving it to the regulated organizations to determine themselves the details of what ought to be protected and how, and to take appropriate measures.

Behind the legislation was a growing awareness of the vulnerabilities inherent in the complex structures of modern society. As errors and accidents are inevitable in complex socio-technical systems (Perrow, 1984) there are obvious risks that the flows of goods, services, energy, etc., that we are dependent upon might be disrupted. Thus, we need to search broadly for possible threats, preventive measures, and preparatory activities directed at what is found. The aim is to reduce vulnerabilities in societally critical operations and to maintain a good crisis management capability. This is thought to be better achieved with a distributed approach than with centrally arranged analyses and planning.

The distributed approach has the advantage that a more genuine understanding and commitment can arise if the reasons for safety and crisis management work are more locally anchored. However, to achieve local interpretation, the generic regulations place high demands on an organization's local competence, capability and ability for development and change. Among the critical factors are organizational culture (including safety culture), work process designs for organizational risk assessments, the ability to interpret and conclude results from such assessments, and knowledge and use of methods and tools for building and improving crisis management capability (e.g., crisis response evaluations and crisis management exercises). Above all, for continuous improvements to be achieved, local organizations need to be learning organizations and have the ability to adapt.

The demands on local actors for competence and know-how that have come with the restructuring of the Swedish system for societal safety and crisis management call for the identification of suitable methods. However, the effectiveness, efficiency and appropriateness of established methods are uncertain. The changing nature of crises stemming from societal and technological developments transforms the demands on crisis management (Boin & Lagadec, 2000), which may render existing methods obsolete. For example, it has been suggested that traditional crisis and emergency management systems are unable to capture relevant aspects of the emergent risks that are characteristic of the today's society (Comfort, 2007). This calls for the development of new theories and methods.

Put together, this amounts to needs regarding the Swedish authorities' toolkits for societal safety and crisis management. The need for efficient, well-designed methods and for supporting, theoretical models is obvious. We need to know more about how public organizations should approach the important task of safety promotion in the society of today. This thesis investigates a number of possibilities to improve the Swedish authorities' toolkits for societal resilience. It focuses on aspects such as crisis response evaluations, crisis management exercises, organizational risk assessments, and safety culture.

2 Research objectives

2.1 General research aims

An organization's efforts to reach increased societal safety and improved crisis management often concern individual and organizational learning. Observations about the past and the present need to be blended with prognoses about the future; facts and estimations need to be collected, analyzed and contemplated; conclusions need to be drawn and patterns of thoughts and of actions need to be changed accordingly. Swedish authorities and organizations have toolkits available to help them to achieve this learning.

Research aim 1: *The general aim of the research presented in this thesis was to suggest improvements of selected parts of the Swedish authorities' toolkits for societal safety and crisis management.*

The selected parts of the toolkits were crisis response evaluations, crisis management exercises and organizational risk assessments. They were considered to be commonly used types of activities in the system for societal safety and crisis management, and were chosen in cooperation with practitioners. To complement the studies of particular types of activities, the research also had a second aim. The safety culture in an organization is often highlighted as an enabler for achieving efficient safety management.

Research aim 2: *The second aim of the research was to investigate how safety culture development can be supported as a means to improve the functionality of other aspects of societal safety and crisis management.*

The research is intended to contribute to the Swedish authorities' abilities to continuously improve their safety and crisis management capabilities. The performance of the organizational systems for this purpose can be enhanced through the development and refinement of various forms of learning activities. This is considered instrumental in achieving the ultimate goal of increased societal safety.

2.2 Research questions of individual studies

Crisis response evaluations

Actual experience is well recognized as a possible source of learning. Organizations often attempt to draw lessons from instances of the real emergency or crisis responses in which they have been involved. Live documentation and post-hoc reconstructions of chains of events and actions taken are recurrent in evaluations of emergency responses. To really improve crisis management capability, however, requires more than a reasonably accurate account of what happened. The necessary learning should be directed toward the future, which certainly will not look exactly like the past or the present.

Research question 1: *How can crisis response evaluations be structured so that they support individual and organizational learning that applies to situations different from the event that occurred?* This question is dealt with in **Paper I**.

Crisis management exercises

Crisis management exercises offer the opportunity to learn from simulated rather than actual negative events. Exercises can be used to prepare for crisis response – or possibly to prepare for resilient avoidance of crisis states. Similar to the situation with evaluations of actual instances of crisis response, exercises need to support 'good learning' of 'the right things'. Crisis management exercises often result in weak or vague learning results (Robert & Lajtha, 2002) that may have narrow applicability (Borodzicz & Van Haperen, 2002). Why is that?

Research question 2: *What can make crisis management scenario exercises yield learning results with broader applicability than to the actual scenario involved?*

Research question 3: *How can the achievement of appropriate learning results for individuals and groups be supported in the context of discussion-based crisis management exercises?* These questions are the theme of **Paper II**.

Organizational risk assessment

Risk assessments in organizations can be seen as a form of learning with a given purpose. Swedish authorities are often quite large organizations, with multi-layered structures divided into branches. From the perspective of the societal system, entire organizations are in turn connected to each other in a 'super-organization'. Thus, the design and

management of systems for organizational risk assessments in Swedish authorities present many challenges.

Research question 4: *What are the main challenges encountered by Swedish authorities in their design of systems for organizational risk assessments?*

Research question 5: *What are the critical factors in the design of such systems?* These questions are treated in **Paper III**.

Communication is integral in all parts of risk assessment work processes, and takes place before, in and after formal analysis activities. In large organizations, the systems for organizational risk assessment require that information travels through long chains of communication, which entail a potential for message distortion and miscommunication that can jeopardize system functionality.

Research question 6: *What communicational challenges do Swedish authorities experience in their organizational risk assessment systems?*

Research question 7: *How can these challenges be countered, so that system functionality is protected?* Communication in organizational risk assessment systems is the theme of **Paper IV**.

Safety culture

Even with a well-designed safety management system in place, satisfactory safety performance is not automatically achieved. In the literature, safety culture (and the related concept of safety climate) has been suggested as a possible reason behind this. Safety culture can affect an organization's ability to effectively take on its safety-strengthening tasks, which makes it important to examine and develop an organization's safety culture. The presentation of safety culture data is critical in systematic safety culture development.

Research question 8: *How can visualizations of safety culture data be used to support safety culture development?* That is the theme of **Paper V**.

3 Theoretical framework

3.1 Systematic safety and crisis management

Knowledge about prominent views on system safety and how to achieve it is necessary for navigation in the field of societal safety management. This chapter provides an overview of theories that can be used to position the research of this thesis in a bigger picture, both theoretically and concerning actual practice.

3.1.1 Safety, crisis and the management of both

Fruitful safety and crisis management efforts require models of what the management work is all about. In particular, such models need to differentiate between crises and the normal, non-crisis states.

Safety has traditionally been defined as "freedom from unacceptable risk (Hollnagel, 2011a, p. xxix)." As mentioned in the introduction, the Swedish government has stated that societal safety (and security) concerns such issues as protecting the life and health of the population and society's functionality (Proposition 2005/06:133).

Defining 'crisis' can be quite complicated:

> A crisis is defined or interpreted in relation to other events, periods, stages or states that were or are 'not a crisis'. A crisis is unexpected compared to earlier expectations; it is urgent compared to other less urgent matters; it is of high stake, compared with issues of lower stake and so on. A crisis cannot be understood as a single isolated phenomenon because it is by definition a relative concept. (Laere, 2013, p. 17)

With the pragmatic aims of the research reported in this thesis, I will not attempt at a more specified definition of crisis here. Instead, the concepts of safety and crisis are treated below through a résumé of different views on safety and crisis management, along with their various assumptions and characteristic conceptualizations. Hopefully, the reader will notice how the images of proactive safety and crisis management found in the literature have much in common.

The term 'crisis' typically denotes somewhat major events, while the term 'safety' has a wider scope and can concern all magnitudes of adverse events. In practice, this meronomical relation between the concepts suggests that proactive efforts at crisis management may be seen as a subset of proactive efforts at safety management.

Some of the sources referred to use the terms 'emergency' and 'emergency management', which in this text I have chosen to treat as sufficiently corresponding to 'crisis' and 'crisis management' to consider them as interchangeable.

3.1.2 Approaches to safety and crisis management

According to normal accidents theory (Perrow, 1984), tight couplings and complex interactions inevitably will lead to system failures. Thus the large, complex socio-technical systems man has created can hardly be failsafe, which means that the functionality of our society is under threat.

Safety can be understood and managed in many ways. Classical safety management aims at reducing faults and errors in order to increase safety. The main logic is to constrain performance, for example, through rules, barriers and defenses. In recent years, however, this static view of safety and the avoidance of crises has been questioned, and alternative perspectives have been put forward.

Current views of effective ways to achieve safety often rely on viewing organizations as *open systems*, which are systems with the property of self-maintenance (Boulding, 1956) and that exchange information, energy or material with their environments (Kast & Rosenzweig, 1972). Through the use of feedback, systems can maintain desired states, and intentionally change their future outputs (Kast & Rosenzweig, 1972). These characteristics are incorporated in many prominent, contemporary theoretical systems on safety and crisis management.

Without really defining crises, but focusing on avoiding them, Weick and Sutcliffe (2007) argue that safety is a dynamic non-event. This is because the production of stable output requires constant change in order to adapt and to maintain equilibrium (Weick, 1987). A similar view was expressed by Hollnagel and Woods (2006), stating that safety is not a system property, but a quality of system functioning. A popular term reflecting the dynamic properties of safety is *resilience*. Resilience can be defined as: "The intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions (Hollnagel, 2011a, p.xxxvi)."

The best way to deal with a crisis is to prevent it from even happening, which Weick and Sutcliffe (2007) liken to "keep the unexpected as a non-event." They suggest that organizations with certain functional characteristics can achieve "organizational mindfulness," which allows for the detection of weak signals of possible disturbances

on their way, that later, in hindsight, might be labeled as early warnings. If proactive action is taken it is possible that a disturbance may be avoided altogether, thus maintaining safety and avoiding crisis. Weick and Sutcliffe (2007) suggest that organizations should:

- Be preoccupied with failure (from small slips to big problems)
- Be reluctant to simplify (models, descriptions, etc., that mold situational awareness and sensemaking)
- Be sensitive to operations (i.e., never lose track of core business, and of possible disturbances to it)
- Be committed to resilience (i.e., the ability to maintain or regain a dynamically stable state)
- Show deference to expertise (diversity enables richer detection and more flexible management of threats, and flexible organizations allow for competence optimization)

In recent years there has been a trend in research on safety management to stress the need of not only looking at failures and accidents, but also at success scenarios (Weick & Sutcliffe, 2007; Hollnagel, 2009; Hollnagel, Woods, & Leveson, 2006). It is the success scenarios that we want to achieve and protect. Hollnagel (2009) argues that things that go right should be given more attention in the examination of things that go wrong. He states that because things go right for the same reasons they go wrong, we should not look for things that went wrong, but for things that did not go right. As safety or reliability increases, the number of errors, faults or crises decreases, which entails less failure material to analyze; but usually there is an abundance of success-related material to learn from, which is reflected in Figure 1. Furthermore, learning through trial-and-error is untenable if the consequences of failure are too grave (Weick, 1987) – we cannot afford to wait for crises to happen before we try to learn how to manage (or even avoid) them.

A central notion in this field of safety promotion is the necessary choice between efficiency or thoroughness, described by Hollnagel (2009) as the "efficiency-thoroughness-trade-off (ETTO) principle". Slightly simplified it says that one always, in every situation, has to choose between performing slow, meticulous work with low error-rates and low efficiency, or fast but careless work relying on experience and luck, yielding higher error-rates and efficiency.

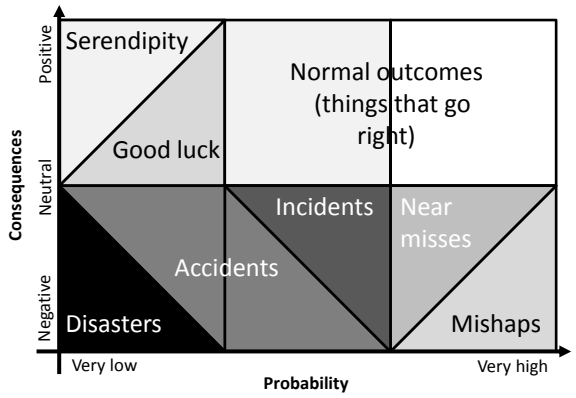


Figure 1.
Range of outcomes combining success and failure scenarios. Adapted from (Hollnagel, 2011a).

The management of novel situations tends to require our full attention and conscious analysis. Such knowledge-based human activity benefits from domain-specific knowledge. Through the accumulated experience of similar situations, behavior-guiding rules and eventually even automated response patterns evolve. This frees up the limited human cognitive capacity for conscious, knowledge-based activities, so that it can be directed to new aspects (Rasmussen, 1983).

If much experience is accumulated and thus automated response patterns are well established, and situational factors do not differ, choosing efficiency over thoroughness can pay off (Hollnagel, 2009). However, there is also a risk for errors due to unfortunate uses of automated levels of functioning (Reason, 1990). Safe performance demands that operational surprises are detected (Weick, 2011), which may require that attentional resources are redirected so the activity is controlled on a higher cognitive level.

