

# Emergency call centers and large scale incidents: A comparison of the operators' perspective and a resilience model

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## **Abstract**

A key feature of civil safety is the ability to respond to unwanted incidents. The first link in the response chain is usually the emergency call centers, and the purpose of this study was to investigate the work at an emergency call center in connection with large scale incidents. The delivery of the study is two-fold: firstly, a bottom-up analysis was performed in order to outline work at the emergency call center during large scale incidents. This approach resulted in a content model depicting the features of work during large scale incidents. Secondly, a theory driven top-down analysis was performed based on the same data in order to investigate whether a resilience perspective on safety is an appropriate framework for work at the emergency call center during large scale incidents. The data consisted of emergency call center operators' reflections around their own work during large scale incidents, and was gathered through semi-structured interviews. Statistical comparisons between the resilience model and the content model revealed that the former was not able to account for all the statements captured in the content model, and hence it does not provide a complete framework for understanding work at the emergency call center during large scale incidents. This study provides insight to a field that has received little attention from previous research and contributes to a better understanding of the role emergency call centers play with regard to emergency management and hence to civil safety.

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### **Emergency call centers and large scale incidents: A comparison of the operators' perspective and a resilience model**

Several incidents and accidents in the past few years have led to an increased focus on civil safety and on how we should prepare to handle large scale incidents (e.g. Alexander, 2005; Batho, Russell & Williams, 1999; Justis- og beredskapsdepartementet [JD], 2013; Perry & Lindell, 2006). Terrorist attacks and school shootings have struck both small and large communities (Statsministerens kontor, 2012; Perry & Lindell, 2003), natural disasters such as Hurricane Katrina and the tsunamis in south-east Asia in 2004 and in Japan in 2011 have proved that we are vulnerable to the forces of nature (Direktoratet for samfunnssikkerhet og beredskap [DSB], 2012a; McConnell & Drennan, 2006) and due to the complexity of modern socio-technical systems accidents will happen (Perrow, 1984). Examples of large scale industrial accidents from the recent past include the Deepwater Horizon oil spill in the Gulf of Mexico in 2010, the nuclear accident in Fukushima that followed after the previously mentioned earthquake and tsunami in 2011 (DSB, 2012a) and the large explosion in a Texas fertilizer plant in April this year (Levs & Mungin, 2013).

Emergency management is a central component in maintaining the safety of ordinary citizens, both by preventing incidents from happening and by mitigating adverse outcomes resulting from such events (Haddow, Bullock & Coppola, 2011). As it is impossible to prevent all large scale incidents, preparation and planning that enable successful handling of unwanted incidents is a necessity (McConnell & Drennan, 2006). The emergency response services are usually the core organizations to respond to events that pose a threat to the safety of people and property, and the emergency call centers are usually the first receivers of information of incidents and events from the public (Whalen, Zimmermann & Whalen, 1988). Despite their role as the first link in the emergency response chain and thus the first link with regard to efforts made to mitigate adverse outcomes and restore civil safety, the work at emergency call centers in relation with large scale incidents is largely unknown.

The aim of this thesis is to shed light on this work and how it contributes to emergency response, and in the next instance, civil safety. The thesis will first outline the terms civil safety and preparedness. Next, a brief introduction of the Norwegian rescue service will be provided, followed by a presentation of the roles and responsibilities of the emergency call centers. Existing knowledge related to emergency management will then be described in order to outline the factors known to be of relevance to successful management of unwanted incidents. Two approaches will be made in order to investigate work at the emergency call

center during large scale incidents. Firstly, a bottom-up approach will be applied in order to generate a systematic overview of the factors relevant to this work. Secondly, an existing theoretical framework will be applied in order to investigate whether it provides a good foundation for understanding this work. Modern societies can be understood as socio-technical systems (Fredholm & Göransson, 2011), and it has been stated that emergency response takes place in a complex world (Kendra & Wachtendorf, 2006). Hence, a perspective that argues that safety in complex socio-technical systems require the ability to anticipate, monitor, respond and learn (Hollnagel, 2008a, 2011; Madni & Jackson, 2009) will be applied in order to investigate whether these qualities are relevant factors with regard to the work at an emergency call center during large scale incidents.

### **Civil Safety and preparedness**

Civil safety and emergency preparedness entails preventing and planning to manage incidents that pose a threat to lives and values in a society. There are different definitions of civil safety, but in this context it will be understood as “[...] society’s ability to maintain important social functions and to safeguard citizens’ life, health and basic needs under various incidents of strain” (JD, 2002). There are two different aspects to this understanding of civil safety. Possible scenarios must be identified and if possible prevented and precautionary measures that limit the consequences of occurring incidents must be taken. These measures are referred to as preventive security efforts. The other aspect of civil safety is preparedness. Preparedness entails taking measures that enable the appropriate agencies to respond when unwanted incident occur (Statsministerens kontor, 2012). As it is impossible to prevent all unwanted incidents, these two approaches must complement each other (Hollnagel, 2008b). Risk can be understood as possible adverse outcomes or negative consequences resulting from present processes or future events (Hollnagel, 2008c) that constitute a threat “to life, property or the environment” (Mendonca, 2005, p. 953). Emergency management is concerned both with avoiding and handling the risks that pose a threat to civil safety and has been argued to be of great importance to the everyday safety of citizens (Haddow et al., 2011). This emphasis mirrors the goals of civil safety that entails both prevention and handling of unwanted incidents.

The Norwegian Rescue Service is the publicly organized activities aimed at protecting people from harm posed by acute dangers or accidents, (JD, 2011; Håndbok for redningstjenesten, 2008) and thus a crucial part of the emergency management related to handling risks that occur, and to civil safety. The Ministry of Justice and Public Security is

responsible for the Norwegian Rescue Service (Statsministerens kontor, 2012). The main actors within the rescue service are the three first response services, police, health and fire (Statsministerens kontor, 2012). The first response services can be viewed as “the sharp” end with regard to these incidents, and they are a key contributor to preparedness (Haddow et al., 2011), i.e. the measures taken to handle risk when it arises.

Incidents are usually brought to the attention of the response services through emergency call centers (Whalen et al., 1988), and the operators at the emergency call center must make sense of the information provided by the caller and decide whether a response is in place (Normark, 2002). They are also responsible for communicating with and supporting personnel on-site during response to various degrees (Brann- og eksplosjonsvernloven, 2009; Forskrift om organisering av brannvesen, 2012; Forskrift om akuttmedisin utenfor sykehus, 2013; Politidirektoratet [POD], 2011; JD, 2009). Failing to recognize the severity of a reported situation and apply an appropriate response may lead to devastating consequences. A case study by Whalen and colleagues (1988) illustrates how lack of understanding of an emergency situation resulted in loss of life, and a study by Berdowski and colleagues (2009) revealed the importance of operators at call centers recognizing incidents of cardiac arrest during the emergency call. During the terrorist attack on Oslo 22<sup>nd</sup> of July 2011, a caller reported the registration number on the car the terrorist used to drive to the next target, however this information was not evaluated in time (Statsministerens kontor, 2012).

These examples illustrate the important part emergency call centers play with regard to handling unwanted incidents. Given the fact that emergency call centers usually are the first instance to respond to incidents, it can be argued that they play a key role in maintaining civil safety and preparedness. In fact, it has been claimed that shortly staffed emergency call centers may be a serious weakness with regard to preparedness (JD, 2013; Statsministerens kontor, 2012), and hence to mitigation of adverse effects resulting from incidents that have occurred.

The occurrence of unwanted events that threaten civil safety cannot be eliminated completely. It is therefore of great importance that society is prepared to handle such incidents and to limit the adverse effects they cause. By exploring the work at an emergency call center, the knowledge of how the operators who work there contribute to resolve unwanted incidents is strengthened. A better understanding of this work may very well increase society's ability to handle unwanted incidents in a successful way. The next section will outline the organization and responsibilities of Norwegian emergency call centers.



### **Emergency call centers**

The first response services, police, health and fire, are the recipients of emergency calls from the general public. The emergency call centers are responsible for replying to calls from people in need, dispatching resources, communicate with the other emergency call centers when situations call for it, disseminate information within its own organization and for supporting the personnel on-site to varying degrees. (Brann- og eksplosjonsvernloven, 2009; Forskrift om organisering av brannvesen, 2012; Forskrift om akuttmedisin utenfor sykehus, 2013; POD, 2011).

The emergency call centers are organized in different ways, both within and between the emergency response services. Each emergency response service is in charge of operating its own emergency call centers. Today, there are 22 fire department call centers, 29 police department call centers and 19 health service call centers (JD, 2013). The fire department call centers are organized municipally, and the Norwegian Directorate for Civil Safety and Emergency Preparedness (DSB) which is under the jurisdiction of the Ministry of Justice and Public security is the authority in charge of the emergency call centers (Brann- og eksplosjonsvernloven, 2009; Forskrift om organisering av brannvesen, 2012). The call centers for the health services are the responsibility of the four Regional Health Enterprises and under the jurisdiction of the Ministry of Health (Forskrift om akuttmedisin utenfor sykehus, 2013). The National Police directorate and The Ministry of Justice and Public Security are responsible for operating the police emergency call centers (JD, 2009).

The police emergency call centers are also operation centrals. This implies that the effort from the police is led and coordinated by the operational leader at the operation central in cooperation with the incident commander at the incident site (POD, 2011). In the other emergency response services the efforts to solve an incident is led by the highest ranking person on the incident site or by the incident commander from the police on site and the operational leader if the effort involves all the emergency response services. The autonomy of the emergency call centers when it comes to control over resources vary between regions and emergency response services (POD, 2011; DSB, 2012b).

There is some empirical knowledge related to work at emergency call centers (e.g. Berdowski, Beekhuis, Zwinderman, Tijssen & Koster, 2009; Furniss & Blandford, 2006; Normark & Randall, 2005; Whalen et al., 1988). However, the existing research is from contexts outside the Norwegian emergency response service. Most of the studies focus on emergency call centers that do not belong to a particular emergency response service, but acts as a common recipient of emergency calls for all the emergency response services (e.g.

Normark, 2002; Normark & Randall, 2005). Further, there is little empirical knowledge of the role of the emergency call centers during the response to large scale incidents. Experience from large scale incidents suggest that the ability of emergency call centers to reply to calls during disasters is important to handling these disasters (Statsministerens kontor, 2012), and that support from emergency call centers may improve the response through more efficient use of available resources (DSB, 2012b).

Despite their role as the initial recipient of information and the first instance to respond to incidents (Whalen et al., 1988), there is little empirical knowledge of their role during large scale incidents. The topic of emergency management, however, has received attention. The next section will outline relevant knowledge about emergency management, relevant features of large scale incidents and existing knowledge on how they are best dealt with.

### **Emergency Management**

Successful handling of disasters is highly contingent on the response provided by emergency organizations (Dawes, Cresswell & Callahan, 2004; Quarantelli, 1988). The purpose of emergency management, and thus also the purpose of the first response services, is to handle accidents and incidents and to make society “more resistant to the impact of extreme events, thus enhancing societal restoration and recovery” (Mendonca, Jefferson & Harrald, 2007, p. 49). There has been much research on emergency planning and response to crises, disasters and emergencies. This research focus both on the importance of planning and preparing response to incidents (e.g. Batho et al., 1999; McConnell & Drennan, 2006; Perry & Lindell, 2003; Waeckerle, 1991), but also on the fact that hardly every contingency can be planned for when it comes to these types of incidents due to the complexity of the circumstances (Kendra & Wachtendorf, 2006; Mehrotra, Znati & Thompson, 2008), high level of unpredictability (McConnell & Drennan, 2006), and the changes they cause in human systems (Mendonca et al., 2007).

This knowledge of response to emergencies and large scale events illustrate that though planning and preparation are key aspects of successful crisis- and disaster management, it cannot be relied on as the sole source of emergency management, (Dawes et al., 2004; Kendra & Wachtendorf, 2006; Mendonca, 2005; Mendonca et al., 2007; Rankin, Dahlbäck & Lundberg, 2013) and hence of civil safety. Flexibility and preparedness to respond to unforeseen events are necessary additions to plans and standard operating procedures when large scale incidents occur (Mendonca, 2005; Mendonca, Beroggi & Wallace, 2003; Mendonca et al., 2007; Rankin et al., 2013). This creates a need for “the sharp

end” of emergency response to be able not only to plan, practice and prepare, but also to be able to handle both anticipated and unexpected incidents in a hands-on and flexible manner. The next section will outline a perspective on safety that takes this notion into account and describes safety as a dynamic non-event that depends on planning and anticipation of events, but also on response and flexible handling of incidents that do occur (Hollnagel, 2008a).

### **A theoretical perspective: Safety through resilience**

According to Hollnagel (2008c, p. 2), safety can be understood as “a state in which the risk of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level”. Further, he argues that this can be achieved in three ways; by eliminating the risk altogether, by making sure that unwanted events do not happen, and by protecting from the results of unwanted events that take place (Hollnagel, 2009, p. 8).