Since the ETTO principle is inevitable, and humans cannot perform with complete situational understanding, some errors and faults will necessarily occur. When they do, it is a good idea to take the opportunity to learn and improve. The balance between efficiency and thoroughness is partly determined by culture, which thus affects accident rates.

Resilience engineering also acknowledges the relation between normal, planned for performance and the deviations and failures that may lead to crises. Performance variability is necessary. Normally it contributes to success, but sometimes it leads to failure (Hollnagel, 2009). Resilience engineering relies on a systems view, which Hollnagel (2006) summarizes in four points:

- Both normal performance and failure are emergent phenomena, dependent on complex interactions.
- The outcomes of actions sometimes do not match intentions, expectations or requirements. This is more often due to contextual variability than to failure of actions, components or functions.
- The efficiency of human work comes from its adaptability and flexibility.
- Human adaptability and flexibility are also the reasons for the failures that occur (but rarely the cause of such failures).

The goal of resilience engineering is to increase operational success, which relies on four cornerstones (Hollnagel, 2011a):

Responding to the actual, regular and irregular events, either through prepared responses or through adjusting normal functioning.

Monitoring the critical, knowing what can become a threat in the near future. Monitoring must be directed towards both the inner and outer environments of the system.

Anticipating the potential, knowing what to expect regarding future developments, threats and opportunities.

Learning from the factual, using experiences to draw lessons regarding successes as well as failures.

We can conclude that safety is not static, and neither is 'successful work' – they both require variation and adaptation. We can also conclude that various forms of learning are required to achieve the dynamic stability or resilience that is needed for safe performance.

3.1.3 Phases and processes

Crisis management is often described as consisting of different phases in relation to specific crisis events. *Disasters* are sometimes positioned in relation to the more 'normal' crises and emergencies as events with negative consequences greater than the stricken society can handle. However, as Dombrowsky (1995) elegantly explained, disasters are not events at all: "Disasters do not cause effects. The effects are what we call a disaster" (Dombrowsky, 1995, p. 244). Nevertheless, when the term disaster occurs in this thesis it does so due to referred sources that treat things I judge relevant from a societal safety and crisis management perspective. What referred sources say about the management of disasters (e.g., regarding disaster phase models) might as well be said about crisis management.

Disaster process models are often based on identifying the stages, events, actions and time frame that make up the course of a disaster (Kelly, 1999). In such models, phases are commonly arranged temporally, as before, during or after the critical event. In practice, deciding on precise borders between such phases is neither possible nor desired. For a certain disaster, for example, different segments of a population may experience different stages at the same time (Neal, 1997).

Different purposes pose different demands for models. From an operational perspective centering on the acute phases of crisis management – with such resilience-critical tasks as detecting emerging crises and initiating responses – certain aspects become important, such as easily and correctly identifying an approaching crisis, monitoring the course of events and directing management activities. Such a perspective is the aim of Kelly (1999), who suggests that models can help distinguish between critical elements and noise. From a more detached perspective, other aspects become more important to model. For example, the relative importance of learning aspects might increase once the acute phase of crisis management is over.

The chronological idea of phases, which presumes succession, can sometimes be substituted with a view of the facets of crisis management as more of interconnected functional aspects that can run in parallel. As noted by Neal (1997), it is essential to differentiate between temporal and functional aspects of crises or disasters. An example is given in Figure 2, showing a simple model that relates the phases and activities of emergency management to each other along a timeline. The research presented in this thesis pertains to 'before' and 'after' an actual, on-going crisis, with indirect relations to the 'during' phase.

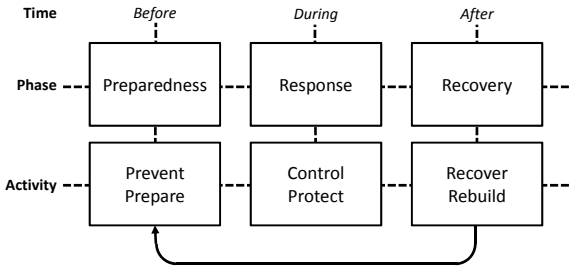


Figure 2.
Three phases in dealing with a disaster or emergency. Adapted from Enander (2010, p. 38).

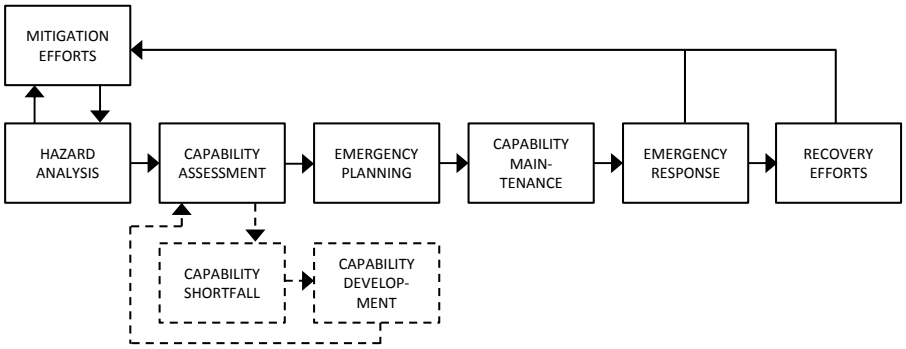
With a functional focus, McLoughlin (1985) noted that a balanced program for emergency management should include:

- *Mitigation* - Activities that reduce the degree of long-term risk to human life and property from natural and manmade hazards.
- *Preparedness* – Activities that develop operational capabilities for responding to emergencies (e.g., emergency operations plans).
- *Response* – Activities taken immediately before, during, or directly after an emergency that save lives, minimize property damage, or improve recovery.
- *Recovery* – Short-term activities that restore vital life-support systems to minimum operating standards and long-term activities that return life to normal (e.g., temporary housing, debris clearance and facility restoration).

The Federal Emergency Management Agency (FEMA) of the U.S. developed the Integrated Emergency Management System (IEMS) as a means towards a multi-hazard approach to emergency management (McLoughlin, 1985) (see Figure 3).

The function of mitigation has a relatively looser coupling to operational crisis or emergency management than, for example, emergency planning and capability maintenance have. While other activities in the emergency management process focus on dealing with manifest problems, mitigation aims at eliminating problems by either removing the sources of potential disturbances, reducing their frequency or intensity, or changing the way hazards can interact with people and their support systems. The last of these amounts to altering the way people live and the systems they create in order to reduce risks (McLoughlin, 1985). Learning and improvement deserve attention in all phases or functions of the emergency management process. In Figure 3, the formal learning loops are represented by the arrows connecting emergency response and recovery efforts with mitigation efforts.

The research presented in this thesis mainly concerns activities that belong in the mitigation efforts and hazard analysis functions of the IEMS model.



Hazard Analysis: Identifying what can happen, how likely it is and what problems it would bring are essential for emergency planning. Combining hazard knowledge with the potential impacts on the community results in a measure of the community's vulnerability.

Capability Assessment: After hazard analysis the resources available for an actual emergency can be assessed. The identified resources for emergency operations serve as input to emergency planning, and identified deficiencies serve as input to the sub-process of capability improvement (*Capability Shortfall, Capability Development*).

Emergency Planning: The process of planning can be highly valuable in building collective capability, and resulting plans can be used to brief persons who have not participated in the planning process.

Capability Maintenance: Unless continuously maintained a developed ability to take appropriate and effective action will diminish over time. Updating plans, performing exercises, testing equipment, etc., is necessary to keep capability.

Emergency Response: When needed, appropriate actions should be taken. Depending on the source of disturbances, somewhat different courses of action might be called for.

Recovery Efforts: Once immediate life-saving and property protecting efforts can be phased out, it is time to restore community functions.

Mitigation Efforts: Systematic efforts to prevent the preventable and prepare for the unpreventable should be part of all societal emergency management systems. The function of mitigation can and should be integrated with more or less all other branches of societal functioning; risk reduction ought to be integral in planning and performing more or less everything.

Figure 3.
The IEMS model. Adapted from (McLoughlin, 1985).

3.1.4 Analyzing risks and vulnerabilities

One of the legal cornerstones contributing to the societal activities that motivated the current research requires that Swedish municipalities and county councils shall perform *risk and vulnerability analyses* (SFS 2006:544). However, it does not define the concepts. "Risk assessment" is formally defined as the overall process of risk identification, risk analysis and risk evaluation (ISO 31000:2009), and is generally accepted as an integral part of systematic safety management, where it delivers input to risk treatment (ISO 31000:2009). Performing a risk analysis is not an end in itself, but a means to gain valid input into management processes (McLoughlin, 1985; ISO 31000:2009).

In the practical world of Swedish municipalities and county councils, risk and vulnerability analysis concerns the examinations of what bad things might happen, and estimations of how likely they are. It is important that the organizations themselves and their vulnerabilities are taken into account. For example, an important aspect in crisis management capability is the ability to adapt. In order to maintain resilience, organizations should monitor their adaptive capacity and investigate whether present and future demands of adaptability are being met (Woods, 2009; Woods, 2011).

Paper III and **Paper IV** concern the implementation of organizational risk assessment systems in large organizations. However, risk analysis is not focal in the studies, which look at the organizational systems and communicational practices needed for risk assessment.

3.2 Communication

Communication is integral in more or less all activities related to systematic safety and crisis management. Hence, theories of communication can advance the understanding of safety and crisis management efforts. Aspects of communication are also central in **Paper IV**, which treats communicational problems and solutions in hierarchical systems for organizational risk assessment.

When two people communicate, they do so by means of messages. The sender of a message has an intended meaning, which emanates from the sender's knowledge structures and is expressed in the form of information (Davenport & Prusak, 2000). The sender codifies the message into data (i.e., syntactic entities without inherent meaning (Aamodt & Nygård, 1995), which is then transmitted. The receiver interprets the message's data into meaningful information through the application of his or her knowledge structures (Aamodt & Nygård, 1995). A prerequisite for mutual understanding, and thus for effective communication, is shared meaning structures

(Dixon, 1999), which means that there is correspondence between the sender's and the receiver's bodies of knowledge that shape the coding and interpretation processes (Aamodt & Nygård, 1995).

If the receiver interprets the data into information as intended by the sender, the communication is successful. The subjective nature of interpersonal communication makes approximate message correspondence between sender and receiver generally considered as sufficient.

The subjective dependence on the knowledge structures of communicators poses some general challenges. For example, the risk of message distortion increases with the number of codification and interpretation processes it goes through, which means that long chains of communication entail a greater risk of miscommunication. This causes a potential problem for the operation of risk assessment systems in large organizations and is studied in **Paper IV**.

Communication is also an essential part of the process of learning. Organizational learning requires that the output from risk assessments should reach and be used by the right parts of the organizations at the right time.

3.3 Organized learning for increased resilience

Safety management often amounts to identifying and moving relevant information between different times, places, organizational units, people, processes, etc. Much of this can be framed as learning, be it individual, organizational or systemic.

3.3.1 Learning outcomes – What to aim at?

The point of learning is that something experienced or detected in one situation is applied in another. Regarding learning, the connection between situations is referred to as *transfer* (Baldwin & Ford, 1988). In each moment, innumerous earlier situations affect the present through transfer processes, and each moment potentially affects innumerous future situations by means of transfer. A potential for transfer is the main reason behind all attempts at intended or arranged learning, such as crisis management exercises or evaluations of instances of crisis management. These are studied in **Paper I** and **Paper II**. Sometimes the 'sending' end of transfer processes is in focus, sometimes the 'receiving' end, and sometimes both.

For an individual to pick up anything at all, so that it has a potential to later be applied in or somehow affect another situation, he or she has to discern it in relation to all other things present (Marton & Booth, 1997). It is by experiencing patterns of variation and

invariance that our potential for awareness, and thus for future action, is molded (Bowden & Marton, 2004; Marton & Pang, 2006). According to Marton & Booth (1997), it is through similarities in the sets of relevant dimensions of possible variation between situations that transfer takes place. Positive transfer benefits from stimulus variability, which means that a variety of relevant stimuli are encountered at the starting point of transfer (Baldwin & Ford, 1988).

A slightly different perspective on transfer is that of knowledge transfer, which treats how the experience of one unit (e.g., individual, group, department or division) affects another (Argote, Ingram, Levine, & Moreland, 2000). Successful transfer requires that the knowledge is generalized to become applicable in the specific context where it will be used (Baldwin & Ford, 1988). Transfer processes within or between individuals play crucial roles in more or less all efforts at systematic safety management, thus highlighting the importance of learning for safety.

Regarding the 'sending' end of transfer, learning for safety often revolves around things that have gone wrong (Hollnagel, 2011b). Accidents and failures function as motivators as well as content to learning processes aimed at improving safety. This is the case in **Paper I**. To be effective, however, learning based on negative events that have occurred has to bridge those events to future possibilities (i.e., possible 'receiving' ends of transfer). Furthermore, a sole focus on unwanted outcomes should be abandoned in favor of a combined focus on positive as well as negative outcomes (Hollnagel et al., 2006). This is (as mentioned above) because the reasons behind failures often also are the reasons behind success (Hollnagel, 2009).

On the level of the individual, Gagné (1984) identified five categories of learning outcomes: intellectual skills, verbal information, cognitive strategies, attitudes, and motor skills. In actual learning, the obtained results often contain a mix of elements from the different categories. In the strategic planning of arranged learning situations, however, it is possible to aim specifically at elements from certain categories. Although real performance requires an interplay of elements pertaining to all of the categories, training may be directed towards or stress certain categories.

Concepts and conceptual ability determine much of an individual's higher cognitive capabilities (Jonassen, 2006), which are vital for human capability in various forms of safety and crisis management (e.g., Weick, 2011; Comfort, 2007). Thus conceptual aspects of learning are important in various forms of safety-related learning. They are central to discussion-based crisis exercises, which are studied in **Paper II**. Concepts and conceptual ability correspond to intellectual skills, verbal information and cognitive strategies in Gagné's model (1984).

The concept of Intended Learning Outcomes (ILOs) has been established in the field of higher education (Hussey & Smith, 2002; Harden, 2002; Hussey & Smith, 2003). ILOs are broad statements describing what participants should possess after a learning

process (Harden, 2002). ILOs can (and often should) reflect elements from multiple of Gagné's categories (Gagné, 1984).

ILOs can be used before a learning process in setting the goals. During a learning process, they can be used to direct learning. Afterwards, they can be used to assess the results achieved – Were the ILOs met? To be useful, ILOs should reflect knowledge, understanding, skills and abilities (Hussey & Smith, 2002). In a crisis management context ILOs could be used to link analyzing activities (e.g., risk analyses and event evaluations) to preparatory and mitigating activities (e.g., training and exercises). Then assumed needs should guide the formulation of ILOs. The possible use of ILOs in the context of crisis management exercises is described in **Paper II**.

Efforts at learning, for example through crisis exercises, can have good results in terms of developing competences that meet predicted needs. However, no matter the degree of research behind analyses of competence needs, a perfect result is not possible: "A resilient system must be both prepared, and be prepared to be unprepared" (Pariès, 2011, p.6).

3.3.2 Individual and organizational learning

The main point of learning is to achieve a potential for transfer. On the level of the individual, learning requires that one experiences variation (in contrast to invariance) (Marton & Pang, 2006; Marton, 2006; Marton & Booth, 1997). This primes the learner for experiencing future variation by enabling the discernment of relevant dimensions of possible variation (Bowden & Marton, 2004).

In analyzing learning processes it can be valuable to separate the process of learning from the content of learning (Gagné, 1972). Although such a separation is artificial, since what is learned is dependent on how it is learned (Marton, 1981), it may still be useful in comparing different learning situations.

Organizations can also learn. According to Argyris & Schön (1996) organizational learning occurs when individuals (that make up the organization) learn *for* the organization. Dixon (1999) describes how interactions among organizational members can develop shared knowledge structures, which facilitate communication and cooperation.

When organizations perform risk analyses, arrange crisis management exercises or evaluate how they have responded to crises, they attempt to learn. In those cases, the starting points of transfer processes might be rather obvious (i.e., the risk analyses, exercises and response evaluations), but where the transfer is supposed to go might be less clear. In order for learning to be effective, the (learning) results have to be directed somewhere. This can happen through the integration of work processes, so that safety information is put to use, or through re-designs of the organization and its socio-

technical system, as when procedures are changed or organizational members' knowledge and competence evolve. In any case, the idea is to change some future potential. That is organizational learning for safety in practice.

3.3.3 Crisis and emergency management exercises

There are many different kinds of crisis and emergency management exercises, ranging from tabletop to full-scale simulation exercises (Lindell, Perry, & Prater, 2006). In scenario-based exercises the participants interact around a scenario (i.e., a dynamic description of a chain of events), typically in tabletop settings rather than out in the field and not necessarily with chronological realism (Alexander, 2000). Discussion-based crisis exercises are suitable for shaping organizations' crisis management capabilities by enhancing strategic and tactical aspects of crisis management (Crichton, Flin, & Rattray, 2000; Crichton, 2009; Woltjer, Trnka, Lundberg, & Johansson, 2006). Swedish municipalities use discussion-based tabletop exercises as well as more realistic simulation games to improve their crisis management preparedness (Laere, 2013). **Paper II** concerns the learning effectiveness of discussion-based exercises.

3.3.4 Response evaluation methods

It is generally accepted that lessons can be learned from instances of crisis or emergency response. This notion is reflected in the feedback loops linking post-event phases to pre-event phases in models of crisis and emergency management. It is, however, important to aim at the 'right' lessons, since the future will not be exactly like the past (Lagadec, 2007; Levy, 1994). **Paper I** takes on the challenge that two situations connected by a transfer process never will be identical.

Regarding post-event learning efforts, it should also be noted that accident investigations are more of social and psychological processes than objective or technological ones, since investigations are more about constructing causes than finding them (Hollnagel, 2009). That is an interesting observation, indicating the importance of conceptual harmony to man. It is also in line with the idea of **Paper I** that what actually happened may not be so important in crisis management evaluations. Of interest, instead, is what might happen, and how to prepare for managing that. That is what learning from what has occurred in order to strengthen crisis management capability should be about.

3.4 Safety culture

Work procedures and actions that are likely to lead to safer operations can be identified, and safety management systems can be designed around them, including routines for risk assessment, learning loops, etc. Yet, this whole 'machinery' will not function if the people working in the system do not understand the system design (including their own roles as contributors to operational resilience) or do not share the value of prioritizing safety. This is where safety culture comes in.

3.4.1 Defining safety culture

Many scholars and practitioners agree that certain cultural traits can contribute to the effective functioning of safety-improving operations. Such cultural traits are often labeled 'safety culture'. However, there is no consensus on how to define or operationalize the concept (cf. Guldenmund, 2007; Antonsen, 2009). This thesis does not attempt to solve the grand problem of establishing a single, 'perfect' definition of safety culture, fitting scientific as well as practical needs. However, it would be appropriate to briefly review some points of reference regarding the matter.

For scientific research purposes, factor analysis is often employed to reach orthogonal dimensions of safety culture (Guldenmund, 2000). This is appropriate if the aim is to develop simple and mathematically lean models of culture. However, dimensions arrived at through such methods may fit less well with the language of operational practice in the organization studied (due to semantic artificiality) or with established theories on effective safety organization.

Hale (2000) suggested that safety culture can be viewed as the aspects through which organizational culture affects organizational safety performance, which shifts the problem to defining organizational culture instead of safety culture.

Organizational culture is also a widely debated concept. Schein's (2004) model of organizational culture is often cited in the literature on safety culture. According to Schein, organizational culture can be analyzed through a three-layered structure. The bottom layer consists of basic assumptions that have been formed by experiences and reflect taken-for-granted aspects of the organization and its context. The basic assumptions are not directly accessible to organizational members (who carry them) or to external observers. Instead, they have to be inferred from observations of the two higher levels in Schein's model. The middle level consists of espoused beliefs and values, such as strategies and justifications that have been or could be made explicit. The third level contains the directly observable cultural artifacts, such as organizational structures, processes and behaviors. The artifacts cannot be understood on their own, since they

get their meaning from the deeper cultural levels. The three levels in the model mutually influence each other.

The study in **Paper V** looks at ways to enhance safety culture. For the empirical parts of the study, an operational definition of safety culture was used, originally developed by Ek (2006) in the form of a model encompassing nine aspects of safety culture. *Working situation:* The working situation of organizational members can reveal threats to the performance of core processes as well as to effective risk management work. *Flexibility*: A flexible culture is able to adapt the organizational structure to situational demands. *Communication* is central to proactive as well as reactive safety management. *Reporting*: In a reporting culture members report their errors and near misses. *Justness*: In a just culture, the fallibility of humans is acknowledged, so that people are not afraid of being unjustly blamed when they report safety-relevant information. *Learning*: A learning culture reflects the will and ability to draw relevant lessons from safety-related information. *Safety-related behaviors* reflect perceptions of safety-critical actions. *Attitudes towards safety* concern how safety performance and safety management are valued by organizational members. *Risk perception:* The risk perception of organizational members reflects the level of danger they see.

Four of Ek's nine aspects (reporting, flexibility, justness and learning) come from Reason's (1997) description of what lies behind an "informed culture." The central idea of the model is that organizational culture strongly affects some necessary but not sufficient conditions for organized organizational learning and development in relation to resilience and crisis management capability.

3.4.2 Applications of safety culture

Based on assumptions that safety culture can affect safety performance and that safety culture can be improved, it is widely used in efforts to promote safety. Systematic safety management can encompass recurrent investigations of an organization's safety culture, as a basis for possible interventions (Antonsen, 2009). To indicate whether and where corrective measures would be appropriate, safety culture questionnaires should yield relevant and valid information (Guldenmund, 2007). Frequent investigations of safety culture have also been suggested as a mitigating strategy, able to detect alarming fluctuations (Akselsson, Ek, Koornneef, Stewart, & Ward, 2009).

From a strictly academic point of view, the absence of a single, tentatively agreed-upon definition casts doubt on the usability of the concept of safety culture. It also renders comparisons between different safety culture studies a risky business, requiring close attention to definitional differences. In applied settings, with the primary aim to study and change actual organizational performance, the relative importance of other aspects increases. For example, intelligible questionnaire items and actionable data compilation categories can become crucial.

3.4.3 Changing organizational culture

If safety culture is defined as the aspects through which organizational culture affects organizational safety performance, general theories on how to change organizational culture may be applicable to changing safety culture.

Centralized, programmatic change is seldom successful. The interdependence of different aspects of a composite organizational system entails complexity, which may make it impossible to predict the emergent effects of specific interventions (Alvesson & Sveningsson, 2008).

In attempts at programmatic change of organizational culture where espoused values are communicated to employees, those values are often reinterpreted (Ogbonna & Harris, 1998) and only superficial changes are accomplished. This has little or no actual effect on the deeper cultural levels of assumptions or beliefs (Alvesson & Sveningsson, 2008).

The basic assumptions at the bottom of organizational culture (Schein, 2004) require that change processes of organizational culture are performed with the continuity of local history in mind. Organizational (safety) culture tends to differ between different units, organizational levels, personnel groups, etc. This can be understood through Schein's (2004) model, according to which the basic assumptions of a group are formed by their collective history. The tendency for cultural heterogeneity is another reason why local efforts rather than grand programs are preferable in attempts at cultural change, so that the actual culture of a specific organizational unit can be taken into account.

All organizations constantly undergo change, and (safety) culture is formed and reformed by the day-to-day interactions (Weick & Quinn, 1999). Therefore, relevant information has to be available to the organizational members in local workplaces, in order to support a beneficial adaptation to the actual circumstances.

Development plans formulated by someone else, which are not aligned with the local, collective history, cannot successfully change organizational culture. In the end, the organizational members have to do the job of cultural change themselves. This should be acknowledged in the design of processes or projects for safety culture development, or of instruments to be used in them (e.g., safety culture questionnaires or reports).

4 Methods and materials

4.1 The research process

Some theses are characterized by descriptions of linearly progressing research, typically in cumulative areas of 'normal science'. Others are more philosophically oriented, closely examining small details of concepts and phenomena from different angles. This thesis belongs to neither of these categories. Instead, it covers a group of related studies, reporting a line of research that started with a broad research project plan that was granted funding. Based on literature studies and interactions with practitioners an array of ideas on how to approach the original problem was suggested. Some of these ideas lay behind the studies reported in the papers around which this thesis is constructed, and some paths proved to be dead ends. Yet other paths are still not fully explored. The studies that are reported in the appended papers were to a large extent performed in parallel, and the relations between them are thematic connections and not successional ones.

Not all research aims at finding out how things are. Some instead aims at designing how things could or should be. The latter category can be included in "the sciences of the artificial" (Simon, 1996). "A natural science is a body of knowledge about some class of things – objects or phenomena – in the world: about the characteristics and properties that they have; about how they behave and interact with each other (Simon, 1996, p. 1)." Natural science is aimed at understanding reality (March & Smith, 1995). The research presented in this thesis is not really about how things are; it is more concerned with how things might be, given certain circumstances, and thus it falls better into Simon's (1996) idea of a *design science*. Design science is aimed at creating things that serve human purposes (March & Smith, 1995). The research reported here is about organizations, organizational behavior, organizational systems, human interaction, etc., which are better understood using principles of design science rather than natural science.

A rational design process is guided by a set of requirements that need to be fulfilled in order to achieve the overall purpose. Often the object of design is considered a system, which can be broken down into subsystems that correspond to different functions needed to fulfill the system purpose (Simon, 1996). Design processes encompass the steps of alternative generation and alternative selection, but not necessarily the step of

optimization. It can be enough to satisfy the requirements, without optimizing either subsystems or the total system (Simon, 1976).

A suggested design solution can be evaluated in terms of its ability or efficiency in relation to its system purpose. For example, if a necessary requirement for the fulfillment of a purpose is not met, the fulfillment of the entire system purpose is threatened (Simon, 1996). The evaluation of a proposed design solution can utilize simulated or implemented test runs that examine the design solution's functionality. A single instance of successful implementation demonstrates feasibility, but does not prove general applicability or functionality.

Another relevant dimension, sometimes correlated with the natural/design science dimension, is the distinction between basic and applied research. Basic research is interested in finding out how things are. Applied research is interested in solving problems and delivering practically usable results. This thesis project is about applied research, collecting empirics from real organizations to achieve results that can be developed into applicable conclusions. Practitioners have contributed to the formulations of some of the 'real world problems' and research questions. Access to these organizations and their daily operations has necessitated adaptation, concerning time and sometimes form, to their particular idiosyncrasies. The relatively close cooperation with practitioners has contributed to rich background knowledge, which may be a mixed blessing. On the one hand, it aids interpretation and effective communication; on the other, it can complicate data treatment and obscure relevant details.