Much effort is laid down by governments and first response services in planning and preparing for possible scenarios. One example is the increased focus on plans for responding to terrorist attacks after the 9/11 attacks on New York (Perry & Lindell, 2003), and after the terrorist attacks on Oslo and Utøya in 2011 (JD, 2013). Safety by design is a form of safety that results from precautionary measures taken ahead of time (Hollnagel, 2008a), i.e. eliminating risk and making sure unwanted incidents do not happen. This mirrors the prevention aspect of civil safety. However, Hollnagel (2008a) argues that safety by design as the sole foundation of safety only can be viable in systems that are completely specified and where there is good predictability. These systems are referred to as tractable (Hollnagel, 2008a). Given the complexity of modern societies, it is impossible to prevent all unwanted incidents from happening (Perrow, 1984). Further, it is impossible to plan for every possible contingency (Boin & McConnell, 2007; Hollnagel, 2008a; Mendonca et al., 2007; Weick & Sutcliffe, 2007). There will often be a discrepancy between what was planned for and what happens, hence execution of plans must be flexible and adaptive (Klein, 2007). This creates a need to judge the importance and relevance of tasks in real time in order to prioritize and make decisions (Dekker, 2003; Hollnagel, 2009), otherwise known as performance variability. As has been argued earlier in the study, unwanted incidents don't follow a standard line of development. Key features of large scale incidents are that they are unpredictable, unforeseen and that they can be difficult to make sense of and apply standard procedures to (McConnell & Drennan, 2006;). Even fairly standard emergency situations that are handled on a regular basis can be impossible to predetermine in detail (Kendra & Wachtendorf, 2006). Hollnagel argues that “safety by design [...] must be complemented with

safety by management” (Hollnagel, 2008a, p. 1). Thus, in addition to managing emergencies by prevention and development of standard procedures and plans, measures that aim to ensure civil safety should also take into account the need to prepare to handle unforeseen events. Looking back to Hollnagel’s (2009) description of how safety can be maintained, this underlines the need to be able to protect the public from adverse outcomes when unwanted incidents occur. This thesis argues that emergency call centers play a key task with regard to this.

**A resilience perspective on safety.** Resilience is defined as “the intrinsic ability of a system to adjust its functioning prior to, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions” (Hollnagel, 2011, p. xxxvi), i.e. both avoiding and handling risks. The ability to restore the system and continue working despite changes and degradations in working conditions is also a key feature of resilience (Hollnagel & Woods, 2006). The ability to stay in control and to cope with incidents that occur, both within the system and in its environment, is another important feature of resilience. The ability to maintain control and adjust can be seen as particularly important with regard to emergency response that must handle incidents ranging from relatively simple emergencies to highly demanding disasters and catastrophes.

According to Hollnagel (2008a), performance variability is a key factor in complex socio-technical systems as conditions and situations often will differ from what was expected in advance. A characteristic of large scale incidents, as previously outlined, is that they are difficult to predict and hard to plan for due to their complexity (e.g. Kendra & Wachtendorf, 2006; Quarantelli, 1988). It has been argued that management of unexpected events require a change of behavior, whilst retaining the sense of what needs to be done (Weick & Sutcliffe, 2007, p.). In other words, response must be adapted to the given circumstances. This can imply following procedures when appropriate, but also to recognize the need to deviate from the original plan (Hollnagel, 2008a). Performance variability such as improvisation and adaptation has been shown to be of great importance in safety-critical environments and when responding to large scale incidents (Gauthereau & Hollnagel, 2005; Kendra & Wachtendorf, 2006; Mendonca, 2005; Mendonca et al., 2007; Trotter, Salmon & Lenné, 2012;). In fact, failing to adapt performance according to external conditions has been detrimental in the past. The response to the shootings at Columbine High in 1999 and at Virginia Tech in 2007 were criticized for following procedures and waiting for Special Forces rather than deviating from procedures and initiating the response (Statsministerens kontor, 2012). Failure to recognize that a situation deviates from what was anticipated and hence a failure to adapt the response

may cause highly adverse outcomes (Pariès, 2011) and the ability to adapt can be argued to be necessary to preserve civil safety.

### **A model of the required qualities of a resilient system**

Hollnagel (2008a; 2011) argues that a resilient system is characterized by four so-called cornerstones of resilience. These cornerstones are qualities or abilities the system must be in possession of in order to be resilient, that is, able to deal with complexity and stay in control despite stresses and pressures on the system (Hollnagel 2008a, 2011). These four cornerstones are *Response*, *Anticipation*, *Attention* (also referred to as *Monitoring*) and *Learning and Updating*. *Response* concerns the ability to respond to both expected and unexpected incidents in an appropriate manner (Hollnagel, 2008a, 2011; Hollnagel & Woods, 2006). This also implies adaptation and flexibility when predefined responses are unable to meet the current conditions in a satisfactory manner (Hollnagel, 2008a). *Response* is related to knowing what to do (Hollnagel, 2011; Hollnagel & Woods, 2006). *Anticipation* is related to the system's ability to anticipate future threats and opportunities, and to know what to expect (Hollnagel, 2011). This feature allows for risk avoidance or preparations that enable the system to deal with risks that arise. *Attention*, or monitoring, is also a key feature of resilient systems. This is related to recognizing what might constitute a threat in the near future, both within the system and in its environment (Hollnagel, 2008a, 2011). In order to respond to risks, it is necessary to recognize the presence of these risks. Finally, the ability to *learn* and *update* the knowledge, competence and resources in the system is necessary to be resilient (Hollnagel & Woods, 2006). It is necessary to learn both from successes and from failures (Hollnagel, 2011), and to adapt the system as a whole to the dynamics of its environment. Hollnagel and Woods (2006) have developed a model describing the required qualities of a resilient system (Figure 1).

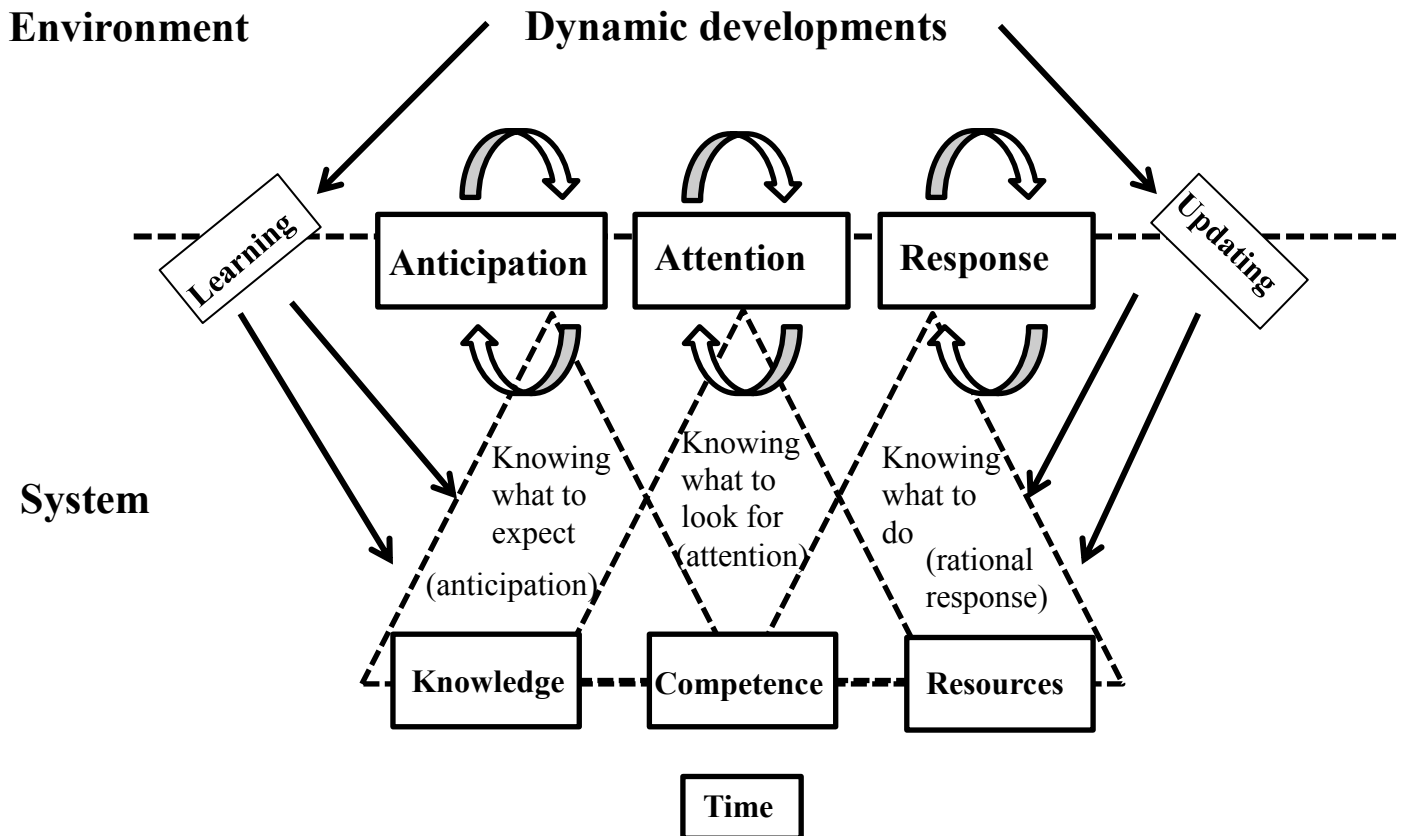


Figure 1: Required qualities of a resilient system, based on Hollnagel & Woods (2006)

In addition to outlining the four cornerstones of resilience, the model presents four factors that are argued to influence *Anticipation*, *Attention* and *Response* (Hollnagel & Woods, 2006). These influencing factors are *knowledge*, *competence*, *resources* and *time*, (Hollnagel & Woods, 2005, 2006). Lack of *knowledge* of what is going on is a factor that may hinder the ability to stay in control. *Knowledge* is concerned with the ability to recognize what happens. It also entails the encapsulated experience of the system, as well as the requisite imagination, that is the ability to “go beyond what is expected and to look for more than just the obvious” (Hollnagel & Woods, 2006, p. 349). *Competence* refers to the ability to know what to do and how to do it (Hollnagel & Woods, 2006). Lack of *competence* will cause loss of time (Hollnagel & Woods, 2005) due to labored and slow response. Lack of *resources* will hamper the ability of the system to respond to factors that are identified as threats (Hollnagel & Woods, 2006). *Time* is referred to as an independent factor (Hollnagel & Woods, 2006). In dynamic environments such as accident sites time is a limited resource. Further, unexpected events require more time than more expected or routine events as decisions and understanding is less straight forward (Hollnagel & Woods, 2005), and lack of time can also cause the

system to fall into a reactive mode (Hollnagel & Woods, 2006). It is argued that knowledge is important to *Anticipation* and *Attention*, and that competence and resources are necessary to *Response*. Further, it is argued that poor planning can cause lack of time (Hollnagel & Woods, 2006). Learning and updating of the system's knowledge, competence and resources are necessary to maintain the ability to be resilient. As the model illustrates, the qualities that are outlined must be maintained constantly (Hollnagel & Woods, 2006), and the cornerstones and influencing factors are suggested to have a mutual effect on one another.

### **Understanding the role of the emergency call centers**

Civil safety and emergency management entails both preventive efforts aimed at eliminating threats all together, and preparedness measures taken to enable successful response to unwanted incidents that do occur despite preventive efforts (Haddow et al., 2010; Statsministerens kontor, 2012). Experience from large scale incidents such as the London bombings in 2005 and the Oslo bombing in 2011 has shown that emergency call centers play an important role in emergency management (Statsministerens kontor, 2012; DSB, 2012b). In order to understand the role emergency call centers play with regard to civil safety, it is necessary to know what their work consists of. A better understanding of the work at emergency call centers during large scale incidents could potentially contribute both to planning and preparedness measures and also to a strengthened ability to handle unwanted incidents flexibly when they occur. It has been argued that safety in complex socio-technical systems need to rely on safety by management in addition to prevention and planning. A resilience perspective on safety has been introduced, and it has been claimed that emergency management, much like safety in intractable systems, must include the ability to respond to anticipated and unforeseen events alike.

### **The present study**

The present study is an explorative case study of the work at an emergency call center during large scale incidents aimed to generate new knowledge of the factors that are of importance to this work. The delivery will be two-fold: firstly, an inductive, bottom-up analysis of the work at the emergency call center during large scale incidents will provide a thorough and detailed overview of the factors that are of importance to this work. As there is little knowledge of the topic under investigation this will provide a foundation for understanding what this work consists of. Secondly, a deductive approach will be made through the application of an existing theoretical framework.

Data material was collected by means of semi-structured qualitative interviews based on a SWOT framework. This approach encourages the participants to share their reflections around their own work at the emergency call center during large scale incidents whilst limiting the influence of the interviewer on the topics that emerge (Hoff et al., 2009). A mixed method approach was applied which implies that data material first was gathered qualitatively followed by a quantification of the qualitative data material through unitizing. Firstly, a qualitative, non-theoretical bottom-up analysis was performed in order to identify aspects relevant to work at an emergency call center during large scale incidents. Secondly, a theory-driven, top-down approach was made in order to investigate whether an existing theoretic framework constituted an appropriate context for understanding work at the emergency call center.