In the tradition of general systems theory it is acknowledged that open systems tend to display *equifinality*, which means that certain results may be achieved with different initial conditions and in different ways (Kast & Rosenzweig, 1972). As a consequence of relevance to the study of organizations, which indeed are open systems, it is not sufficient to examine static structures in order to evaluate organizational qualities. To enable meaningful discussions on organizational purposefulness, *dynamics* and *processes* need to be taken into account. Sometimes, the collection of empirics has had to span longer intervals (as in **Paper III** and **Paper IV**) or rely on multiple, complementary sources of data (as in **Paper I, Paper III**, **Paper IV** and **Paper V**).

In social research it is not possible to study some problems with traditional, systematic methods using control of variation. Comfort (1985) discusses how action research may be employed instead to arrange research in such settings. Comfort (1985, p. 101) describes the purpose of social (action) research as, "The problem remains the gritty one of individual and organizational learning on a daily basis, the return of information gained from experience and reformulation of evolving problems to the redesign of organizational structure and process." According to Comfort, the purpose of social research is to design organizations and practices that work effectively and efficiently towards societal goals. This is in line with the research reported in this thesis.

4.2 Methods

The research presented has used a number of different methods for data collection, data analysis and design evaluation. In addition to what is listed below, there have been numerous informal talks and meetings with practitioners, which also have contributed relevant knowledge. The extensive social interactions needed to maintain positive relationships and access to data has also made it difficult in some cases to determine clear-cut borders between the different studies, which makes it hard to disjunctly distribute the methods to the different studies.

The following section outlines the research processes behind each separate paper, and connects the methods and procedures used to their respective, contextual aims. Some of the details included here are not included in the papers that report the studies.

4.2.1 Crisis response evaluations – Paper I

The study's objective was to develop and demonstrate an approach to improve emergency[2] response capability by improving individual and organizational learning from evaluations of specific emergency responses.

Empirical material used in the testing and demonstration of the approach to learning-oriented evaluations was gathered from two retrospective studies of three different episodes of crisis management in a Swedish municipality. The studies were performed as evaluations primarily aimed at improving organizational capability.

The first evaluation included a retrospective account of the events and the management work related to one primary episode of crisis management, but also yielded information on an earlier episode involving several of the informants. Formal interviews were performed with nine people that had been involved in the crisis management activities. The interviews were semi-structured to capture information that answered predefined questions, yet allow for emergent themes. The respondents were asked to describe such things as their roles in the crisis management organization, their views on the chain of events, and what preparatory activities they had experienced prior to the primary episode. The interviews were performed at the respondents' work places with both authors present and were audio recorded. The empirical material was sorted according to the organization's formal crisis management regulations and analyzed through comparisons with literature on crisis and emergency management.

[2] In **Paper I** the term "emergency response capability" was used. However, it would have been as suitable to use "crisis response capability" instead.

We tested the approach we were developing in several ways. The theme of exploring variation was tested in formulating the feedback report to the organization and in presentations and discussions at seminars that disseminated the evaluation results in the municipality's organization. These tests yielded confirmative results, indicating that the approach could be practicably used, which motivated its further refinement.

The second evaluation also involved a retrospective account of the events and the management work related to an episode of crisis management in the municipality. Formal interviews were performed with 12 people that had been involved in the crisis management activities (two of them were interviewed in the first evaluation too). The interviews were semi-structured to capture information that answered predefined questions, yet allow for emergent themes. The respondents were asked to describe such things as their normal jobs, their roles in the crisis management organization, their views on the chain of events, and what preparatory activities they had experienced prior to the episode. The interviews were performed at the respondents' work places with both authors present and were audio recorded. Minutes from meetings during the episode and formal preparedness plans provided complementary data. The empirical material was sorted according to the organization's formal crisis management regulations and analyzed through comparisons with literature on crisis and emergency management.

Paper I demonstrated the suggested approach through examples of variations of the constructed scenarios of three crisis management episodes.

4.2.2 Crisis management exercises – Paper II

This study developed a theoretical framework that describes some of the necessary requirements for individual learning and beneficial factors for individual and organizational learning from discussion-based crisis management exercises. The framework is intended to be useful in planning, performing and evaluating exercises.

During the development of the theoretical framework, the authors observed crisis management exercises of various kinds in different public organizations.

The framework was developed from literature studies and theoretical reasoning. Its application was tested by arranging a crisis management exercise that was designed and performed according to the framework, with the authors as exercise planners and facilitators. The test exercise involved the crisis management group of a mid-size Swedish municipality, and had eleven participants. In everyday work they all had managerial positions, and in the event of crisis management they had specified roles in the municipality's crisis management organization. The exercise was in the form of tabletop discussions, and consisted of two parts. The parts had different starting scenarios, described as parameter sets. In line with the framework, the exercises revolved

around collectively altering the scenario descriptions. The whole exercise session was documented through video and audio recording, and notes taken by the authors during the session. Evaluations of the participants' experiences were performed immediately after the exercise and through questionnaires a few weeks later. On the whole, the test run indicated that the framework could be used as a principal guide in planning and performing a discussion-based crisis management exercise focusing on learning through variation.

Paper II presented the test run exercise using the framework on learning as a running example, providing illustrative instances of the theoretical discussions.

4.2.3 Organizational risk assessment – Papers III and IV

The studies aimed to identify problems in the practical work with organizational risk assessment systems in Swedish public organizations, and come up with results that could support the design and management of such systems.

The experiences of people working with the design and management of the organizational risk assessment systems were considered a valid source of data. Data collection was performed through semi-structured interviews with six informants from four organizations. The interviews were audio recorded and transcribed. Both authors were present at the interviews, with one being the interviewer and the other monitoring the interview guide and keeping track of what had been said.

A two-step design was used to gain richer pictures. The first round of interviews was analyzed, and preliminary results regarding the challenges experienced in system design and management were identified. A year later a second round of interviews was performed with the same informants with the same theme. However, in the second interview, the informants were shown the list of preliminary findings, and were asked to comment on whether they recognized the challenges or anticipated them in their own organization. They did not know from which organization(s) each challenge came. This procedure cross-fertilized the discourses between the organizations, with the possibility to reveal aspects that otherwise might have passed undetected.

By combining theories on organizational design and the system descriptions and challenges from the empirical data, generic design considerations for organizational risk assessment systems in large organizations were developed. Similarly, using theories on communication and the communicational challenges reported, generic countermeasures to miscommunication in hierarchical risk assessment systems were developed.

4.2.4 Safety culture – Paper V

The safety cultures in three different organizations in one Swedish county council were investigated through a questionnaire-based survey. The research aimed to explore ways to support safety culture development through visualizations of safety culture data. This was done integrated with practical safety culture development efforts in the studied organizations.

Ways to present safety culture assessment data that were considered to support the emergent change of safety culture were identified and developed using theories of learning and communication.

In **Paper V**, ways to present and visualize safety culture data, including relations between different aspects of safety culture, are demonstrated by empirical data.

4.3 Materials

This thesis has used empirical data from five Swedish public organizations. Basic facts about the organizations are presented in Table 1.

Table 1.

The organizations studied.

	Organization				
	A	*B*	*C*	*D*	*E*
Kind of organization	Municipality	Municipality	Municipality	County council	County council
Approx. No. of citizens served	300,000	100,000	30,000	1.2 million	1.5 million
Approx. No. of employees	19,000	9,000	3,000	33,000	50,000
Used in paper…[3]	Papers I, II, III, IV	Papers III, IV	Paper II	Papers III, IV	Papers II, III, IV, V

[3] Some of the usages indicated here are not explicit in the papers describing the studies.

5 Research contributions

5.1 Summary of papers

5.1.1 **Paper I**

Improving Emergency Response Capability: An Approach for Strengthening Learning from Emergency Response Evaluations

The objectives were to develop and demonstrate an approach to improve emergency response capability by strengthening individual and organizational learning from the evaluations of specific emergency responses.

Ideally, an evaluation of an emergency response improves an organization's ability to manage future emergencies. To improve capabilities, the development of adequate response potentials for a variety of possible emergencies is of utmost importance. However, such learning is not unproblematic. Learning often revolves around what has happened, rather than focusing on what might (or will) happen, and evaluation processes are not always sufficiently linked to development processes that can disseminate the results.

An approach for strengthening learning from the evaluations of emergency responses was created based mainly on theories of individual and organizational learning. It was subsequently demonstrated through application to three emergency response cases in the city of Malmö, Sweden.

Knowledge or skills acquired in one task that facilitate carrying out subsequent tasks are often referred to as *positive transfer*. When two situations are similar, transfer between them may be quite specific. Experiencing variation is a prerequisite for positive transfer. By experiencing and being aware of variation in a specific situation, the individual develops her ability to do the same with corresponding variation in other, similar situations. This is the foundation from which the individual can manage new situations. When two situations have few or no specific common elements, general transfer is still possible concerning more general principles. The general transfer abilities of individuals may be enhanced by developing their capacity to discern critical aspects in novel situations.

The main result was an approach consisting of three consecutive phases, A-C (see Figure 4).

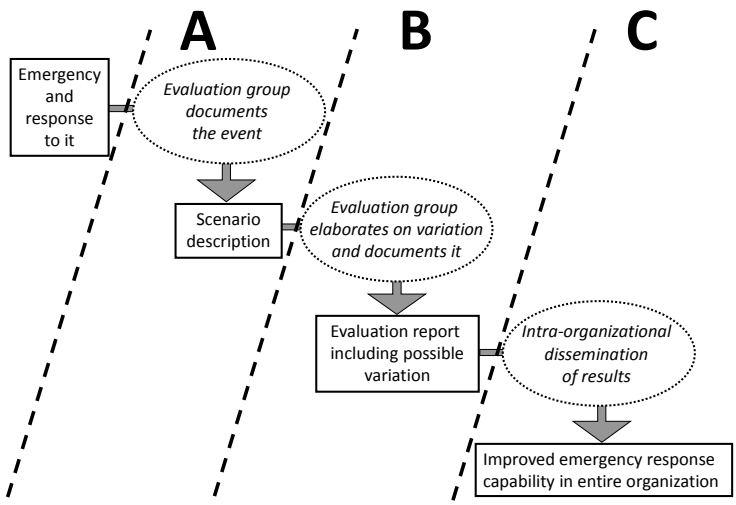


Figure 4.
Three phases of the proposed approach to learning from crisis response evaluations (adapted from **Paper I**).

Phase A - Describing the scenario

The aim of the first phase is to construct a documented description of the crisis that occurred, including the response to it. Documentation starts with a classical scenario description that orders the events along a timeline. In the resulting description, every aspect that has a potential for variation is seen as a parameter. This means that events as well as the relations between them are modeled as parameters. The scenario description of the crisis – what actually happened – can then be seen as a fixed vector of parameter values in the description obtained.

Phase B - Exploring variation

The main goal of phase B is to create an evaluation report that includes an illustrative elaboration of the actual scenario. In addition, the people involved in phase B develop their abilities to discern critical aspects in novel situations, and thus improve their capability to manage them.

The first kind of variation is in the values of the parameters that build up the scenario described in phase A. In practice, it is not possible to vary all conceivable parameter values. It is thus necessary to discern what the most critical aspects of the emergency that occurred are and, in turn, what parameters are critical to consider.

The second kind of variation is in the set of parameters. This variation can be realized by comparing the scenario description of the current case with the descriptions of other

cases, both those that have occurred (i.e., earlier crises) and imagined ones (e.g., results of risk and vulnerability analyses). When comparing scenarios, similarities may indicate parameters that deserve closer attention, while differences help to reveal possible variation.

Phase C – Intra-organizational dissemination of results

The goal of phase C is to transfer knowledge from the evaluation process to relevant parts of the organization, ultimately aiming at good management of future emergencies. It is important to transfer knowledge beyond the groups that participated in phases A and B. Developing better emergency response capability thus requires additional activities. This can be achieved through, for example, tabletop exercises, full-scale exercises or seminars focusing on variation.

The demonstration of the developed approach in **Paper I** indicates that the variation-centered approach to crisis response evaluations can improve experience-based learning in organizations, and thus improve crisis response capability.

5.1.2 Paper II

Learning Effectiveness of Discussion-based Crisis Management Exercises

To support the understanding and management of exercises, **Paper II** develops a framework on learning from discussion-based crisis management exercises, focusing on necessary requirements and beneficial factors for the conceptual learning of individuals.

Crisis management exercises often expose the existing capability so that it can be assessed, but the learning potential is often far from fully utilized. Deficiencies, problems or dysfunctions in crisis management observed during an exercise often remain unmanaged afterwards, and thus reappear in the next exercise or actual crisis response. Moreover, the learning results achieved from crisis management exercises often have very limited applicability. Figure 5 summarizes the relationship between exercises and crisis outcomes.

The theoretical framework was developed based on theories of learning and crisis management. It describes some of the necessary requirements for individual learning and beneficial factors for individual and organizational learning from crisis management exercises. The central assumption of the framework is that learners are required to experience variation to achieve conceptual learning. The framework connects the learning aspects of scenarios and discussions to the potential for improvement of the individual's capabilities. From the framework, guidelines are derived that are intended to support and facilitate practical work with learning-focused crisis exercises (see Figure 6).