A thematic analysis of the data material was performed in order to provide a systematic representation of the work at an emergency call center during large scale incidents, and to answer the following research question:

*What are the important aspects of the work at the emergency call center during large scale incidents according to the operators who work there?*

The thematic analysis resulted in a representation of the work factors that are important to the operators at the emergency call center during large scale incidents. As the interview questions were designed to probe reflection on this work, the themes resulting from the thematic analysis should reflect the entire data set. Hence, there should be no significant difference between the total amount of statements and the number of statements captured by the thematic analysis. The following null-hypothesis will be tested in order to investigate this notion:

*H0-1: There is no significant difference between the number of statements captured by the content model and the total number of statements.*

Secondly, a Resilience perspective on safety will be applied, and it will be investigated whether this perspective is an appropriate framework for the data that was obtained through the interviews. The ability to mitigate the effects of unwanted incidents is a key task for emergency response, and hence for the emergency call centers who are the first link in the response chain. Research on emergency response has shown that planning and preparation must be combined with flexible execution and adaptation as large scale disasters seldom



develop according to predefined plans. A perspective on safety that advocates the need for safety by management as a necessary addition to avoidance and planning has been introduced. If resilience is relevant to the work at the emergency call center during large scale incidents, a model depicting the characteristics of a resilient system should be able to account for the majority of statements generated from the interviews. To investigate whether resilience is relevant to work at the emergency call center during large scale incidents, the following null-hypothesis will be tested:

*H0-2: There will be no significant difference between the number of statements captured by the model of the required qualities of a resilient system, and the total number of statements from the interviews.*

As the content model developed through the thematic analysis is thought to provide an accurate reflection of the work at the emergency call center during large scale incidents, there should be no significant difference between the number of statements captured by the content model and the model of the required qualities of a resilient system if resilience is a relevant factor to this work. Hence, the final null-hypothesis to be tested is the following:

*H0-3: There will be no significant difference between the number of statements captured by the content model and the number of statements captured by the model of the required qualities of a resilient system.*

Finally, as the content model and the resilience model are thought to capture all statements relevant to work at the emergency call center during large scale incidents, the residual statements should not contain any information of relevance to this work. Hence, the following research question will be answered:

*H-R: Residual statements that are not covered by the themes developed through the thematic analysis and content analysis do not contain any statements relevant to the work at the emergency call center during large scale incidents.*

## Method

### Introduction to the project

The project was carried out in cooperation with SINTEF. SINTEF is coordinating the EU project BRIDGE, which aims at improving crisis and emergency management in the EU countries (including Norway). The goal of the project is to develop organizational and technical solutions to improve crisis management (<http://www.bridgeproject.eu/en/about-bridge/objectives>). The data material was collected in collaboration with another student from the Work and Organizational Psychology Master Program, but resulted in two different theses.

### Understanding the domain

Before initiating the study, we were given the opportunity to participate in two large scale, cross agency training exercises with the emergency response services. The first exercise simulated a large scale bus accident and the second simulated a large scale train accident. This provided an introduction to how the first response units work and cooperate during large scale incidents. Through SINTEF, contact was established with an emergency call center in a large city in Norway. We were offered the opportunity to observe a whole shift, and following this we decided to make a case study of the work at the emergency call center. Relevant laws, regulations and government publications (Brann- og eksplosjonsvernloven, 2009; DSB 2012a; DSB, 2012b; Forskrift om akuttmedisin utenfor sykehus, 2005; Forskrift om organisering av brannvesen, 2002; Håndbok for Redningstjenesten, 2008; JD, 2002; JD, 2004; JD, 2009; JD, 2011; JD, 2013; POD, 2011; Statsministerens kontor, 2012) were investigated to clarify the role of the emergency response services, emergency call centers, and the goals of safety and preparedness in Norway.

### Participants

The participants in the study consisted of the operators working at the emergency call center. Out of 17 employees working full time at the station, 14 chose to participate in the study. Three people were unable to participate, for various reasons. The respondents had worked full time at the central for an average of 4.78 years ( $R=$  3 months to 9 years,  $SD=$  2.55). Some of them had worked part time before they started working full time, and others had worked at other emergency call centers. All the respondents had worked in the first response unit as operative personnel before they started working at the emergency call center. The average time of tenure as operational personnel in the emergency response service was 16 years ( $R=$  0 to 33,  $SD=$  9.60). All the respondents were men. The interviews were performed in a meeting

room at the emergency call center during the shifts between the 26<sup>th</sup> of November and the 6<sup>th</sup> of December 2012. The interviews varied somewhat in length, between 20 and 74 minutes. The average length of the interviews was 44.4 minutes ( $SD= 13.5$  minutes).

### **Design – mixed methods**

According to Lund (2011), a mixed method approach allows the researcher to combine the strengths of qualitative and quantitative approaches, that is, hypothesis generation and hypothesis testing, respectively. Johnson and Onwuegbuzie (2004 p. 17) defines mixed methods research as “the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study”. In this study, qualitative interview data was collected by the means of open-ended research questions based on a SWOT framework. The interviews were transcribed and unitized. The unitizing constitutes a quantification of the qualitative interview data (Tashakkori & Teddlie, 2002). These units of text can, given a rigorous unitizing procedure, be treated as statistical entities (Tashakkori & Teddlie, 2002). A bottom-up thematic analysis of the entire data set was then conducted according to the guidelines provided by Braun and Clarke (2008). This analysis resulted in a thematic map (Braun & Clarke, 2008), referred to as a content model, that provided a non-theoretic overview of the themes and sub-themes that had been outlined by the researchers during the analysis. Next, a theory-driven content analysis was performed where the data set in its entirety was coded on to an established model of the required qualities of resilient systems (Hollnagel & Woods, 2006). Finally, statistical analyses were performed to test the hypotheses.

### **Data Collection**

**Preparations for data collection and interviewing.** The aim of this study was to investigate work at the emergency call center during large scale incidents as perceived by the operators working there. Semi-structured qualitative interviews were judged to be the most appropriate approach to gain access to the perspective of the operators. According to King (2004), a key feature of qualitative interviews is that the interviewee is considered to be a participant rather than a mere respondent. The participant is understood to actively shape and influence the course of the interview (King, 2004). Another important aim of the qualitative interview is to gain access to experience and the meaning of these experiences before imposing a scientific perspective on the topic of interest (Kvale & Brinkmann, 2009).

**Interviewing.** The interview guide was based on a SWOT structure, and a PEACE framework. The SWOT structure allows the research participant to reflect on the strength,

weaknesses, opportunities and threats related to a particular theme without imposing a theoretical framework on the responses (Hoff et al., 2009). The participants were asked to reflect on the strengths, weaknesses, future opportunities and future challenges (threats) related to the work at the emergency call center during large scale incidents. “Large scale incidents” was not predefined by the researchers, as we wanted the research participants own understanding of what constitutes a large scale incident to guide their reflections. Follow up questions were based on predetermined questions (please refer to the interview guide in appendix A). The predetermined questions provided a framework for paraphrasing topics brought up by the research participant during the course of the interview to further highlight or clarify meanings and descriptions.

According to Willig (2008), careful preparation and planning is an essential feature of semi-structured interviewing. PEACE is an acronym for Planning, Engage and explain, Account, Closure and Evaluation (Clarke & Milne, 2001), and this framework was used to guide the interviewing process. The information that was distributed among the participants before the interview process started contained the interview questions as well as background information about the project, giving them an opportunity to prepare for the interview situation. Before introducing the research questions, we asked the participants to tell us about their experience as operators, and their previous work experience. This is in line with Willig’s (2008) recommendation that interviews open with more public questions. Both researchers participated in each interview. One was in charge of leading the interview; the other focused on follow-up questions, clarifications, asked for examples to illustrate the respondent’s points and took notes. When the researchers were done asking their questions, the participant was given the opportunity to add any information that he felt necessary and to reflect on his experience of the interview situation.

### **Preparations for analysis**

**Transcription of the recordings.** The recordings were transcribed, a process that involves transforming the audiotaped material recorded during the interviews into text (Halcomb and Davidson, 2006). A procedure was developed to guide the transcription (Appendix B). The written material is suitable for further thematic and content analysis. The transcripts were conducted near verbatim, i.e. they portray what was actually said during the interviews, but the phrasing was slightly altered when it was considered to be necessary to “tidy up” the text, as oral language is not as fluent as written language. This is in line with Halcomb and Davidson (2006), who propose that as mixed method approaches aim to identify

common ideas or themes in the data material, it is not necessary to provide a detailed verbatim transcription of the material. Hence, the content of what was said was emphasized rather than the exact phrasing (Poland, 2003). The interviews were transcribed by the researcher who observed during the interview as soon as possible after the interview was performed. Notes were taken during the interview where it was thought necessary to inform the process of transcribing. Sections that were inaudible were written up as “**unclear moment**” in the transcriptions.

**Unitizing and unitizing reliability.** The purpose of unitizing is to separate text (or other sources of data) into independent units so that it can be analyzed further (Krippendorff, 2004). As the study aimed to investigate perceptions of work at an emergency call center during large scale incidents, the emphasis was on meanings in the text. Hence, the goal of the unitizing was to separate units of texts that conveyed a single meaning. This involves identifying units of text that are as small as possible whilst still containing meaning that is clearly identifiable and separate from other meanings (Krippendorff, 2004). This is referred to as semantic coding (Krippendorff, 2004). A unit can consist of parts of a sentence, a whole sentence or several sentences (Hoff et al., 2009).

The purpose of unitizing is to prepare data material for further analysis (Krippendorff, 2004). One way of doing this is to quantify text. The units of text can thus serve as basis for statistical analyses of the data material. Meanings are separated and counted, and hence they can provide numerical information on a particular topic. To be able to say something meaningful about the material, different meanings must be distinguished in the raw material (Krippendorff, 2004). To ensure that this separation was not arbitrary, but in fact based on predetermined boundaries, a unitizing procedure was developed (see appendix C). Both researchers coded a subset of a randomly selected transcription, and inter-rater agreement was identified on the basis of Zhargooni’s (2011) adaptation of Boyatzis’ Percentage of Agreement of Presence (Boyatzis, 1998). This procedure revealed an agreement of 76.5%. For further information on this procedure, please refer to Zarghooni (2011).

### **Thematic analysis and Content Analysis**

**Thematic Analysis.** After being transcribed and unitized, the interview transcripts were analyzed thematically according to a six step procedure described by Braun and Clarke (2008). Please refer to Braun and Clarke (2008) for further information on this process. As the goal of the analysis was to create a systematic and organized overview of the entire data material, the data set that was analyzed consists of the entire data corpus (Braun & Clarke,

2008). Providing a rich overall description of a topic (in this case the operators' account of work at an emergency call center during large scale incidents), might be "a particularly useful method when you are investigating an under-researched area, or you are working with participants whose view on the topic are not known" (Braun & Clarke, 2008, p. 83). An inductive, bottom-up approach to coding was selected, which means that coding was data-driven, as opposed to theory-driven (Braun & Clarke, 2008). This implies that the coding was aimed at categorizing all the relevant statements from the interviews into appropriate sub-themes and themes, hence providing a simplified framework for understanding the work at the call center during large scale incidents. Coding was performed manually on a semantic level, meaning that "the themes are identified within the explicit or surface meaning of the data" (Braun & Clarke, 2008, p. 84). Latent meanings were not interpreted into the text, and the statement units were coded according to their explicit content.

The statements from the unitizing procedure were transferred to SPSS and coded according to a codebook (see appendix D). To maintain the context of the transcripts, the statements were transferred into SPSS in the same ordering as they were transcribed (according to Braun & Clarke, 2008). The process of coding is iterative and required several rounds of developing the codebook. All the statement units were coded, and the units that did not fit in any of the definitions of the codes were labeled *Residuals*. Units were only placed into one code. When all the data had been coded into categories, relevant main-themes that covered each category were developed. According to Braun and Clarke (2008), an important aspect to consider when coding is the outlining of boundaries around themes. Questions that need to be considered regard the size and pattern a theme must constitute in order to be a theme. The development of the main themes was loosely guided by Van Gigch's (1974) summary of system components. This is an inventory of the components that constitute a system, for example elements (e.g. procedures), goals and objectives (of the system), structure (e.g. organization), and this framework was used as a guideline to define the boundaries between the components influencing the work at the central during large scale incidents (i.e. the system under investigation).

After careful revision of the themes generated through the thematic analysis, the final result was six main-themes that covered the 12 codes, hereafter referred to as sub-themes. The main themes covered up to four sub-themes. When the themes and sub-themes were thought to provide a good reflection of the data set, it was decided to discontinue the coding of the data.

**Content analysis.** A theory-driven content analysis of the same data material was also performed. The purpose of this content analysis was to investigate whether a model of the required qualities of a resilient system was an appropriate framework for understanding the operators' reflections around work at the emergency call center during large scale incidents. As the interviews were collected with the targeted purpose of shedding light on the work at the emergency call center during large scale incidents, the sampling consisted of the entire data set (Krippendorff, 2004). In this case, an established model was used in order to identify whether this framework was an appropriate framework for the data material obtained. This can be understood as a directed content analysis (Hsieh & Shannon, 2005). Hence, the model in question as well as literature related to the model served as the basis for developing the codebook guiding the content analysis, and determined the exclusivity of the categories and the appropriate level of measurement (Neuendorf, 2002). Please refer to the codebook in appendix E for a complete account of the literature used to operationalize the resilience model. Statement units that did not fit in any of the categories were coded as residuals.

Coding was done manually and the statements were coded in SPSS, hence SPSS serves as the coding form (Neuendorf, 2002). The codebook constitutes an operationalization of the model in question, which enables the study to be replicable (Neuendorf, 2002). The model in question consists of four processes or abilities that must be in place in the system referred to as the four cornerstones of resilience (e.g. Hollnagel, Pariès, Woods & Wreathall, 2011), as well as four conditions that are suggested to influence the four cornerstones and the ability of a system to stay in control (Hollnagel and Woods, 2006). Hence, the codebook consisted of two parts; one depicting the four cornerstones of resilience and a second one depicting the four conditions that influence the system's ability to stay in control and be resilient. This opened up for the possibility of each statement being coded in the first part, the second part or both parts of the model, depending on their fit with the description of the single categories within the two parts. Statements were only coded once within the same part of the model. Further, the categories in the two parts of the model were considered to be value free, which indicates that statements were coded into the category based on the presence of the particular categories regardless of whether it was considered to be a positive, negative or neutral aspect of work during large scale incidents by the operators. When performing statistical analyses, the statements that were coded in both parts of the model only counted as one statement, i.e. the presence of a statement in the model was counted as one statement regardless of whether the statement fit in one or both parts of the model.

**Statistical analysis**

First, a thematic analysis of the entire data set was performed in order to provide a systematic and detailed description of the content of the data (Braun & Clarke, 2008). Next, a directed content analysis was performed, where the statement units were coded into an existing theoretical framework (Hsieh & Shannon, 2005). Finally, statistical analyses were performed to investigate the data material and to test the hypotheses. Descriptive statistics were produced in order to provide numerical information about the data material. As the intent of the study was to investigate the presence of statements provided by the same people in two different frameworks and see if there was a statistically significant difference in the scores, i.e. the amount of statements captured by each of the models, it was decided that paired samples t-tests was an appropriate measure to test the hypotheses. Effects sizes were also calculated for all the paired-samples t-tests to evaluate whether the significance value was substantive (Field, 2009; Pallant, 2007). As several t-tests were performed, a Bonferroni adjustment was considered as a means to reduce the possibility of a type 1 error, which implies judging that there is a difference between the two groups when in fact there is not. However, performing this adjustment increases the chance of a type 2 error, which implies an increased chance of judging the difference between the two groups to be insignificant when in fact there is a significant difference (Pallant, 2007; Perneger 1998). Thus, the Bonferroni adjustment was not performed.

**Ethical considerations**

Informed consent implies that the research participant is fully informed about the research project and that they agree to participate before the data collection begins (Willig, 2008). To ensure this, we presented our project to the shift leaders and manager before initiating the interview process. The shift leaders were urged to disseminate the information to their teams. Electronic and paper versions of the information letter was handed out to all potential participants a minimum of three days before the interviews (see appendix F). Before starting each interview, the purpose of the project was restated and participants were given the opportunity to ask any questions they might have with regard to the project. Consent forms were signed and collected before starting the interviews (see appendix G). Information of the right to withdraw from the study was provided in the information letter, and the participants were reminded of this right before starting the interview. Each interview was closed by asking the participant to share how he had experienced the interview situation. Most participants reported that the interview situation had been a positive experience, and that they had enjoyed talking about their work. An appointment was made with the manager that we would come



back and present our final findings after completing the study. Finally, confidentiality was ensured by storing sound files on secure SINTEF-servers, and by anonymizing all information that might reveal the respondent in the transcriptions. Permission to collect and store data material was granted by the Norwegian Social Sciences Data Services (NSD) to the BRIDGE project (project number 28066), which also applied for this project as it is part of the BRIDGE project.

### **Results**

The purpose of the study was to investigate the work at an emergency call center during large scale incidents as experienced by operators working at the call center. This investigation firstly aimed to identify the important factors in a bottom-up fashion and to provide a detailed and rich account of these factors. Secondly, the study aimed to identify whether a model outlining the required qualities of a resilient system is an appropriate framework for the work at the emergency call center. The interviews (N=14) concerning work at the emergency call center during large scale incidents were unitized into 3115 separate statement units. These statement units were analyzed thematically and coded onto an existing theoretical framework, and aggregated on a statement level (N=3115). This served as the basis for further analysis.

### **Results from the thematic analysis**

The purpose of the thematic analysis was to investigate the factors that are important during large scale incidents according to operators at an emergency call center in order to answer the following research question: *What are the important aspects of the work at the emergency call center during large scale incidents according to the operators who work there?*

The thematic analysis resulted in six main themes that cover 12 sub-themes. Firstly, the sub-themes were developed following a framework described by Braun and Clarke (2008). Next, in the final process of defining the themes the sub-themes were organized under main themes. The purpose of organizing the sub-themes under larger main themes was to ensure that the boundaries around each theme were of the same magnitude. In order to define these boundaries, a summary of system components described by Van Gigch (1974) was used as a guiding framework. This summary outlines the different components a given system consists of, and the sub-themes were ordered into main themes guided by this inventory. Table 1 provides an overview of the distribution of statement units covered by each sub-theme.

Table 1: *Frequency of statements in the sub-themes derived from the thematic analysis*

Sub-theme	Frequency	
	n	%
Characteristics as Operator	38	1.2%
Drills and Exercises	156	5,0%
Experience and Competencies	236	7.6%
Selection and Recruitment	45	1.4%
Organization of the Emergency Response Services	518	16.6%
Availability of Resources	200	6.4%
Support Systems	377	12.1%
Relations	133	4.3%
Communication and Information Flow	356	11.4%
Overview of Ongoing Incidents	207	6.6%
Operational Support	151	4.8%
Adaptability and Preparedness	499	16%
Total Sub-themes	2916	93.6%
Residual	199	6.4%
Total	3115	100%

The first sub-theme was labeled *Characteristics as Operator*. This sub-theme reflects the operators' concern with personal aptitude, which was considered key to successful functioning at the call center. Ability to stay focused, to stay calm and collected and to handle the incoming tasks during high pressure was outlined as important abilities, as well as interest and motivation to do a good job at the call center. *"It's important to treat the caller in a good way, and don't get stressed. Keep calm even though you know the situation is highly critical"*.

The second sub-theme revolves around the importance of practicing and developing skills in the daily work and through drills and exercises, and on the importance of developing competence and knowledge to be able to handle both regular and irregular incidents. *"I believe practicing and things like that, mass handling of the things that are important [to work during large scale incidents]"*. This sub-theme was labeled *Drills and Exercises*.

The third sub-theme, *Experience and Competencies*, reflects the view of the operators that experience and background as first response personnel are crucial factors to the work at the emergency call center. Knowledge of the local area and organization of the local emergency

response service were other competencies that were regarded as relevant to work at the emergency call center during large scale incidents. Statements regarding the ability to utilize tools and support systems in an efficient manner also fitted into this sub-theme. *“Our strength is the diverse composition of competencies and experience from working as first response personnel”*.

The fourth sub-theme is *Selection and Recruitment*. This theme contains statements regarding the importance of, and challenges related to recruiting candidates with the desirable skills, abilities and competencies, and statements regarding criteria for the selection of new operators to the emergency call center. *“Finding solutions with regard to recruitment of operators is a challenge in the system”*.

The fifth theme contains statements regarding the organization of the emergency call center (organization of tasks, roles and responsibilities, organization of physical working conditions, organization of learning/development, organization of resources), the organization of the emergency response service the call center belongs to, organization across the emergency services (health service, police and fire department), and finally organizational development, both within the call center, the emergency response service and across the emergency departments. *“During sharp missions, we have a mutual agreement with the other emergency call centers where [...] the first recipient of an incident is responsible for alerting the other emergency call centers”*.

Sub-theme number six, *Resources*, is concerned with availability of resources (human and material) and strain on these resources due to various factors, such as high pressure on the operators as a result of many callers when large incidents have occurred. *“Our biggest advantage is the availability of resources, out in the field”*.

Sub-theme number seven, *Support Systems*, capture statements regarding different aspects of the support systems in use at the emergency call center and the influence of these systems on the work at the center during large scale incidents. *“We have too many screens and keyboards to manage. You need to perform several operations [...] in order to dispatch the resources”*.

Sub-theme eight, *Relations*, concerns the role of relations and how they influence work at the emergency call center during large scale incidents. Relations between the operators at the call center, between the operators and callers, between operators and operators at other emergency call centers, and operators and staff on site are all mentioned as important to this work. *“It is easier to ask others for help if you know them, particularly when you are under a lot of pressure”*.

*Communication and Information Flow*, is the ninth sub-theme developed through the thematic analysis. This sub-theme captures statements that are concerned with various aspects in connection with availability and flow of information before and during incidents. The theme also captures statements regarding communication. *“The information flow between the emergency response services is not good enough”*.

*Overview of Ongoing Incidents* is concerned with maintaining the overview of ongoing situations. Work at the emergency call center as well as work at the incident site must be monitored, and efforts must be taken in order to distinguish new incoming incidents among ongoing ones. *“That’s how it is, you need to stay informed about what is going on. Read the logs [...] during an ongoing situation. It’s all there”*.

Sub-theme number 11, *Operational Support*, contains statements regarding how the operators at the call center support each other and the personnel on site and the situation specific operational support they provide. *“Predicting the development at the incident is of great help to the personnel on site”*.

The final sub-theme, *Adaptability and Preparedness*, contains statements concerned with more general goals of staying prepared and adapting to the given conditions at all times. Having the necessary freedom to make adaptations was also brought up by the operators as a necessary factor in this context. *“If I sense that we need more resources at an incident site, I dispatch more resources. I don’t need to report that”*.

**Main themes.** After the 12 sub-themes were identified they were organized into broader, more general themes. Table 2 outlines the distribution of scores across the main themes and provides an overview of aspects that are of relevance to work at the emergency call center during large scale incidents. These main themes will be the basis for the discussion of the work at the emergency call center during large scale incidents.

*Characteristics as Operator, Drills and Exercises, Experience and Competencies* and *Selection and Recruitment* were grouped together under a main theme labeled *Skills and Competencies*. This main theme contains the sub-themes that were concerned with various aspects of knowledge and competencies held by the operators and factors influencing knowledge and competencies. These factors can be understood as inputs to the system in the framework of system components suggested by Van Gigch (1974), and hence they were grouped together under one main theme. The sub-theme *Organization of the Emergency Units* constituted a main theme in itself. All references to the organization of the physical and organizational aspects of the emergency units were collated by this main theme. This theme corresponds to Van Gigch’s structure component. Structures are system components that bind

the elements of a system together, in other words the system's organization (Van Gigch, 1974).

Table 2: Frequency distribution of scores across the main themes of the Content model

Theme	Frequency	
	n	%
Skills and Competencies	475	15.2%
Organization of emergency units	518	16.6%
Resources and Support Systems	577	18.5%
Relations	133	4.3%
Information and Overview	563	18.1%
Operational Goals	650	20.9%
Total main themes	2916	93.6%
Residual	199	6.4%
Total	3115	100%

The third theme, *Resources and support systems*, consists of the sub-themes *Availability of resources* and *Support systems*. This theme captures statements regarding the influence of support systems and availability of resources during large scale incidents. This theme corresponds to what is referred to as Elements in Van Gigch's summary of system components. Elements are personnel, equipment, procedures etc. (Van Gigch, 1974). The fourth theme, *Relations*, does not contain sub-categories. Neither does the theme fit in to Van Gigch's inventory of system components. Nevertheless, the theme is clearly distinct from the other main themes and hence it constitutes a main theme. The fifth main theme, *Information and overview*, is comprised of *Communication and Information* and *Overview of ongoing incidents*. This main theme also does not fit very well with Van Gigch's system components. It bears some resemblance to conversion processes, which are changes in the system state (Van Gigch, 1974). The two sub-themes that are covered by this main theme contain statements concerned with processes that take place during incidents.

The sixth and final theme that has been outlined through the thematic analysis of the work at the emergency call center during large scale incidents is *Operational Goals*. This main theme consists of the sub-themes *Operational support* and *Adaptability and preparedness*, and contains statements concerned with identifying and achieving the goals of the organization. This is similar to the goals and objectives component in Van Gigch's

inventory and is concerned with the purpose of the system in question. Statements regarding the operational goals of the emergency call center are captured by this main theme.

### Results from the content analysis and descriptive statistics

A content analysis was performed in order to investigate whether a model of the required qualities of a resilient system would capture the majority of the statement units resulting from the interviews. In the following section, results from and descriptive statistics related to the resilience model will be presented, as well as descriptive statistics outlining the relation between the content model and the resilience model. Table 3 illustrates the amount of statements captured by each part of the resilience model.