Experiencing variation is necessary for learning that intends to improve capability, and is thus an indispensable function of crisis management exercises. Utilizing scenarios can offer the variation necessary for learning, along with relevant content. The interaction inherent in discussion-based exercises also provides variation to the individual participants. Interactions can strengthen the collective capacity because they support the development of shared knowledge.

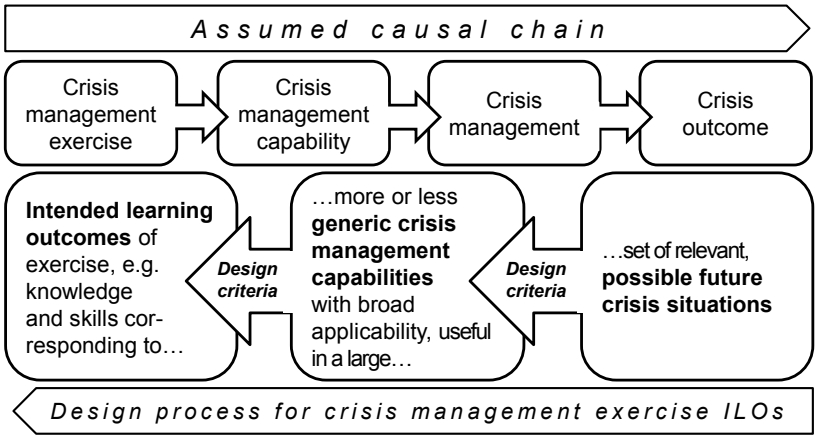


Figure 5.
Upper part: *Assumed causal chain* from crisis management exercise to crisis outcome. Lower part: *Design process* linking future situations to intended learning outcomes (ILOs) of crisis management exercises (adapted from **Paper II**).

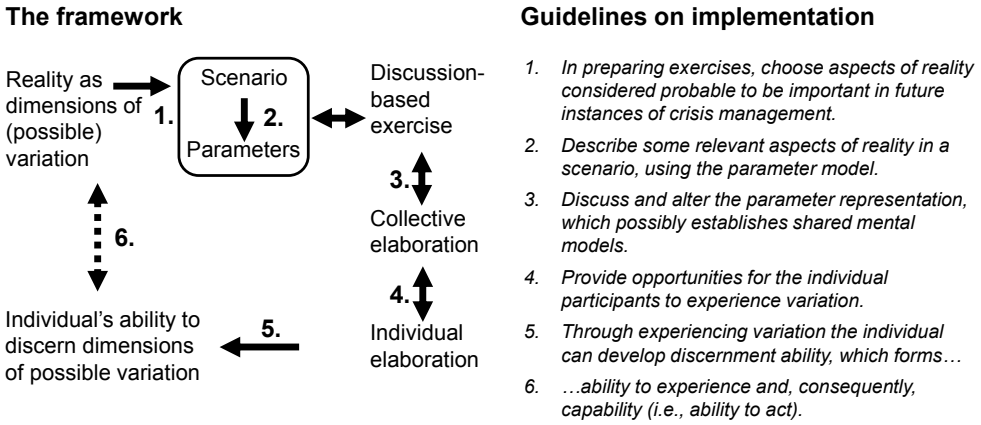


Figure 6.
A theoretical framework on learning from discussion-based crisis management exercises, including guidelines on application (adapted from **Paper II**).

In the upper left corner of Figure 6, actual or potential situations are represented by their significant dimensions of (possible) variation. In preparing or enacting a scenario, particular patterns of variation corresponding to assumedly relevant situations or phenomena are codified into intended learning outcomes and incorporated into the scenario description. A scenario is seen here as a description of the thematic content of an exercise crisis, and we suggest that it is modeled as consisting of parameters, each representing an aspect of the scenario. All possible aspects of a scenario can be represented as parameters, qualitative or quantitative. A scenario is thus described by a set of parameters and their hypothetical values.

By discussing and altering a scenario description, participants collectively elaborate it, using critical examination and imaginative evolution. Correspondingly, individual elaboration takes place both in response to and independently of the discussions. Individual elaboration offers the opportunity for developing one's ability to discern. A change in the ability to discern dimensions in situations transforms the individual's ability to experience situations, which in turn determines his or her potential for action.

The parameter model is a way of dynamically representing scenarios and structuring communication about them. Discussions in an exercise session should evolve around variation of values of the parameters that describe the scenario, and of the parameter set. The pattern of variation and invariance jointly constituted by the facilitator and the participants determines what is possible to learn.

5.1.3 Paper III

Generic Design Considerations for Organizational Risk Assessment Systems in Large Organizations

Sweden has a national system to improve safety and crisis management, intended to safeguard society's functionality. By law, Swedish local authorities and county councils are obliged to regularly conduct risk and vulnerability analyses and to assess their emergency management capability. A summary of the results are to be reported to national authorities. The law is expressed in the form of generic regulations, which means that it is left up to the regulated organizations to decide on the details of implementation. To meet the legal requirements, Swedish authorities have designed internal systems for performing and reporting risk and vulnerability analyses.

Large organizations are typically vertically layered in hierarchies and horizontally divided into different functional areas. These common organizational characteristics have implications for organizational risk management that should be reflected in the risk assessment systems of large organizations. **Paper III** uses design theory to develop generic design considerations for organizational risk assessment systems in large organizations. The aim of the considerations is to support the design and management

of such systems. As a basis for the development, four large, public organizations in Sweden were examined concerning their systems for performing and reporting organizational risk assessments: two local authorities and two county councils with between 9,000 and 50,000 employees, serving between 100,000 and 1.5 million citizens. All four organizations had a divisionalized form, being hierarchically structured with a central top management unit leading a number of administrations. Most administrations in turn consisted of an administration management unit and several subordinate businesses in which the organizations' core operations were performed.

The risk assessments in all four organizations were arranged in a bottom-up manner, where the results of analyses pertaining to separate units were reported upward through the hierarchy.

Data was gathered by interviews with the people responsible for the design, implementation and management of the risk assessment systems in each organization. The practitioners were asked about the design processes for the systems, the resulting designs of the systems, and the challenges and problems anticipated or experienced in working in the systems. The data analysis consisted of comparing the content from the interviews with theories on organizational design, communication and learning. General design considerations were developed by combining theories and empirical input.

Generic design considerations

An organizational risk assessment that aims to produce overviews of the risk and vulnerability situations of the units within an organization requires analysis functions operating on the separate units. We call such analyses pertaining to single organizational units and their areas of operations *first order analyses*. To capture the relevant specifics of each unit in hierarchically structured organizations, risk and vulnerability analyses should be performed unit-wise on all levels, not omitting operational activities on higher levels, such as management activities on the intermediate level of administrative units. However, such an atomistic approach is not sufficient on its own. In organizational risk assessments aiming for organizational-level relevance, unit-wise analyses need to be complemented by system-oriented analyses.

An organizational risk assessment that aims to capture the risk and vulnerability situation of the composite organization, or a subsystem thereof containing an aggregate of organizational units, requires an analysis function that operates from a system-oriented perspective. For all units above the lowest level in a hierarchically designed organization, analyses with a systems perspective should be performed on the subsystem made up of the unit itself and all of its subordinate units. Since the first order analyses of the units included in such subsystems can be part of the input to the system-oriented analyses we call them *second order analyses*.

Organizational risk assessment in large organizations needs a combination of first and second order analyses, which should be reflected in the design of risk assessment systems.

It is not sufficient in a second order analysis to simply add or aggregate information from the first order analyses of the units in the system, because this does not guarantee a valid picture of the risk and vulnerability situation for the composite organization. In a second order analysis, data from the first order analyses of the constituent organizational units needs to be reanalyzed, adopting a context-fitting frame of reference with level-appropriate questions and methods.

To allow for benchmarking and exchange of ideas, organizational risk assessment systems should not be designed only for second order analysis, but also for knowledge transfer of first order analysis data and results between units. Furthermore, viable work processes require committed participants, and successful learning and development requires that processes are fed back to themselves in a way that enables process improvement. This requires feedback loops.

After identifying, analyzing and assessing risks and vulnerabilities, the results should be put to use. Output from analyses needs to reach and be implemented in the right parts of the organization at the right time. To enable such transfer, organizational risk assessment systems need to be integrated with the work processes of other organizational systems.

5.1.4 Paper IV

Countering Communicational Challenges in Hierarchical Risk Assessment Systems

Large organizations are commonly hierarchically structured with work tasks laterally distributed into thematic divisions, which should be reflected in their systems for organizational risk assessment. The resulting hierarchical systems for organizational risk assessment entail long chains of communication, where information travels through several steps of communication. This brings a potential for message distortion and miscommunication. **Paper IV** aims to describe generic countermeasures against miscommunication in hierarchically organized systems for organizational risk assessment, applicable in the design and implementation of such systems.

Two rounds of interviews with practitioners from four large, public organizations resulted in a description of communicational challenges associated with the work in hierarchical systems for organizational risk assessment. Theories of communication and learning corresponding to the empirical material were then used to synthesize generic countermeasures to the types of challenges found in the empirical data.

Generic countermeasures against miscommunication

Create and use shared knowledge. Through sharing experiences and interacting with each other, people develop shared meaning structures that enable effective communication and coordination. The goal is to establish correspondence between the sender's and the receiver's frames of reference, because differences between the frames of reference used in communication can lead to miscommunication. For example, the use of narratives can trigger the appropriate parts of the receiver's frames of reference.

Bridge communicational gaps. Each step of interpersonal communication includes a risk of unintended or deliberate message distortion, due to the necessary coding and interpretation processes. The threat can be reduced by functions that bridge the steps of communication processes. Letting individuals participate on both sides of a formal step of communication can contribute to a larger set of shared knowledge and more corresponding frames of reference, which improves communicative accuracy.

Use dialogue. In a dialogue consecutive messages are sent back and forth between two communicators alternating between being sender and receiver, which facilitates the immediate detection of miscommunication and thus which enables corrections. Dialogue and feedback can be included in the design of risk assessment systems in various ways. For example, interaction can complement the handing over of written reports, and dialogues during the phases of risk identification and analysis can contribute to increased validity and reliability of the results.

Standardize communication and related work. The effect of standardization of communication comes from a reduction of the degrees of freedom in messages, which simplifies the creation and use of shared knowledge through a reduction of the needed common set of the sender's and receiver's frames of reference. For example, standardization of the methods for the senders' work can reduce the variability of message content, and formal reporting templates can reduce the variability of the content in and the format of reports.

Compare with peers. Comparing risk assessment information between organizational units can contribute to learning, help to reveal deliberate distortion of messages, and expose possible misconceptions. It can also contribute to reappraisals of the reliability of messages.

Stick to the purpose. Risk assessment data should always be examined with the purpose of the ongoing analysis in mind, acknowledging the functional purpose(s) of the currently studied organizational unit(s). Repeatedly comparing with the purpose can also help to reveal cases of deliberate or unintentional communication of system-irrelevant information.

Integrate processes. Effective system design for safety and crisis management requires different sources of information and the creation of closed loops between work processes. For example, the output of risk assessment should be used in other work

processes. One way to connect different units is to use individuals as carriers, and not only use formal reports. Networking between key actors can effectively disseminate information and support learning.

The aspect of communication is essential in systems for organizational risk assessment in large organizations, and the problem with communicational challenges is serious and general. The fact that interpretation is unavoidable is vital to consider in the designing of systems for organizational risk assessment in large organizations.

It is impossible to completely circumvent the stage of interpretation in human communication and its possibility for distortion of meaning. However, the generic countermeasures presented can mitigate the challenges of potential miscommunication. Some can be designed into risk assessment systems, while others can be used in system operation.

The generic countermeasures were inspired by the reported challenges, which need not be peculiar to the organizations studied. Similarities regarding organizational structures and organizational risk assessment system purposes can create the same challenges in other organizations. The combination of the empirical connection and the theoretical rationale behind the generic countermeasures provide a basis for valid application of the countermeasures in other settings.

5.1.5 Paper V

Development-oriented Visualizations of Safety Culture Data

The monitoring of safety culture to guide tailored interventions has been suggested as a part of rational organizational safety management. **Paper V** explores ways to support the development of organizational safety culture. The central question is: How can safety culture data be presented to promote further inquiry and support deeper analysis? **Paper V** develops methods for this, including ways to visualize safety culture data and its inner relations, and provides a theoretical rationale for some often practiced ways of visually presenting safety culture data.

Ways to visualize safety culture data are described in the light of theories on safety management, the development and change of organizational (safety) culture, and learning. The suggested methods for visualization are illustrated with data from development-oriented safety culture assessments in different parts of a Swedish county council's organization.

Learning and change of safety culture requires that organizational members experience variation that reveals the possibility for change in relevant dimensions of reality. The possibility for variation in safety culture can be presented through showing histograms over the responses of single questionnaire items (See Figure 7). The possibility for

different perceptions and opinions can provide a relevance structure for continued inquiry and demonstrate the possibility for improvement.