Table 3 *Frequency of statements captured by the two parts of the Resilience model*

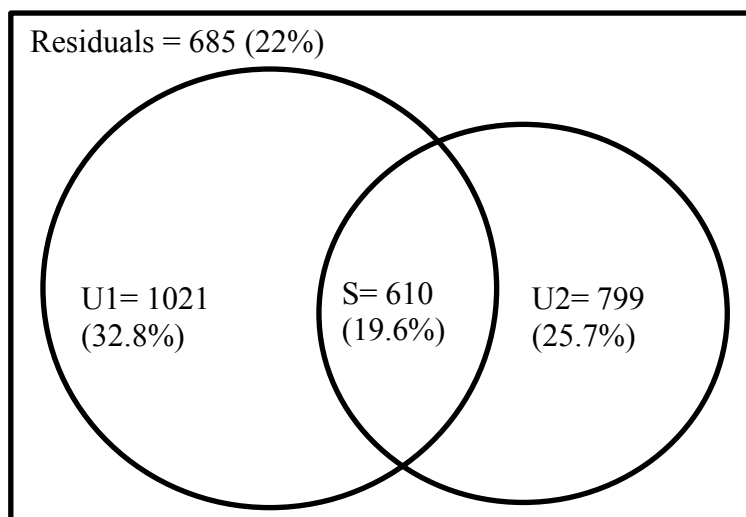
		Frequency	
		n	%
1. The four cornerstones of resilience	Anticipation	290	9.3%
	Attention	444	14.3%
	Response	740	23.8%
	Learning and Updating	157	5%
Statements captured by the four cornerstones of resilience		1631	52.4%
Residual		1484	47.6%
Total		3115	100%
2. Influencing conditions	Knowledge	222	7.1%
	Competence	444	14.3%
	Resources	654	21%
	Time	89	2.9%
Statements captured by the influencing conditions		1409	45.2%
Residual		1706	54.8%
Total		3115	100%

The first part of the model, covering the four cornerstones of resilience, captured the largest amount of statements (1631, 52.4%). The distribution of statements across the

categories was somewhat uneven, with *Response* capturing the highest degree of statements (740, 23.8%), followed by *Attention* (444, 14.3%), *Anticipation* (290, 9.3%) and with the category *Learning and Updating* covering the lowest amount of statements (157, 5%). The part of the resilience model outlining the influencing conditions captured a slightly smaller percentage of the statements (1404, 45.2%). The code capturing the largest amount of statements in this part of the model, is *Resources* (654, 21%), followed by *Competence* (444, 14.3%), and *Knowledge* (222, 7.1%). The code capturing the smallest amount of statements is *Time*, which only accounts for 2.9% of the statements (89).

Table 3 illustrates the amount of statements captured by each part of the resilience model, and the frequency of statements captured by each individual code. However, the resilience model was separated into two parts, one containing the four cornerstones of resilience, and the other containing influencing factors. A percentage of the statements were coded into both parts of the model (i.e. they fit both with the operationalization of one of the four cornerstones, and with the operationalization of one of the influencing factors). This created an overlap between the two parts of the model. Each part of the model also accounted uniquely for a number of statements. Table 3 illustrates the number of statements that are captured in each part of the resilience model, but it does not illustrate the frequency of statements that are unique to each part of the resilience model and the frequency of statements that are captured by both parts of the resilience model. The Venn diagram in Figure 2 provides an illustration of this.

Total = 3115



*Figure 2.* Illustrating the overlap between the two parts of the model on the Required qualities of a resilient system. S= statements that are covered by both parts of the model, U1= statements captured only by the four cornerstones of resilience, U2= statements captured only by the influencing conditions, Residuals = statements not covered by the model on required qualities of a resilient system

The Venn diagram in Figure 2 illustrates that out of the 52.4% of statements that were captured by the four cornerstones of resilience, 32.8% were only captured by this part of the model, whilst 19.6% of these statements were also captured by the influencing conditions. 25.7% of the statements were uniquely accounted for by the influencing conditions. All in all, the resilience model was able to account for 78% of the statements, leaving a residual of 22%.

The overlap between the resilience model and the content model resulting from the thematic analysis was also calculated, and is illustrated in the Venn diagram in Figure 3.

Total= 3115

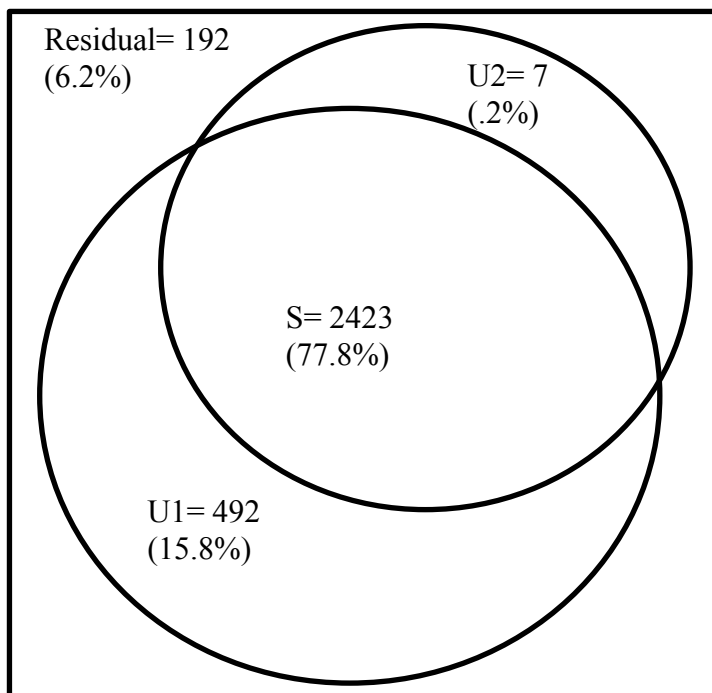


Figure 3: Illustrating the overlap between the statements captured by the Content model developed through the thematic analysis and the statements captured by the Resilience model. S= statements that are covered by both the content model and the resilience model, U1= statements captured only by the Content model, U2= statements captured only by the Resilience model, Residual= statements not covered by the Resilience model or the Content model

As can be seen from this figure, the content model accounted uniquely for 493 statements (15.8%), whilst 2423 statements (77.8%) of the statements were covered both by the resilience model and the content model. Seven statements (.2%) that were coded as residuals in the content model were included into the resilience model (U2). This will be discussed further in the limitations section.

All in all, 22% of the total statements were not accounted for by the resilience model. However, 6.2% of these residual statements were also coded as residuals in the content model



whilst the remaining 15.8% of these statements fit into the content model. In other words, these statements were judged to be of importance to work at the emergency call center during large scale incidents, but were beyond the scope of the resilience model. A cross tabulation of the content model and the model of the required qualities of a resilient system is presented in Table 4.

Table 4. *Cross tabulation of the resilience model and the content model*

Theme	Frequency of statements not captured by the resilience model		Frequency of statements captured by the resilience model		Total
	n	% not within theme	n	% within theme	
Skills and competencies	43	9.1%	432	90.9%	475
Organization of the emergency services	121	23.4%	397	76.6%	518
Resources and Support systems	40	6.9%	537	93.1%	577
Relations	79	59.4%	54	40.6%	133
Information and overview	141	25%	422	75%	563
Operational goals	69	10.6%	581	89.4%	650
Residual	192	96.5%	7	3.5%	199
TOTAL	685 (22%)		2430(78%)		3115(100%)

This cross tabulation outlines which of the categories that overlapped the most and the least between the content model and the resilience model. The theme that was the least accounted for by the resilience model i.e. had the highest amount of statements that did not fit in the resilience framework, was *Relations*. Out of the 133 statements in this theme 79 statements did not fit in the resilience framework, 59.4% of the statements within this theme. *Information and overview* was another theme where a relatively large amount of the statements in the category did not fit in the resilience model, 141 statements, 25% of the statements in the theme were not accounted for by the resilience model. In the theme *Organization of the emergency units*, 121 of the statements did not fit into the resilience framework which leaves 23.4% of the statements in this category unaccounted for by the

resilience model. The Theme that fit most closely with the resilience model was *Resources and Support systems*, 93.1% of the statements in this theme were also accounted for by the resilience model. *Skills and Competencies* contained 475 statements, of which 90.9% were also accounted for by the resilience model, whilst *Operational Goals* contained 650 statements, of which 89.4% were also covered by the resilience model. This suggests that there are aspects of the work at the emergency call center during large scale incidents that are not captured by the resilience perspective, and that the model is insufficient in itself to explain all aspects of this work.

## Hypotheses

**Inferential statistics.** The operators were asked to reflect on their own work during large scale incidents, and hence the data material should contain statements regarding the work at the call center during large scale incidents. Hypothesis 1 stated that there should be no significant difference between the total amount of statements and the number of statements captured by the content model. This hypothesis was tested by the means of a paired samples t-test, which yielded a significant result with a medium effect size ( $d=.50$ ),  $t(3114)=14.58$ ,  $p<.05$ ,  $r=.24$ . In other words, there was a significant difference between the number of statements captured by the content model resulting from the thematic analysis and the total number of statements and the hypothesis was rejected.

Hypothesis 2 stated that there would be no significant difference between the number of statements captured by the model of the required qualities of a resilient system, and the total number of statements from the interviews. A paired samples t-test was conducted to investigate whether there was a significant difference between the total amount of statements and the amount of statements captured by the resilience model. The analysis yielded a significant result with a large effect size ( $d=1.04$ ),  $t(3114)=29.63$ ,  $p<.05$ ,  $r=.46$ . The hypothesis was rejected.

Hypothesis 3 predicted that there would be no significant difference between the number of statements captured by the content model and the number of statements captured by the model of the required qualities of a resilient system. A paired samples t-test was performed to compare the total amount of statements captured by the content model with the total amount of statements captured by the resilience model. This revealed a significant difference between the number of statements captured by the two models with a large effect size ( $d=.82$ ),  $t(3114)=23.59$ ,  $p<.05$ ,  $r=.38$ . Hence, the hypothesis was rejected.

**Analysis of the residual statements.** The final research question to be answered regarded the presence of themes relevant to work at the emergency call center during large scale incidents in the residual statements. The following research question was posed in order to investigate this further: *Residual statements that are not covered by the themes developed through the thematic analysis and content analysis do not contain any statements relevant to the work at the emergency call center during large scale incidents.* The residual codes were analyzed bottom-up by means of a thematic analysis to make sure that no relevant statements were left out of the final themes and that the final themes did in fact reflect all the statements that were relevant to work at the emergency call center during large scale incidents. The analysis of the residuals revealed that these statements did not contain any information that was relevant to the work at the emergency call center during large scale incidents. Hence, the content model is deemed to provide a thorough reflection of work at the emergency call center during large scale incidents.

## Discussion

### Summary of results

The purpose of this study was two-fold. Firstly, the study aimed to identify the factors important to work at an emergency call center during large scale incidents. Secondly the study aimed to investigate whether a model depicting the required qualities of a resilient system was an appropriate framework for the data material obtained through the interviews. The data material consisted of 14 in depth interviews about work at the emergency call center during large scale incidents. A SWOT structure formed the basis for the interviews, probing the interview participants to reflect on current strengths and weaknesses and future possibilities and threats related to work at the emergency call center during large scale incidents. The transcribed interviews were unitized into 3115 separate units of text, each containing a distinct unit of meaning. The entire number of statements was then coded onto a framework bottom-up by means of a thematic analysis, and top-down onto an existing framework. The content model developed through the thematic analysis covered 93.6% of the statements, whilst the resilience framework accounted for 78% of the statements. The content model had 199 residual statements (6.4%), whilst the resilience model was unable to account for 685 statements (22%).

**Thematic analysis.** The first goal of the study was to produce an inventory, referred to as a content model, of the data material in order to answer the following research question: *what are the important aspects of work at the emergency call center during large scale incidents according to the operators who work there?* A thematic analysis was performed,

and resulted in 12 sub-themes covered by 6 main themes. These themes represent the aspects of work at the emergency call center during large scale incidents that were brought up by the operators.

**Content analysis.** The second goal of the study was to investigate whether a model outlining the required qualities of a resilient system was an appropriate framework for understanding the data material. The model was operationalized and the statement units were coded onto the framework. Descriptive statistics representing the frequency of statements in each category were produced. The first part of the model, containing the four cornerstones of resilience, captured 52.4% of the statements. The second part of the model, Influencing conditions, captured 45.2% of the statements. As statements could be coded into both parts of the model, the overlap was calculated. It was found that 19.6% of the statements were captured by both parts of the model. When this was taken into consideration, the resilience model was found to account for 78% of the statements. Out of the 22% of statements that were not accounted for, 15.8% of the statements were captured by the content model and 6.2% of the statements were coded as residuals in both the content and the resilience model.

**Hypotheses.** Hypothesis 1 stated that there would be no significant difference between the total amount of statements and the number of statements captured by the content model. A paired samples t-test revealed a significant difference between the number of statements captured and the total number of statements, with a medium effect size ( $d = .50$ ). Hypothesis 1 was rejected.

Hypothesis 2 stated that there would be no significant difference between the total amount of statements and the number of statements captured by the resilience model. The model consisted of two parts, each containing four codes. Table 3 shows that all the codes contained statements; however the number of statements was not evenly distributed across the codes. Particularly *Learning and Updating* and *Time* accounted for small percentages of statements (5% and 2.9%, respectively). A paired samples t-test was applied to test the relation between the two groups of statements. This analysis yielded a significant result, which implies that there in fact was a significant difference between the amount of statements captured by the resilience model and the total amount of statements. The effect size for this result was also substantive, large according to Cohen's  $d$  ( $d = 1.04$ ). Hence, the hypothesis was rejected.

Hypothesis 3 stated that there would be no significant difference between the statements captured by the content model and the number of statements captured by the resilience model. The t-test resulted in a significant result, implying that there was in fact a

significant difference between the number of statements captured by the resilience model and the statements captured by the content model. Further, the results showed a substantial effect size ( $d = .82$ ), large according to Cohen's  $d$ . Hence, the resilience model is not sufficient in itself to explain the work at the emergency call center during large scale incidents. The hypothesis was rejected.

**Thematic analysis of residual statements.** The final research question that was investigated stated that none of the residual statements contained information that was relevant to the work at the emergency call center during large scale incidents. A bottom-up thematic analysis of the residual statements was performed, revealing that none of the residual statements contained any such information. Hence, the content model is argued to provide a genuine reflection of relevant aspects of work at the emergency call center in connection with large scale incidents.

#### **Comments on the content model and the resilience model**

Next, the results that have been outlined will be discussed and compared to relevant theory and empirical knowledge. The six main themes resulting from the content analysis will be discussed, as well as the four codes from the resilience model that captured the highest number of statements. Finally, the relation between the content model and the resilience model will be discussed. The theoretical implications of the results will also be taken into consideration.

**Results from the thematic analysis.** The six main themes resulting from the thematic analysis had a fairly even distribution of statements, with the exception of *Relations* that only contained 4.3% of the statements. The other themes contained between 15.2% of the statements (*Skills and Competencies*) and 20.9% of the statements (*Operational goals*). A thematic analysis of the residual statements led to the conclusion that these statements did not contain any information of relevance to work at the emergency call center during large scale incidents. Hence, the content model is considered to provide a genuine reflection of this work. In the following, the relation between the results and existing knowledge about emergency management will be discussed.

The first of the themes, *Skills and Competencies*, reflect that the knowledge, abilities and competencies held by the operators is an important factor related to work at the emergency call center during large scale incidents. This corresponds with previous work that has outlined competence and experience as important factors when responding to large scale incidents (Dawes et al., 2004). Knowing how to use technical equipment and communication

tools has been argued to be of importance in a Norwegian context (Andersen, Vigerust & Richardsen, 2012), and this was another aspect of the work at the emergency call center that was emphasized by the operators. Knowledge and competence has also been argued to influence the success of improvisation (Trotter et al., 2011), a form of adaptation has been argued to be of importance to emergency response (Kendra & Wachtendorf, 2006; Mendonca, 2005).

Ensuring a satisfactory level of competency at the emergency call center was argued to rely on recruitment and selection as well as training and exercises. The quality of the workforce and the importance of employing qualified people has been pointed out in a study evaluating the response to the 9/11 terrorist attacks in New York (Dawes et al., 2004). Further, practice and training has been identified as necessary tools to increase preparedness and to deal successfully with unwanted incidents (Andersen et al., 2012; Batho et al., 1999; Dawes et al., 2004; Waeckerle, 1991). Another benefit of practices and drills is that they provide an opportunity for contact across the emergency response units, and hence a possibility to establish relations between the people working in the different emergency response services (Danielsson et al., 2012; Dawes et al., 2004). This was also pointed out by several of the operators.

The next main theme, *Organization of the emergency response services*, reflects how organization, both within and between emergency response services, influences the work at the emergency call center during large scale incidents. The main goal of the emergency response services is to protect lives and health. However, standard operating procedures do not specify how the different emergency response services should cooperate to achieve this goal (Andersen et al., 2012). Collaboration between emergency response organizations is a key factor to successful emergency response (Batho et al., 1999). Previous research related to emergency response has identified challenges related to how the organization of each emergency response service is centered on their own specific goals and that this often counteracts common goals of serving the general population during crises (Dawes et al., 2004). This was also brought up by the operators as a factor influencing their work during large scale incidents.

The possibility of co-location of the emergency call centers in the future was presented as a possible, even likely, change in the organization of the emergency response units by the operators. This has been a topic of public discussion for several decades (e.g. JD, 2004, 2009). Stronger relations between the call center operators from differing emergency response services, more efficient dissemination of information and more experience with working

together across organizational boundaries were presented as possible gains associated with a co-location. Less competent operators and degraded relations within the organization were presented as potential challenges related to a future co-location.

The theme *Resources and support systems* contain statements regarding the influence support systems and availability of resources has on the work at the call center during large scale incidents. The availability of resources was presented as key, and it was argued that a large emergency response service has benefits that smaller emergency response services do not have when it comes to resources. This has also been found to be of importance by other researchers (Dawes et al., 2004). A potential challenge in relation to support systems that was posed by the operators is that these types of technology become necessary to the response, and hence constitute a potential weakness if they for some reason should become unavailable. The potential for failure connected to IT equipment has been pointed out by Mehrortra and colleagues (2008), and large scale disasters such as Hurricane Katrina (Mehrortra et al., 2008) and the 9/11 attacks on New York (Mendonca, 2005) faced challenges related to IT-breakdown.

*Support systems* refers to technological systems aiding the work, and predefined plans and standard operating procedures that assist the operators when they launch the response. Plans have been shown to be of great importance to emergency response (Batho et al., 1999), but it has also been argued that plans often will fail to address all potential contingencies during large scale incidents (Kendra & Wachtendorf, 2006). Previous research argue that plans and standard operating procedures can act as frameworks guiding the interpretation of an incident (Kendra & Wachtendorf, 2006), and that plans and preparedness can act to improve adaptation, much like experienced jazz musicians improvising over a score they know well (Mendonca, 2005). In this sense, plans and adaptations are not mutually exclusive. Predefined response setups were pointed at as highly useful, but the necessity of adaptations outlined in *Operational goals* also entailed the ability to adapt plans. This reflects the notion that plans are frameworks for action rather than step-by-step descriptions (e.g. Kendra & Wachtendorf, 2006; Klein, 2007).

*Relations* was the theme containing the fewest statements. Nevertheless, it was decided that it should constitute a theme in itself. Relations between the responders who cooperate to mitigate the consequences of large scale incidents and accidents have previously been shown to be of great importance (Danielsson et al., 2012; Dawes et al., 2004). Particularly familiarity and knowledge of one another's competence has assisted smooth and flexible solutions to issues where formal procedures are incomplete or absent (Dawes et al.,

2004). Quantarelli (1988) pointed at the challenges related to communicating with people that one has no prior knowledge of during crises and disasters. This was also strongly emphasized by several of the respondents. Shared experiences across agencies responding to disasters has also been argued to support situational awareness (Danielsson et al., 2012), which has been argued to be crucial to decision making and performance in socio-technical systems (Endsley, 1995).

Sharing information is another important aspect with regard to maintaining situational awareness during an operation (Danielsson et al., 2012). The theme *Information and overview* reflect the importance of communicating essential information and maintaining overview of the developments in ongoing situations at all times during large scale incidents.

Communication and information has been proved to be key to successful management of crises and disasters (Quarantelli, 1988), and failure related to communication has been shown to be a recurring problem with regard to the handling of large scale incidents in a Norwegian context (Andersen et al., 2012). Availability of data and information was pointed at as a key challenge in the response to the 9/11 attacks in New York (Dawes et al., 2004). Quality of data, accessibility, usability, ability to share and security connected to the use of data were all pointed out as issues related to accessing the necessary information (Dawes et al., 2004). Lack of systems that allow maps and geographic information to be disseminated across the borders of the different emergency response services was pointed at as a strong disadvantage by the operators. Further, the emergency response services have different policies for sharing information, and one emergency response service may possess information of relevance to the other emergency response services but withhold this information due to internal regulations. This is an example of how organization influences communication and dissemination of information.

The final theme was labeled *Operational goals*. This was the theme that contained the highest percentage of statements (20.9%). This theme reflects the specific actions the operators take to support one another and the on-site personnel during emergency response and the more general goal of responding appropriately whenever necessary. Proactive support to the on-site personnel in order to ensure a smooth operation and adaptation to the current conditions was presented as key abilities by the operators. The management of emergencies and large scale incidents has been described as monitoring the development, implementing pre-defined responses to situations that arise and also to recognize when predefined responses are inappropriate and to adapt the response to the given conditions (Beroggi & Wallace, 1994; Beroggi & Wallace, 2000; Mendonca, 2005), a view largely reflected in the operators'



accounts. Adaptability and the necessary freedom to adapt responses were presented as key factors with regard to the goal of maintaining preparedness at all times. Both adding and withholding resources from the predetermined procedures were pointed at as necessary to respond in a satisfying way and to maintain ability to respond. Flexibility has been shown to be a necessity when facing large scale incidents as standard operating procedures rarely provide complete descriptions of how a response should be performed, and that too much reliance on predetermined plans can lead to inflexibility when faced with unexpected events (Chen, Sharman, Rao & Upadhyaya, 2008). This was reflected by the operators. Prioritization of how resources are distributed is necessary to maintain the ability to respond. This involves determining when it is right to respond, and when it is not right to respond. It also entails establishing additional resources when necessary, factors also pointed out by Chen and colleagues (2008).

**The resilience model.** A content analysis was performed to investigate whether a resilience perspective on safety is an appropriate framework for understanding the work at the emergency call center during large scale incidents as described by the operators. The two codes capturing the largest amount of statements in each part of the model will be discussed. The codes that captured the most statements were related to *Response* and *Attention* (monitoring) of critical aspects of ongoing situations, and also related to having available *resources* and *competence*. *Resources* and *competence* has been argued to be necessary to respond (Hollnagel & Woods, 2006). Madni and Jackson (2009) distinguish between two types of resilience with regard to coping with system disruptions; immediate reaction and long time learning. The distribution of statements in the resilience model suggests that the operators are mainly concerned with immediate reaction when asked to outline the important aspects of work at the emergency call center during large scale incidents. This is reflected in their focus on *monitoring* the given situation and initiating *response*, as well as with having the necessary *resources* and *competence* to respond to and monitor the situation.

In the first part of the model outlining the cornerstones of resilience, the code that captured the greatest amount of statements was *Response*. The response is the measures that are taken to deal with situations that have occurred, and in the context of civil safety it is closely connected with reducing the adverse outcomes that may result from the incidents. The large proportion of statements in this category reflects the fact that dealing with the actual is the most relevant aspect of resilience at the emergency call center during large scale incidents. This code captured 23.8% of the total statements, and is concerned with how standard responses and adapted responses are used in order to deal with unwanted incidents.

Pre-specifying all possible scenarios the emergency call center may have to respond to is an impossible task (Hollnagel, 2008a; Mendonca, 2005; Perry & Lindell, 2003; Quarantelli, 1988). This was also indicated by the operators working there. The importance of having the necessary freedom to adapt the response to the current conditions was pointed out. This is in line with Hollnagel (2008a) who argues that ready-made responses can be insufficient, as there often is a discrepancy between actual situations and situations as imagined. In fact, it has been argued that unvarying performance in complex socio-technical systems can undermine safety (Borys, Else & Leggett, 2009), and that complex and dynamic work environments require judgments from the operators with regard to how and when to perform various tasks (Dekker, 2003). Poorly defined goals and situations require a flexible approach (Klein, 2007). This is not to be understood as advising to throw out all plans and standard operating procedures. Hollnagel (2008a) merely stresses the importance of expecting and preparing to handle incidents that are not expected. In fact, it has been argued that adaptability and preparedness are tightly connected, and that preparation improves the ability to improvise (Gauthereau & Hollnagel, 2005; Mendonca, 2005). The statements that fell into this code reflect the importance of being prepared to take action, both guided by pre-specified plans and by adapting performance to the given circumstances. This is in line with the claim that preparedness also should entail measures that allow for appropriate response even to unforeseen or unspecified events.

*Attention* captured 14.3% of the statements. This category is concerned with monitoring the environment, particularly with regard to developments in ongoing situations. The use of “faint signals” has been argued to be a characteristic of resilient organizations. Faint signals are indicators that might imply pending threats (Westrum, 2006). The importance of recognizing faint signals and to be proactive with regard to response was presented by the operators, particularly with regard to the support provided to the personnel on site and prediction of development in the situation, but also with regard to recognizing information from callers. In an emergency call center context, research has pointed at the importance of early recognition of signals indicating out of hospital cardiac arrest for patient survival (Berdowski et al., 2009). Previous experience from working on-site as first response personnel and professional knowledge of the field of the first response organization was pointed at as important precursors of the ability to recognize more or less faint signals. Identification of symptomatic events and intelligent speculation related to these signals (Hollnagel, 2008a) allow the operators to handle developments in the ongoing situation before they turn into problems and hence to keep things from getting worse, a feature of resilience

(Westrum, 2006). Examples of this can be preparation of resources before they are requested or adapting the resources that are dispatched based on these faint signals. The ability to monitor was also argued to depend on the availability of (human) resources and work pressure. This is in line with Endsley (1995), who argues that dynamic and complex environments challenge the ability to acquire and maintain good situation awareness.