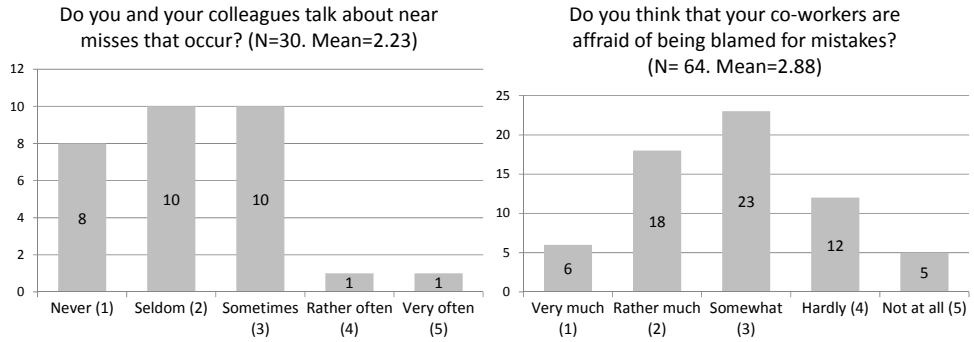


Figure 7.
Histograms showing the dispersions of responses on two items in safety culture questionnaires (Adapted from **Paper V**).

The possibility for variation in safety culture can also be presented by showing profiles in the form of graphs over aggregated data (e.g., values for aspects of safety culture), possibly including confidence intervals. The left side of Figure 8 demonstrates how the safety culture profiles from two hospitals (H1 and H2) are strikingly similar, while the county council's central administration (CA) has a somewhat different safety culture profile. The right side of Figure 8 shows that there is variability of the safety culture within each of the organizations, as different units have different profiles.

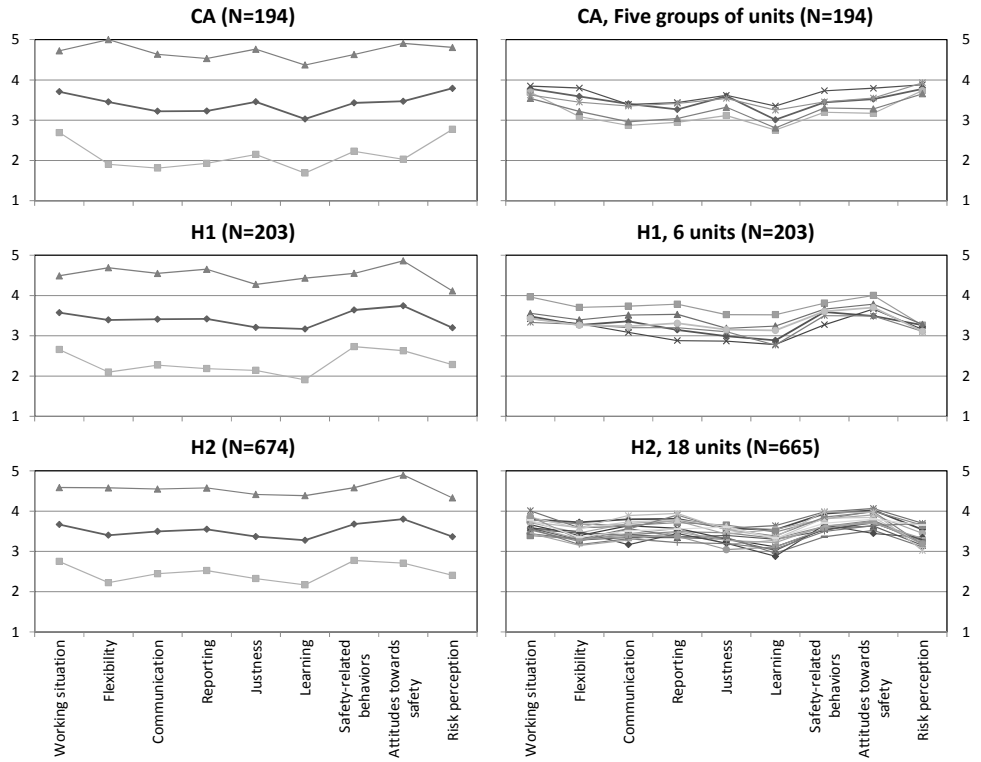


Figure 8.
Left side: Safety culture profiles for the three organizations (means per aspect), incl. confidence intervals (P=0.05). Right side: Safety culture profiles (means per aspect) for the participating units from the three organizations. 5 = good safety culture. (Adapted from **Paper V**.)

The relationships between different aspects of safety culture may be valuable information for change processes. For example, it might be interesting to know if reporting 'near misses' is perceived as important while, at the same time, formal changes due to reported information is perceived as being too small or coming too late. That could indicate a low confidence in the formal processing of incident reports, which might entail a decreased willingness for future reporting. The relationships between aspects in a safety culture data set can be explored through cluster analyses of variables, which may be presented as dendrograms, showing how the responses to separate yet related aspects of safety culture co-vary (See Figure 9 for an example).

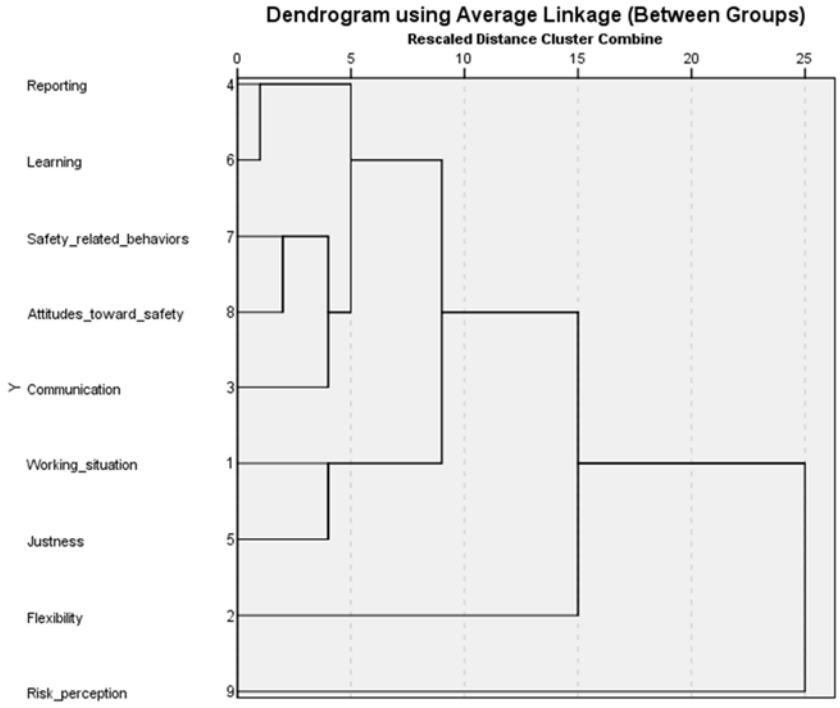


Figure 9.
A dendrogram visualizing a step-wise cluster solution of the responses pertaining to nine aspects of safety culture (Adapted from **Paper V**).

When a correlational matrix is communicated as a table (see Table 2 for an example), serial pair-wise comparisons of values have to be made in order to establish an overview of the relative weights. Visual presentation through a graph where the thickness of the links reflects the degree of correlation gives a more immediate impression (see Figure 10). Table 2 and Figure 10 show the correlations between aggregated aspects of safety culture from a survey. Visual representations and tables of correlation matrices can complement each other.

Table 2.

Correlational matrix on safety culture data from a survey aggregated into aspects (Adapted from Paper V).

	Working situation	Flexibility	Communi-cation	Reporting	Justness	Learning	Safety-related behaviors	Attitudes towards safety	Risk perception
Working situation	1.00								
Flexibility	0.44	1.00							
Communication	0.70	0.75	1.00						
Reporting	0.63	0.71	0.90	1.00					
Justness	0.40	0.59	0.72	0.70	1.00				
Learning	0.52	0.63	0.72	0.77	0.70	1.00			
Safety-related behaviors	0.53	0.40	0.58	0.70	0.52	0.58	1.00		
Attitudes towards safety	0.45	0.66	0.68	0.77	0.58	0.71	0.70	1.00	
Risk perception	0.53	0.33	0.53	0.46	0.39	0.45	0.40	0.46	1.00

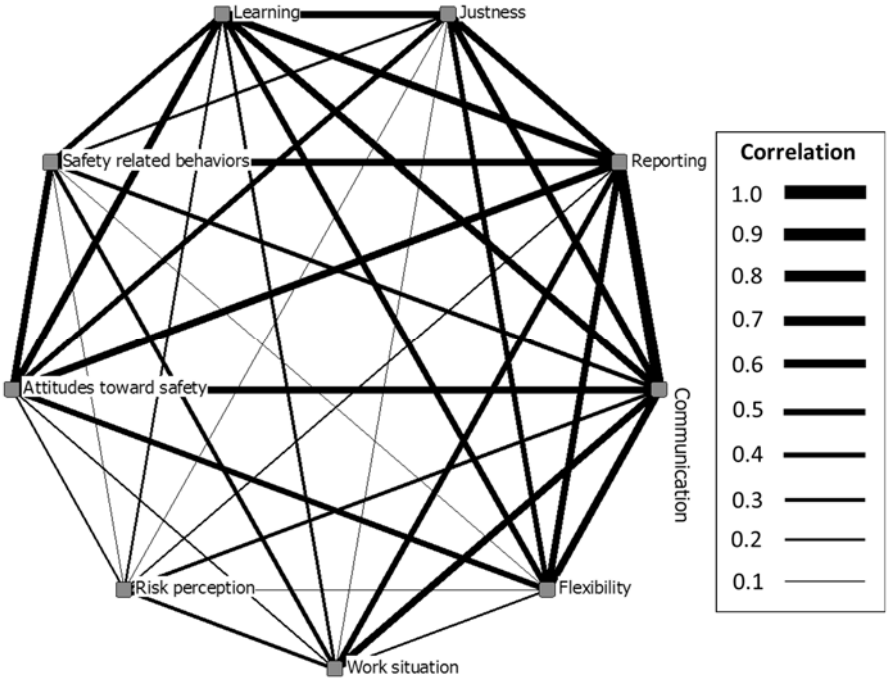


Figure 10.
Graphical representation of the correlations between aspects of safety culture data from a survey (Based on the same data as Table 2) (Adapted from **Paper V**).

Visual presentations of safety culture data make use of geometrical arrangements of data in the simultaneously available visual field. Thus visualizations rely on perception that supports swift comprehension of the material compared to text-based presentations that require serial processing to arrive at a mentally constructed visualization.

Conclusions

To support the learning necessary for emergent change processes, presentations of safety culture data should preferably:

Facilitate the comprehension of data. Successful communication is necessary for the formation of a vivid understanding of the meaning of data. For example, the language used in questionnaire items and possible aggregated forms thereof should be in line with the everyday discourse and activities of the organization, and central concepts should be defined in reports.

Offer suitable relevance structures to the target group, aiding motivation for studying and contemplating the data. For instance, reports may include a rationale describing the roles of assessment and feedback of safety culture as components in safety management.

Provide possibilities to experience variation, which is a necessary requirement for the enabling of learning. Data displays that include variation invite to the exploration of possibilities, which allows the individuals to discern dimensions of possible variation and imagine lines of future development.

Evoke inquiry and inspire hypothesizing. For example, the reading of comments can trigger beneficial thought processes and encourage discussions of safety culture. The inclusion of narratives is thus recommended. In general, contrasts and variation in data may capture awareness and inspire further study.

Visualize relations between different parts of data. Investigating the relations between aspects of safety culture, for example through graphical representations of aspect correlations or dendrograms over cluster analyses, may reveal actionable themes in the form of surprisingly weak or strong connections between theoretically closely related concepts (e.g., between incident reporting and learning). Visualizations of the data can facilitate the examination of relations as well as aid in the comparison with theoretical models.

5.2 Addressing the research aims and questions

The research in this thesis investigates selected parts of the Swedish authorities' toolkits for societal safety and crisis management in order to suggest improvements. This has been carried out by addressing practically oriented research questions. Brief answers to the questions are provided here.

5.2.1 Research aim 1

The general aim of the research presented in this thesis was to suggest improvements of selected parts of the Swedish authorities' toolkits for societal safety and crisis management.

This aim has been represented by research questions 1-7.

Research question 1: *How can crisis response evaluations be structured so that they support individual and organizational learning that applies to situations different from the event that occurred?*

A process for crisis response evaluation should be characterized by a strategic focus on transfer, aimed at creating capability to manage other, more or less similar, situations. There is a need for creating organizational learning, and in such efforts for creating capability variation has a given place. It is important to explore variation around the actual scenario. In the end, findings from evaluations should be assimilated by the organization members as well as codified in suitable artifacts of the organization. Consequently, it is essential for organizations to create planned processes for transferring the information and knowledge obtained from the evaluations of crisis responses to the entire organizations. (The answer is based on **Paper I**.)

Research question 2: *What can make crisis management scenario exercises yield learning results with broader applicability than to the actual scenario involved?*

In planning, preparing and conducting exercises, the focus should be on critical factors for individual learning. This can be achieved through a theoretical understanding of how learning that enables more general transfer comes about. The experiencing of variation is a key to individual learning with broad applicability. Exercise scenarios can contribute with the necessary variation as well as domain-relevant concepts. Through interactions exercise participants can arrive at shared knowledge with relevance for their potential future practice. (The answer is based on **Paper II**.)