In the second part of the model outlining factors that influence the ability to be resilient, *Resources* captured the greatest amount of statements (21%). Availability of resources has been shown to be of importance to emergency response (Dawes et al., 2004) and to influence the system's ability to stay in control (Hollnagel & Woods, 2006; Madni & Jackson, 2009). This was also argued by the operators, several stated that larger emergency call centers benefited from a higher availability of resources, both human and physical. Availability of resources was also argued to influence the possibility of maintaining overview. Particularly the role of the shift leader at the emergency call center was emphasized, and it was explained that a threat connected to large scale incidents is that the operational commander gets preoccupied with the incidents, and is unable to maintain a complete overview of the ongoing situation(s). This differs from the model of resilient systems that only suggests a relation between *Resources* and *Response* (Woods & Hollnagel, 2006).

*Competence* captured 14.3% of the statements. Competence is defined by Hollnagel and Woods (2006, p. 349) as "knowing what to do, and knowing how to do it". The operators were highly concerned with how the competence of the individual operator influences the work at the emergency call center during large scale incidents, and with the importance of having a background from the emergency response service in question. Experience was pointed at as a key factor with regard to knowing what to do and how to do it during the response to large scale incidents. Lacking the ability to know what to do will deplete another crucial resource during incidents; time (Hollnagel & Woods, 2005). Highly skilled people have a wider range of routines and actions to draw on, allowing a better understanding of a situation and possible solutions that might be applied (Klein, 2007). Competence was also argued to influence monitoring, as it allows for more efficient and directed efforts to identify developments.

### **Residuals and overlap between the content model and the resilience model.**

A cross tabulation outlining the overlap between the statements captured by the content model and the resilience model was generated (see Table 4). This table shows that none of the main themes from the content model were captured completely by the resilience framework.

Relations was the theme that the resilience model was the least able to capture, 59.4% of the statements (79 statements) within this theme were not captured by the resilience model. Information and overview was the category with the second fewest statements captured by the resilience framework, 25% of the statements were unaccounted for by the resilience model. The theme labeled *Organization of the emergency units* also had a relatively high amount of residual statements in the resilience model, 32.4% of the statements within this theme were not captured by the model. The resilience model was able to account for 93.1% of the statements that fell into the theme *Resources and Support Systems*, 90.9% of the statements that fell into the *Skills and Competencies* and 89.4% of the statements in *Operational Goals*. All in all only 15.8% of the total statements were accounted uniquely for by the content model. Seven statements that were coded as residuals in the content model were coded into the resilience framework. This will be discussed further under the limitations section. A discussion of the results and how it relates to existing knowledge has been presented. In the following, the implications of these results will be discussed.

### **General discussion**

It has been argued that prevention is an insufficient approach to safety in complex systems (Hollnagel, 2008a), and large scale incidents do occur from time to time despite our best efforts to prevent them. The ability to respond to such incidents when they occur is necessary to limit the adverse effects they cause. The purpose of this study has been to generate a better understanding of the work at an emergency call center during large scale incidents. This knowledge is a necessary foundation for further work aimed at developing the emergency response, and hence to protect civil safety when these incidents occur. Civil safety is concerned with protecting the public during various levels of strain and entails both preventive and responsive actions. The resilience engineering perspective holds that the ability to stay in control during disturbances is necessary to safety. In other words, civil safety and the resilience perspective are both concerned with proactive and reactive measures taken to maintain safety. Key features of resilient systems are the abilities to anticipate incidents, to monitor potential threats in the near future, to respond to anticipated and unexpected incidents alike, and to learn from incidents that have occurred and update the system accordingly (Hollnagel 2008a, 2011; Hollnagel & Woods, 2006).

This study has provided a systematic and detailed description of work at an emergency call center as accounted for by the operators working there. It has also showed the relevance of a resilience-perspective on safety in the context of work at the emergency call center during

the previously outlined circumstances. The practical implications of the results provided in this study will be outlined in the following section. The results from the two analyses that were performed illustrate that the primary concern of the operators when handling large scale incidents is to cater to the needs that these situations create, to be prepared at all times to handle potential new situations, and with the factors that influence these abilities. In the following, some suggestions will be made with regard to how the ability of the emergency call center to cope with large scale incidents can be strengthened.

Training and exercises have been shown to be of great importance to dealing with large scale incidents (Bartho et al., 1999; Dawes et al., 2004). As disasters are rare, experience and competencies with regard to handling large scale incidents must be acquired through other measures. The benefits of training generic abilities (Bergström, Dahlström, Dekker and Petersen, 2011), and the potential benefits of training to recognize and handle changes in a situation in a flexible manner (Grøtan, Størseth, Rø & Skjerve, 2008; Kendra & Wachtendorf, 2006) has been claimed to be beneficial when preparing to handle incidents in variable and complex socio-technical systems. Training and exercises also serve as a means for testing procedures and plans (Dawes et al., 2004). Another potential benefit of training is that different emergency response services are given the opportunity to get to know each other and strengthen relations, which has been shown to be of importance to emergency response in the past (Dawes et al., 2004). Hence, training and exercises may serve to address several of the areas that are of relevance to the work at the emergency call center.

A key notion to keep in mind when developing plans, drills and exercises is that these may influence the ability to expect incidents outside of that which has been planned (Weick & Sutcliffe, 2007). Responses that are too constrained (e.g. by predefined plans and procedures) might have a negative impact on generation of alternative solutions (Chen et al., 2008; Mendonca et al., 2007), which are important when facing contingencies that differ from what has been planned for (Mendonca, 2005). Planning is necessary to successful emergency management (Batho et al., 1999; McConnell & Drennan, 2006; Perry & Lindell, 2003; Waeckerle, 1991), but it should be taken into account that not all things can be prepared for and that plans need to be complemented by adaptations (Gautheraeau & Hollnagel; Kendra & Wachtendorf, 2006; Mendonca et al., 2007). Being able to adapt to the given conditions was presented as an important aspect of their work at the emergency call center during response to large scale incidents. Klein (2007) has coined the term “flexecution”, and argues that planning and execution of plans is a process that entails adaptation and development of goals and approaches. Further, it has been argued that measures that strengthen the ability of the

operators to adapt and improvise when faced with unexpected events may improve response to large scale incidents (Mendonca, 2005; Mendonca et al., 2007). Hence, the importance of flexibility should be taken into consideration when developing plans, standard operating procedures, drills and exercises. Further, reflection around the influence of organizational culture at the emergency call center on flexible versus rule bound managing of events should be made. Experience from large scale incidents has shown that following standard procedures may be detrimental (Statsministerens kontor, 2012, p. 91), however, fear of negative consequences may cause operators to follow procedures even though they recognize a need to adapt.

Potential co-location of emergency call centers from the different emergency response services was presented as a likely development by several of the operators. In light of the results presented in this study, the importance of maintaining the knowledge and competence held by the operators working at emergency call centers should be taken into account in future organizational changes. Further, availability of resources has been argued to be of importance to response (Bartho et al., 1999; Cutter, 2003; Dawes et al., 2004; Hollnagel & Woods, 2005, 2006). This should be taken into account when staffing emergency call centers. An opportunity related to potential future co-location is that a larger emergency call center will have more resources available. Other potential benefits are closer relations between the operators from the different emergency response services, more efficient dissemination of information and shared situation awareness across the emergency response services. It has been argued that the quality of information that forms the basis for decision making is of great importance (Beroggi & Wallace, 1994). Issues regarding dissemination of information during large scale incidents, particularly across the borders of different response organizations, have been pointed at in the past (Bartho et al., 1999; Dawes et al., 2004) and was also emphasized by the participants in this study. The organization of the Norwegian emergency response services and the call centers was pointed at as one reason why information was not disseminated to a satisfactory degree. More efficient sharing of information across organizational boundaries could benefit emergency management. However, a serious consideration that must be made when developing new tools and systems to share information is the balance between security and privacy and the accessibility of information (Dawes et al., 2004).

Systems and tools that support adaptation and flexibility during emergency response have been presented as a potential benefit with regard to successful handling of emergency situations (Mendonca, Beroggi & Wallace, 2003). When developing support systems and

procedures, it is important to keep in mind that operations during large scale incidents should be as similar to operations during more routine incidents as possible (Quarantelli, 1988). It should also be taken into consideration that technological solutions have the potential to hamper situation awareness by adding complexity to systems (Woods & Sarter, 2010). Technological support systems at emergency call centers should reduce complexity related to the work (Normark, 2002), and usability, tolerance of failures and speed are desired qualities (Furniss & Blandford, 2006; Normark, 2002). Challenges with regard to support systems outlined by the operators were mainly related to lacking alignment across different systems, causing the same tasks to be done more than once and unnecessary loss of time as a result. Lack of time may have a negative impact on the system's ability to respond successfully as it forces the system into a reactive mode (Hollnagel & Woods, 2005, 2006). Better alignment of support systems and easier transfer of information across the systems in the emergency response services can cause a smoother and more efficient operation. Implications resulting from the study have been discussed. In the following section limitations related to the implementation of the study will be outlined.

### **Limitations**

**Participants.** The participants consisted of 14 operators at an emergency call center, which is a relatively small number. However, the operators that participated in the study represented the majority of the operators working at the call center (only 3 operators were unable to participate), and thus the study should provide a thorough representation of the emergency call center that was investigated. The transferability to other emergency call centers might be limited, particularly as the organization of the emergency call centers varies, both between the different emergency response services and regionally within the same response service. According to Yin (2009, p. 4), the aim of case studies is to “understand complex social phenomena”. In this case, it was used to explore the complex socio-technical system the emergency call center constitutes, and to provide a thorough and detailed outline of work at the emergency call center during large scale incidents. A benefit of this approach is that it provides a solid starting point for further research on work at emergency call centers.

**Interviews.** By asking the respondents to reflect on a particular topic, the researcher influences the research participant and it has been argued that the topic under investigation will influence the information resulting from the interview (Potter & Hepburn, 2005). A particular advantage of SWOT-interviews is that the interview participant is probed to reflect on different aspects of the topic under investigation (Hoff et al., 2009). Rather than asking

specific questions, the SWOT-structure allows the interview participant to introduce relevant aspects of the topic under investigation, and limits the influence of the researcher and the research questions. Follow up questions were based on predefined formulations aimed to clarify and elaborate the topics introduced by the interview participant, and this may have led to more attention directed at some topics than others. The interviewers were trained in this interviewing approach and how to ask follow up questions in an appropriate manner, and both had previous experience with performing interviews. Thus, the influence from the interviewers was limited as far as possible. Further, “large scale incidents” were not defined by the researchers, and the participants were asked to answer the research questions based on their own understanding of the topic. Outlining what the operators considered to be a large scale incident is beyond the scope of the study.

**Unitizing.** The unitizing procedure aimed to identify meaningful units of text based on a semantic approach. Complete objectivity of the researcher is not possible (Willig, 2008) The process of identifying single meanings is a process that necessitates interpretation on the side of the person performing the unitizing. In order to ensure that this was done as similar as possible by the two researchers, a unitizing procedure was developed. An inter-rater test was also performed to investigate the similarity between the two researchers, resulting in an agreement of 76.5%.

**Coding.** The thematic analysis was performed as a collaboration between the two researchers. Following the six steps of the thematic analysis outlined by Braun and Clarke (2006) as well as developing a codebook to guide the content analysis contributes to construct validity as they contribute to a chain of evidence. This implies that the process from data collection to final conclusions is made visible to the external observer (Yin, 2009). However, as already argued with regard to unitizing, coding relies to some extent on the interpretation of the interviewer. The content analysis aimed to investigate whether a model outlining the required qualities of a resilient system is able to account for the work at the emergency call center during large scale incidents. The model was not very clearly defined in the original source, and additional literature was applied in order to provide thorough operationalization of the categories. This literature described the same constructs as the model, but the constructs may have been elaborated and developed since the model was introduced. In order to ensure replicability, a codebook was developed. This codebook also clearly states where the interpretations of the model are taken from.

Seven statements that were labeled as residuals in the content model were coded into the resilience framework. This is not thought to reflect that the resilience model was able to



capture aspects of work at the emergency call center that the content model failed to address, but simply to be a result of slightly differing interpretations of the statements during the coding process.

**Analysis.** The descriptive statistics outlining the prevalence of statements in the various themes and categories was used as a basis for discussion and thus used as an indication of how relevant these themes and categories were to the context under investigation. It is possible that this assumption is wrong. Further, the statements were aggregated on a statement level (n= 3115). While this increases the power, it might give an inflated impression of the results. The aim of the study was to provide a representation of the work at the emergency call center, and the variety in the presence of statements in each theme between the operators were not discussed as investigating individual differences was beyond the scope of the study.