Research question 3: *How can the achievement of appropriate learning results for individuals and groups be supported in the context of discussion-based crisis management exercises?*

Aspects of reality considered important in future instances of crisis management should be used in parameter-based scenario descriptions. In the exercises, the parameter representations should be altered by means of collective discussions, using critical examination and imaginative evolution. This provides opportunities for the individual participants to experience variation, which can develop capability, and supports the formation of shared knowledge structures that facilitate coordination and communication among the participants. Relevant but unplanned learning results may emerge from the input of the exercise participants. (The answer is based on **Paper II**.)

Research question 4: *What are the main challenges encountered by Swedish authorities in their design of systems for organizational risk assessments?*

There is potential for various forms of miscommunication in the risk assessment work, and practitioners experience problems with integrating risk assessment processes with their functional environment to achieve such things as feedback and learning. (The answer is based on **Paper III**.)

Research question 5: *What are the critical factors in the design of such systems?*

Organizational risk assessment systems should be designed for the combination of first and second order analyses, which means that separate units as well as all hierarchical aggregations up through the organizational system should be analyzed, adopting a systems perspective when appropriate. Communication channels are needed for handing over results and for requesting and delivering new information needed for higher-level analyses. The systems should also be designed for knowledge transfer of first order analysis data and results between units. (The answer is based on **Paper III**.)

Research question 6: *What communicational challenges do Swedish authorities experience in their organizational risk assessment systems?*

The study reported in **Paper IV** found that practitioners experienced or anticipated various forms of communicational challenges. A recurring theme was a concern for possible miscommunication when formal reports were used to transfer information between different steps in the risk assessment systems. Possible miscommunication was seen as a potential threat to system functionality. There might also be cases of deliberate miscommunication, where distorted or irrelevant information is communicated. Keeping the purpose of the analysis and reporting system in mind was another recurring theme, and transferring information to achieve learning or initiate action was also reported as sometimes being problematic. (The answer is based on **Paper IV,** which contains more details on the matter.)

Research question 7: *How can these challenges be countered, so that system functionality is protected?*

Countermeasures can mitigate but not eliminate the challenges of potential miscommunication. Successful communication can be supported by the creation and use of shared knowledge. Steps in communication processes can be bridged to reduce the risk of miscommunication. Various forms of dialogue and standardization can also counter miscommunication. Comparisons with peers can be used to validate information and to support learning. By repeatedly returning to the purpose with risk assessment work, and through integrating it with other organizational processes, the possibilities for miscommunication and its negative effects can be reduced further. (The answer is based on **Paper IV**.)

5.2.2 Research aim 2

The second aim of the research was to investigate how safety culture development can be supported as a means to improve the functionality of other aspects of societal safety and crisis management.

This line of research has applied relevance, and seems able to render valuable results. However, the work has not yet been fully developed. Preliminary findings indicate possibilities with ways to present safety culture data.

Research question 8: *How can visualizations of safety culture data be used to support safety culture development?*

Actual change and development of safety culture requires that the organizational members themselves gain experiences that alter their beliefs and basic assumptions. To enable such emergent change safety culture data from measurements has to be fed back. The presentation of data has to be easily accessible, and should preferably evoke inquiry and inspire to further exploration. Various forms of visualizations can effectively communicate variation and the possibility for differences. Visualizations can also motivate further studies and enable deeper analyses, for example through showing relations between aspects of safety culture. (The answer is based on **Paper V**.)

6 Discussion

6.1 Results

The societal prevention of crises, or the minimizing of their negative outcomes, may benefit from increased efforts for personnel and organizations to learn from previous instances of crisis response. Regarding evaluations of crisis responses, **Paper I** suggests the use of scenario descriptions where paths are not fixed and the order of events is flexible. This can change the focus from what has happened to what might happen, and help to develop capability for managing future events. These results from **Paper I** are highly valuable for practitioners.

Paper II explains how following certain principles can make the generation of generic capabilities more likely. The paper contributes to a theoretical rationale regarding some common building blocks of crisis management exercises (i.e., scenarios and discussions). The results can support the management of established methods for exercises as well as be used in the development of new methods. The proposed framework can be used to understand and manage discussion-based crisis exercises from a conceptual learning perspective. Based on the framework, it is suggested that exercise scenarios should be represented as a set of parameters, and that variation of the parameter set and the parameter values becomes the central theme of exercise activities.

Sometimes discussions on exercise content overshadow the crucial question of the learning process. Since the process of learning strongly affects the product of learning, it is not sufficient to only focus on content or desired outcomes of learning while neglecting the process. The suggestion that the focus should lie on the process of learning rather than on the content of learning may at first seem strange to practitioners in the field. For practical settings this means that the content of the learning process may be put in the background, while certain aspects of the learning process are put in the foreground.

In the literature on crisis management exercises, studies or theories focusing on the actual learning are quite rare. Learning at the micro-level is often treated as a 'black box' and taken for granted. Discussions on what makes up appropriate learning outcomes or how to best model crisis management situations are quite common, though. They concern the content aspect of *what* to learn, but often do not say much about the process aspect of *how* these things can be achieved (e.g., Ford & Schmidt,

2000; Crichton & Flin, 2001; Borodzicz, 2004; Crichton, Lauche, & Flin, 2005). Thus, the approach in this research of bringing in theories and models on learning from other traditions may be a way to vitalize this aspect in the fields of crisis and safety management.

Paper III and **Paper IV** discuss the complex tasks of designing and implementing systems for performing, reporting and making use of risk and vulnerability analyses in hierarchical organizations. **Paper III** develops generic design considerations for organizational risk assessment systems in large organizations. **Paper IV** describes common communicational challenges in such systems, along with possible countermeasures. The results in the form of the suggested design considerations and generic countermeasures to miscommunication might not seem revolutionary, perhaps even appear as trivial. However, they reflect fundamental threats to the fulfillment of system purposes in organizational risk assessment systems. The actual study reported in these papers had a rather small empirical base, but the challenges may be quite common.

The safety culture study of **Paper V** explores a scarcely populated habitat, focusing on how to *change* safety culture rather than capturing it with statistical elegance or philosophical purity. The ideas put forward – for example, to visualize the relations between safety culture aspects and to ensure that the variance is clearly and comprehensibly communicated – are not sufficient on their own. However, they can be an important piece in the puzzle of improving societal safety. In systematic efforts at monitoring and improving safety culture, data from measurements has to be communicated in ways that enables and preferably even enhances processes of cultural learning and change. That makes the study of **Paper V** a valuable complement to the vast amount of literature treating definitions, operationalizations, measurements, etc. of safety culture.

Put together, the results from the different studies can contribute to a more effective and efficient societal safety and crisis management practice. The practical results apply to organizations, systems and activities that share relevant characteristics with the ones studied here. That means that the conclusions and recommendations arrived at are valid for many other organizations, in Sweden and elsewhere.

6.2 Methodological issues

The ETTO principle (Hollnagel, 2009) applies to Ph.D. projects and thesis writing too, necessitating a trade-off between width and depth. The number of studies has to be balanced against the amount of work put in on each of them. This is a compilation thesis comprising five papers on applied research, which means that scientific methods

and theories mainly are considered instrumental, being used in the pursuit of practical results. The research processes of the various studies neither start nor end in scientific knowledge, although some new scientific knowledge has been produced on the way. With that in mind, I would like to make a few comments on methodological issues.

The studies of this thesis all use rather limited samples. (The empirical part of **Paper V** is an exception, with more than 1071 questionnaire respondents from three organizations.) The samples cannot be claimed to be random either; opportunities rather than careful deliberation on optimal study objects determined what organizations to work with. This may compromise generalizability. However, the combination of different sources of information and different types of data that have been used in or formed a background to the studies enables *triangulation* (Jick, 1979), in which the simultaneous use of multiple sources and types of data can increase the support of conclusions. In some aspects the research reported here can be seen as *case studies*. For example, **Paper III** and **Paper IV** look at different aspects of the organizational risk assessment systems in four organizations, which can form the basis for what Yin (2003) labels an embedded multiple-case design.

More than fifty years ago Boulding (1956) noted how science had come so far in its specializations that a fragmentation of the totality was imminent. Boulding's remedy was to develop a common language – general systems theory – which could be used to structure communication between scientific fields, and thus preserve the ability for the exchange of ideas and revitalization across disciplines. This thesis makes use of established theories in some fields, and transfers them for application in other fields. Hopefully some scholars and practitioners can find the results creative and useful. However, it is possible that the mixing of theories from different traditions and schools of thought may introduce inconsistencies. That issue has to be dealt with in continued studies.

Design science basically consists of two activities: building and evaluating (March & Smith, 1995). This thesis has a weak point in the evaluation of generated designs. The cooperation with practitioners sometimes did not allow for more than single test runs. Often they could not afford to test numerous different methods or designs. On a global level more empirical testing and evaluation of the designs developed is needed.

The research reported in this thesis has been conducted with rather difficult empirics. The *ceteris paribus* assumption is not worth much when dealing with truly complex matters. In a complex system, different factors are interconnected in such ways that they affect each other, a characteristic that effectively may render mechanistic reduction and studying-one-parameter-at-time worthless. Since the sources of information have been organizations, and people working in these organizations, it has been like aiming at a moving target. Grabbing tentative conceptualizations of reality to work with has been like attempting to capture snapshots of dynamic events. Constant flux in

organizations occupied with work renders equivalents to the photographic phenomenon of motion blur.

Since everything is ever changing, and the universe (probably) is not in any specific state more than once, each action is somehow particular to its time-space situation. Scientific research efforts are as influenced and bounded by tradition, history and pre-understanding as everything else. This means that any research act, (like the ones that make up the foundation of this thesis) is somehow uniquely linked to its actual surroundings, and impossible to detach from it without loss of information and meaning. Such separation requires abstraction, which brings generalizability at the expense of detail. Analogous is the enigma of transfer of learning: How can something experienced in one situation be transferred to another situation through learning, when every situation is unique? One solution lies in the utilization of abstraction, climbing symbolic hierarchies in search of similarities and disregarding differences. The notion of (knowledge) transfer applies to the process of a scientific endeavor as well as to the object of study in some of the research projects reported here. In this thesis I have tried to strike a balance between the specific and the general, in describing empirics as well as in theoretical explications, in order to reinforce the validity of conclusions and support generalizations of the results to other contexts.

6.3 Further research

In general, the developed approaches, methods, frameworks and guidelines need further testing in real settings to enable validation and improvement of them as practical tools. From a theoretical perspective, the results need to be refined through a deeper integration with the scientific literature. In such efforts the degree of theoretical orthodoxy constitutes an interesting parameter, which should be varied to arrive at valuable learning.

In the field of social science, studying such things as society, organizations and human behavior, the objects of study are constantly changing. This fact results in a need for perpetual re-research and repeated investigations of phenomena and settings already examined. For example, the risk assessment systems studied in this thesis project have surely evolved since we examined them. It would certainly be interesting to return and compare our earlier findings on challenges and solutions to the situation five years later. That would yield valuable input to further research on the design of such systems, and could also help the practitioners in fine-tuning their designs. A broadened perspective, using empirics from more levels of the societal risk assessment system, would be valuable for evaluating and adjusting the performance of the overall system.

Another line of research that could have practical utility would be to evolve the thoughts on how to improve learning from crisis management exercises. The framework developed in this thesis (**Paper II**) could be refined, and the effects of its application in exercise processes, in particular concerning the development of crisis management capability, ought to be studied more.

In a larger perspective, the general issue of investigating long-term learning effects from crisis management training and exercises still remains to be examined. In relation to that, the practical and philosophical problem of determining what competence needs the future calls for has to be considered. Without an idea of what to aim for, training and exercises are pointless activities.

7 Conclusions

This thesis presents suggested improvements of items in Swedish authorities' toolkits for societal safety and crisis management. The research was motivated by practical needs and delivers results that can be used to facilitate and improve the effectiveness of organizational efforts.

The thesis has shown how learning results with broader applicability can be achieved from the evaluations of singular crisis responses. In order to succeed, learning has to focus on the far end of transfer, aiming at capabilities that can be used in various possible future situations. This can be achieved by the deliberate use of variation. A parameter-based scenario description summarizing what actually happened can be used as a starting point for the exploration of the possible variation of more or less all parameters. To increase the chance of the learning results ever being used, and thus increase the probable value of the work, dissemination beyond the evaluation group is needed. This can be realized by directing evaluation results to relevant work processes, and for example, use them in exercises.

Crisis management exercises often produce vague results with unnecessarily limited applicability. This thesis has developed a framework that can help to strengthen the learning effects of discussion-based crisis management exercises. When exercises are prepared, aspects of reality that are considered to be of probable importance in future instances of crisis management should be identified. Some of them should then be used as parameters in a scenario description. During the exercise the participants should discuss and alter the parameter representation. This can establish shared mental models, and provide variation for the individual participants to experience. Experiencing variation can improve the ability to discern, which is fundamental for capability.

Important principles for the design of organizational risk assessment systems have been described. Organizations are purposefully designed systems. The reasons behind their designs should be taken into account when performing organizational risk assessment. *First order analyses* pertaining to single organizational units and their areas of operations should be performed unit-wise on all levels, and *second order analyses* with a systems perspective should be performed for all aggregated subsystems up through the composite organization. In second order analysis, data from the first order analyses of constituent organizational units needs to be reanalyzed, adopting a context-fitting frame of reference with level-appropriate questions and methods. It is not sufficient in

a second order analysis to simply add or aggregate information from the first order analyses of the units in the system. Additional input may also be required.

Organizational risk assessment in large organizations faces many communicational challenges that may pose a threat to system functionality. Such communicational challenges can be countered in various ways. For example, efforts to create and use shared knowledge, the bridging of steps of formal communication, the use of dialogue, or standardization of parts of communicational work can help to reduce the threat of miscommunication.

A safety culture can be developed through emergent change, which requires that relevant information is available to the organizational members. Presentations of safety culture data intended to support such processes should preferably:

Facilitate the comprehension of data. For example, the language used in questionnaire items and possible aggregated forms thereof should be in line with the everyday discourse and activities of the organization, and central concepts should be defined in reports.

Offer suitable relevance structures to the target group. For instance, reports may include a rationale describing the roles of the measurement and feedback of safety culture as components in safety management.

Provide possibilities to experience variation. Data displays including variation invite participants to explore possibilities, which allow the individuals to discern dimensions of possible variation and imagine lines of future development.

Evoke inquiry and inspire hypothesizing. Contrasts and variation in data may capture awareness and inspire further study. The inclusion of narratives is thus recommended. The reading of comments, for example, may trigger beneficial thought processes.

Visualize relations between different parts of data. Visualizations of the data, for example through graphical representations of aspect correlations or dendrograms over cluster analyses, can facilitate the examination of relations between aspects of safety culture as well as aid in the comparison with theoretical models.

8 References

Aamodt, A. & Nygård, M. (1995). Different roles and mutual dependencies of data, information, and knowledge – An AI perspective on their integration. *Data & Knowledge Engineering, 16,* 191-222.

Akselsson, R., Ek, Å., Koornneef, F., Stewart, S., & Ward, M. (2009). Resilience safety culture. In *Proc 17th World Congress on Ergonomics. International Ergonomics Association*.

Alexander, D. (2000). Scenario methodology for teaching principles of emergency management. *Disaster Prevention and Management, 9,* 89-97.

Alvesson, M. & Sveningsson, S. (2008). *Changing organizational culture: Cultural change work in progress*. London: Routledge.

Antonsen, S. (2009). *Safety culture: Theory, method and improvement*. Aldershot, UK: Ashgate.

Argote, L., Ingram, P., Levine, J. M., & Moreland, R. L. (2000). Knowledge transfer in organizations: Learning from the experience of others. *Organizational Behavior and Human Decision Processes, 82,* 1-8.

Argyris, C. & Schön, D. A. (1996). *Organizational learning II: Theory, method, and practice*. Reading, PA: Addison-Wesley.

Baldwin, T. T. & Ford, J. K. (1988). Transfer of training: A review and directions for future research. *Personnel Psychology, 41,* 63-105.

Boin, A. & Lagadec, P. (2000). Preparing for the future: critical challenges in crisis management. *Journal of Contingencies and Crisis Management, 8,* 185-191.

Borodzicz, E. (2004). The missing ingredient is the value of flexibility. *Simulation & Gaming, 35,* 414.

Borodzicz, E. & Van Haperen, K. (2002). Individual and group learning in crisis simulations. *Journal of Contingencies and Crisis Management, 10,* 139-147.

Boulding, K. E. (1956). General systems theory: the skeleton of science. *Management Science, 2,* 197-208.

Bowden, J. & Marton, F. (2004). *The university of learning - Beyond quality and competence*. London: Routledge.

Comfort, L. K. (1985). Action research: A model for organizational learning. *Journal of Policy Analysis and Management, 5,* 100-118.

Comfort, L. K. (2007). Crisis management in hindsight: Cognition, communication, coordination, and control. *Public Administration Review, 67,* 189-197.

Crichton, M. T. (2009). Improving team effectiveness using tactical decision games. *Safety Science, 47,* 330-336.

Crichton, M. T. & Flin, R. (2001). Training for emergency management: tactical decision games. *Journal of Hazardous Materials, 88,* 255-266.
Crichton, M. T., Flin, R., & Rattray, W. A. R. (2000). Training decision makers: Tactical decision games. *Journal of Contingencies and Crisis Management, 8,* 208-217.
Crichton, M. T., Lauche, K., & Flin, R. (2005). Incident command skills in the management of an oil industry drilling incident: A case study. *Journal of Contingencies and Crisis Management, 13,* 116-128.
Davenport, T. H. & Prusak, L. (2000). *Working knowledge: How organizations manage what they know*. Harvard Business Press.
Dixon, N. M. (1999). *The organizational learning cycle: How we can learn collectively*. Hampshire, England: Gower.
Dombrowsky, W. R. (1995). Again and again: Is a disaster what we call a 'disaster'? Some conceptual notes on conceptualizing the object of disaster sociology. *International Journal of Mass Emergencies and Disasters, 13,* 241-254.
Ek, Å. (2006). *Safety culture in sea and aviation transport.* Ergonomics and Aerosol Technology, Department of Design Sciences, Lund University.
Enander, A. (2010). Human needs and behaviour in the event of emergencies and social crises. In L.Fredholm & A. Göransson (Eds.), *Emergency response management in today's complex society* (pp. 31-72). The Swedish Civil Contingencies Agency.
Ford, J. K. & Schmidt, A. M. (2000). Emergency response training: strategies for enhancing real-world performance. *Journal of hazardous materials, 75,* 195-215.
Gagné, R. M. (1972). Domains of learning. *Interchange, 3,* 1-8.
Gagné, R. M. (1984). Learning outcomes and their effects: Useful categories of human performance. *American Psychologist, 39,* 377-385.
Guldenmund, F. W. (2000). The nature of safety culture: a review of theory and research. *Safety Science, 34,* 215-257.
Guldenmund, F. W. (2007). The use of questionnaires in safety culture research: an evaluation. *Safety Science, 45,* 723-743.
Hale, A. R. (2000). Editorial: Culture's confusion. *Safety Science,* 1-14.
Harbom, S. (2010). Management of various types of emergency. In L.Fredholm & A. Göransson (Eds.), *Emergency response management in today's complex society* (pp. 73-108). The Swedish Civil Contingencies Agency.
Harden, R. M. (2002). Learning outcomes and instructional objectives: is there a difference? *Medical Teacher, 24,* 151-155.
Hollnagel, E. (2006). Resilience - the challenge of the unstable. In E.Hollnagel, D. D. Woods, & N. Leveson (Eds.), *Resilience Engineering: Concepts and precepts* (pp. 9-17). Aldershot, UK: Ashgate.
Hollnagel, E. (2009). *The ETTO principle: efficiency-thoroughness trade-off: why things that go right sometimes go wrong*. Aldershot, UK: Ashgate.
Hollnagel, E. (2011a). Prologue: the scope of resilience engineering. In E.Hollnagel, J. Pariès, D. D. Woods, & J. Wreathall (Eds.), *Resilience engineering in practice: A guidebook* (pp. xxix-xxxix). Aldershot, UK: Ashgate.

Hollnagel, E. (2011b). To learn or not to learn, that is the question. In E.Hollnagel, J. Pariès, D. D. Woods, & J. Wreathall (Eds.), *Resilience engineering in practice: A guidebook* (pp. 193-198). Aldershot, UK: Ashgate.

Hollnagel, E. & Woods, D. D. (2006). Epilogue: Resilience engineering precepts. In E.Hollnagel, D. D. Woods, & N. Leveson (Eds.), *Resilience engineering: Concepts and precepts* (pp. 347-358). Aldershot, UK: Ashgate.

Hollnagel, E., Woods, D. D., & Leveson, N. (2006). *Resilience engineering: Concepts and precepts*. Aldershot, UK: Ashgate.

Hussey, T. & Smith, P. (2002). The trouble with learning outcomes. *Active learning in higher education, 3,* 220-233.

Hussey, T. & Smith, P. (2003). The uses of learning outcomes. *Teaching in Higher Education, 8,* 357-368.

ISO 31000:2009. (2009). Risk management - Principles and guidelines.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly, 24,* 602-611.

Jonassen, D. H. (2006). On the role of concepts in learning and instructional design. *Educational Technology Research and Development, 54,* 177-196.

Kast, F. E. & Rosenzweig, J. E. (1972). General systems theory: Applications for organization and management. *Academy of Management Journal, 15,* 447-465.

Kelly, C. (1999). Simplifying disasters: Developing a model for complex non-linear events. *Australian Journal of Emergency Management, 14,* 25-27.

Laere, J. (2013). Wandering through crisis and everyday organizing; Revealing the subjective nature of interpretive, temporal and organizational boundaries. *Journal of Contingencies and Crisis Management, 21,* 17-25.

Lagadec, P. (2007). Crisis management in the twenty-first century: "Unthinkable" events in "inconceivable" contexts. In H.Rodríguez, E. L. Quarantelli, & R. R. Dynes (Eds.), *Handbook of Disaster Research* (pp. 489-507). New York: NY, Springer.

Levy, J. S. (1994). Learning and foreign policy: sweeping a conceptual minefield. *International Organization, 48,* 279-312.

Lindell, M. K., Perry, R. W., & Prater, C. (2006). *Introduction to emergency management*. Hoboken, NJ: John Wiley & Sons.

March, S. T. & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems, 15,* 251-266.

Marton, F. (1981). Phenomenography - Describing conceptions of the world around us. *Instructional science, 10,* 177-200.

Marton, F. (2006). Sameness and difference in transfer. *Journal of the Learning Sciences, 15,* 499-535.

Marton, F. & Booth, S. (1997). *Learning and awareness*. Mahwah, NJ: Lawrence Erlbaum.

Marton, F. & Pang, M. F. (2006). On some necessary conditions of learning. *Journal of the Learning Sciences, 15,* 193-220.

McLoughlin, D. (1985). A framework for integrated emergency management. *Public Administration Review, 45,* 165-172.

Neal, D. M. (1997). Reconsidering the phases of disasters. *International Journal of Mass Emergencies and Disasters, 15,* 239-264.
Ogbonna, E. & Harris, L. C. (1998). Managing organizational culture: compliance or genuine change? *British Journal of Management, 9,* 273-288.
Olsen, O. E., Kruke, B. I., & Hovden, J. (2007). Societal safety: Concept, borders and dilemmas. *Journal of Contingencies and Crisis Management, 15,* 69-79.
Pariès, J. (2011). Resilience and the Ability to Respond. In E.Hollnagel, J. Pariès, D. D. Woods, & J. Wreathall (Eds.), *Resilience engineering in practice: A guidebook* (pp. 3-8). Aldershot, UK: Ashgate.
Perrow, C. (1984). *Normal accidents*. Princeton University Press.
Proposition 2005/06:133. Samverkan vid kris - för ett säkrare samhälle. Stockholm: Försvarsdepartementet.
Rasmussen, J. (1983). Skills, rules, and knowledge; signals, signs, and symbols, and other distinctions in human performance models. *IEEE Transactions on Systems, Man and Cybernetics, 13,* 257-266.
Reason, J. (1990). *Human error*. Cambridge university press.
Reason, J. T. (1997). *Managing the risks of organizational accidents*. (6 ed.) Ashgate Aldershot.
Robert, B. & Lajtha, C. (2002). A new approach to crisis management. *Journal of Contingencies and Crisis Management, 10,* 181-191.
Schein, E. H. (2004). *Organizational culture and leadership*. (3rd ed.) San Francisco: Jossey-Bass.
SFS 2006:544. *Lag om kommuners och landstings åtgärder inför och vid extraordinära händelser i fredstid och höjd beredskap. ("Act on municipal and county council measures prior to and during extra-ordinary events in peacetime and during periods of heightened alert.")*. Svensk författningssamling.
Simon, H. A. (1976). *Administrative behavior: A study of decision-making processes in administrative organization.* New York: Free Press.
Simon, H. A. (1996). *The sciences of the artificial*. MIT press.
Weick, K. E. (1987). Organizational culture as a source of high reliability. *California Management Review, XXIX,* 112-127.
Weick, K. E. (2011). Organizing for transient reliability: The production of dynamic non-events. *Journal of Contingencies and Crisis Management, 19,* 21-27.
Weick, K. E. & Quinn, R. E. (1999). Organizational change and development. *Annual Review of Psychology, 50,* 361-386.
Weick, K. E. & Sutcliffe, K. M. (2007). *Managing the unexpected: Resilient performance in an age of uncertainty*. San Francisco: Jossey-Bass.
Woltjer, R., Trnka, J., Lundberg, J., & Johansson, B. (2006). Role-playing exercises to strengthen the resilience of command and control systems. In *Proceedings of the 13th European Conference on Cognitive Ergonomics: Trust and Control in Complex Socio-Technical Systems* (pp. 71-78). Zurich, Switzerland.
Woods, D. D. (2009). Escaping failures of foresight. *Safety Science, 47,* 498-501.

Woods, D. D. (2011). Resilience and the Ability to Anticipate. In E.Hollnagel, J. Pariès, D. D. Woods, & J. Wreathall (Eds.), *Resilience engineering in practice: A guidebook* (pp. 121-125). Aldershot, UK: Ashgate.
Yin, R. K. (2003). *Case study research: Design and methods*. (5 ed.) Thousand Oaks, CA: Sage.