### **Future studies**

The aim of this study was two-fold: to generate a fundamental understanding of work at an emergency call center during large scale incidents as accounted for by the operators working there, and to investigate whether an existing theoretical perspective on safety in complex systems was able to account for the previously mentioned work aspects. In order to develop and strengthen the emergency response provided by the emergency call centers during large scale incidents it is necessary to understand the work that takes place during these circumstances.

The study is a case study focusing on one particular emergency call center. Given the fact that the organization of emergency call centers differ greatly both within the emergency organizations due to geographical and local differences, but also between the emergency organizations, future studies should investigate whether the results are applicable in other contexts than the one explored. The study also investigated the work at the emergency call center on a group level. Future studies should investigate whether there are individual differences between the operators with regard to what is considered key tasks during response to large scale incidents.

A resilience perspective on safety was applied and found to be able to account for a large proportion of the statements. However, there was a significant difference between the content model and the resilience model with regard to the amount of statements they were able to capture. Further research should investigate whether other existing theoretical frameworks are able to account for the statements the resilience model failed to capture. As

one of the aims of resilience engineering is to identify the factors that allow systems to be resilient and build them in to the systems, future research should investigate whether relations, organization and information and communication may influence a system's ability to be resilient. These factors were outlined as relevant aspects of emergency work at the call center, but were not well captured by the resilience model.

### **Conclusion**

The study entailed two goals. Firstly, a content model depicting the factors relevant to work at an emergency call center during large scale incidents was developed through a bottom-up analysis of statements regarding this work. This content model is argued to provide a genuine reflection of the work that takes place at the emergency call center during large scale incidents. Secondly, a framework outlining a resilience perspective on safety was applied. This framework was not able to account for all the statements that were captured by the content model, and hence it was judged to provide an incomplete framework for describing all the relevant aspects of work at the emergency call center during large scale incidents. Nevertheless, the resilience model was able to capture a large proportion of the statements considered to be of importance to this work, showing that aspects related to resilience is relevant to the operators and their work during large scale incidents. This study creates a foundation for understanding the contribution of emergency call centers when large incidents occur, and it also links this knowledge to relevant empirical knowledge and theory. Further research should investigate whether the factors outlined in the content model also apply in emergency call centers across geographical regions and across the emergency response organizations. This could serve as a foundation for developing the emergency call centers and to strengthen their contribution to emergency management, and hence to civil safety.

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## **Appendix A**

### **Intervjuguide**

#### **Introduksjon før intervjuet:**

Kort om oss og masteroppgaven.

Vårt samarbeid med SINTEF, som leder BRIDGE-prosjektet.

Kort om BRIDGE: fokus på tekniske og organisatoriske løsninger for å forbedre håndtering av større hendelser.

Har du fått lest informasjonsbrevet?

Og nå kan du signere samtykkeskjema.

#### **Om operatøren:**

Hvor lang erfaring har du som operatør? Her, og evt. andre sentraler?

Hva slags bakgrunn har du? Antall år?

Annet, hva og antall år.

#### **SWOT:**

De to første spørsmålene gjelder nåtid, de to siste gjelder fremtid. Det kan være at du må gjenta noe, det viktigste er at informasjonen kommer frem.

#### **Arbeid på sentralen ved større hendelser**

##### **Nåtid**

- Jeg vil først høre om hvilke styrker ser du ved måten dere på sentralen jobber på ved større hendelser i dag?
- Jeg er fortsatt interessert i å høre om hvordan dere arbeider per i dag, men vil gjerne at du forteller om hvilke svakheter ser du ved måten dere på sentralen jobber på ved større hendelser i dag?

##### **Fremtid**

- Hva mener du på sikt kan være utfordringer knyttet til måten dere jobber på ved sentralen ved større hendelser?
- Hvilke muligheter ser du for måten dere arbeider på ved sentralen i fremtiden ved større hendelser?

**Avslutningsvis:**

Er det noe du vil legge til eller utdype?

Hvordan synes du det har gått?

**Forsterkere:**

Hva mener du med..?

Kan du spesifisere/utdype/forklare hva du mener med...

Har du et eksempel på det?

Du nevnte....., kan du si noe mer om det/utdype det/gi et eksempel på det?

Du har allerede nevnt noen styrker/svakheter/positive/negative sider ved....., hvilke andre S/W/O/T gjelder her?

## Appendix B

### Transkriberingsprosedyrer

#### De overordnede retningslinjer for transkribering er:

1. Tilpasse transkribering til formål med undersøkelsen
2. Konsistens (reliabilitet)
3. Åpenhet (vi beskriver hva vi har gjort)

#### Når det gjelder selve transkriberingen er det disse retningslinjene som gjelder:

- Vi skriver ikke ned navn eller annet som kan identifiseres (F.eks. Hoff et al., 2009). Stedsnavn og andre demografiske identifiserbare data erstattes med [by]/[distrikt] eller lignende
- Vi skriver på bokmål, dvs. ingen dialekt.
- Vi skriver det som blir sagt, men rydder opp i den grammatiske strukturen uten å endre meningsinnhold. (Poland, 1995).
- Vi setter punktum ved naturlige pauser

Pauser, og andre verbale uttrykk som latter, hosting etc. blir ikke markert fordi dette er ikke er relevant meningsinnhold og heller ikke sentralt for formålet med undersøkelsen (Poland, 1995).

- Dersom noe er uklart markeres dette med **uklart tidspunkt** i bold
- Vi frastår fra å gjette/tolke hva som blir sagt (Poland, 1995).
- Vi skriver IKKE inn «Mmm» og «Eh» når dette er markert
- Vi noterer IKKE «...» når en person tenker eller ikke fullfører en setning.
- Ved tilfeller hvor flere snakker samtidig markeres dette med uklart dersom det ikke lar seg gjøre å forså hva som blir sagt, ellers transkriberes det som blir sagt slik at det den ene sier først skrives helt ut for så å transkribere det den andre sier helt ut (heller enn å bryte opp setningene i små og mindre forståelige deler)
- Intervjuer markeres med Int.1 og Int.2, etterfulgt av innrykk
- Respondent markeres med forkortelse for operatør – OP etterfulgt av innrykk

**Tillegg:** Notere et tidsstempel for hvert femte, tiende, femtende, osv. minutt. Tidsstempelet noteres i nærmeste snakkebytte mellom intervjuer og intervjuobjekt (nærmest hvert femte minutt), samt ved begynnelse og slutt av intervjuet. Format (tt.mm.ss)

## Appendix C

### Unitizing Procedure

#### Mål med unitizing:

Målet med unitizing er å isolere meninger fra hverandre. Meningsfulle ytringer må forstås i seg selv. Vi må forme kortest mulige enheter, med deler av eksempel/spørsmål for å klargjøre poenget. Vi vil skille ut hvert enkelt statement som sier noe meningsfullt i seg selv om hvordan operatørene opplever arbeidet ved sentralen.

#### Definisjon meningsfylt ytring:

Så korte utsagn som mulig, men fortsatt meningsfulle. «The best content analyses define their context units as large as is meaningful (adding to their validity) and as small as is feasible (adding to their reliability)” (Krippendorff, 2004, p. 102).

#### En unit er et separat statement hvor man har:

- Tematisk brudd, nye poenger, nye meninger
- Nye aktører
- Nye sider ved saken. Eksempelvis: **Har du vært ute så tar du ting fortere, og [har du vært ute så] er interessert**
- Separate handlinger/operasjoner
- Tidsmessig skifte mellom fortid, nåtid og fremtid.
  
- Vi deler statements så langt det er mulig å dele uten å miste mening for å forme kortest mulig enheter.
- Eksempler og beskrivelser av ting som de er unitizes for seg selv, og nyanseres ved tematisk brudd
- Summary statements unitizes for seg selv
- Dersom et poeng gjentas, skal dette unitizes separat dersom gjentakelsen er meningsgivende i seg selv.

Ved store, generelle temaer lager vi også mindre statements av undertemaer:

- Eksempler er:
  1. Store/generelle temaer: planverk

2. Mindre statements: spesifikke prosedyrer, kartverk, organisering,  
Premisser for et kommende eller allerede uttalt poeng/ytring (eksempelvis  
bakgrunnsinformasjon/kontekst, premisser som understøtter et poeng) unitizes også for seg selv.

- Eksempel: «Vi har [hjelpemiddel].» Hvordan det påvirker samhandling/beslutning blir gjerne utdypet. Premisset/konstateringen unitizes for seg selv for et eget statment, og poengene som følger premisset unitizes også som separate statements. Premisset kan inkluderes i utsagnet for å gjøre det mer forståelig.

### Samme unit når:

- Setningen bindes sammen av «fordi», «dermed», «dersom», «derfor» og lignende bindeord. Hvis det er tematisk brudd på hver side av bindeordet, skal det likevel unitizes hver for seg.
- Hvis «det» eller «da» erstattes med samme ordlyd som foregående setning, velger man å legge alt i en unit.
- Eksempel som kun inneholder ett tema, unitizes som en unit selv om disse kan bli lange

### Gjennomføring av unitizing

- Hele teksten skal fargekodes i enheter, men unntak av det intervjuer sier.
- Les først gjennom transkripsjonen en gang og del opp i units, les deretter gjennom en gang til for å få helheten og sile ut eventuelle «ekstra-units»
- Legg til informasjon fra spørsmål/eksempler i setninger rundt i parentes for å klargjøre meningsfulle ytringer.
- Hvis det refereres til «det/den/dette» o.l., må det eksemplifisere med klamme, for eksempel ved svar på spørsmål må det refereres til deler av spørsmålet stilt.
- Statements som ikke gir mening, f.eks. ufullførte setninger, og statements som ikke er av relevans for analysen, «sola skinner jammen i dag», unitizes på samme måte som andre statements, og kodes som residual.
- All tekst (med unntak av det som ble sagt av intervjuerne og ja/nei svar på oppklarings spørsmål) unitizes.
- Introduksjonen til intervjuet unitizes ikke, unitizing begynner etter første intervju spørsmål og avsluttes etter at informanten har hatt anledning til å utdype eller legge til informasjon etter siste intervju spørsmål.

## Appendix D

### Codebook

A bottom-up thematic analysis was performed based on the framework described by Clark and Braun (2008). After several revisions of the codes, main themes were outlined and the final categories placed under appropriate themes. The unitized statements from the interviews with the operators were then coded on to the following framework, outlining the emergent themes in the data set. Each unit of text was only coded in to one code. Statement units that did not fit in any of the categories are coded as *Residuals*.

#### Theme 1: Skills and competencies

The theme comprises four sub-themes, ‘Characteristics as operator’, ‘Drills and exercises’, ‘Experience and competencies’ and ‘Selection and recruitment’. All statements that this theme capture regards the operators that work at the call center during large-scale incident. The sub-theme ‘Characteristics as operator’ contains personal characteristics that describe the operators, as interest and motivation to do a good job, and their ability to handle stressful situations. The second sub-theme ‘Drills and exercises’ include the importance of and their attitude towards developing and improving their skills. ‘Experience and competencies’ capture the operators’ former experience on the field, both on the field and at the call center, following their knowledge about their own personnel and department as well as knowledge and skills related to support systems and tools. The last sub-theme ‘Selection and recruitment’ capture statements regarding criteria and procedure for selection and recruitment of operators, and challenges related to that. In summary, this theme is concerned with the skills and competencies held by the operator, factors of importance and how to improve them.

##### 1. Characteristics as OP (operator)

- Interest in the work and motivation to do a good job at the call center
- Personal aptitude – ability to handle stress, have distributed attention, and keep calm under pressure and when communicating with callers

**Description:** this code contains topics regarding the operator, and his personal skills and abilities. The operator must be fit to work at the call center, and be able to handle high pressure.



## 2. Drills and exercises

- Train as you fight – always follow the same blueprint when handling incidents, regardless of the magnitude of the incident. No major changes when large incidents occur.
- Always practice procedures
- Practice new procedures
- Drills and exercises – the importance of practicing
- Training- education

*Description:* Topics regarding development and acquiring new skills and competencies. Practicing, learning, developing.

## 3. Experience and competencies

- Experience from operational duty as well as experience as operator
- Knowledge about local area
- Other relevant experiences
- Skilled users of support systems and tools
- Teams composed to contain a wide array of competencies and previous experience

*Description:* The importance of previous experience from operational service, knowledge about the organization of the emergency unit, knowledge of local area, ability to use support systems and tools efficiently, the benefit of teams that consist of operators with different experiences.

## 4. Selection and recruitment

- Practices with regard to recruitment and selection of operators to the call center – relevant criteria for selection
- Challenges regarding recruitment

*Description:* Who should work at the call center, how to recruit candidates. Challenges with regard to recruitment.

## Theme 2: Organization of the emergency units

The theme comprises the sub-theme ‘Organization of the emergency units’. It is a comprehensive theme, and incorporates the organization of the call center, organization of the

department, and the organization of the cooperation between the different emergency departments. Regarding the organization of the call center, the theme captures statements about working-conditions and location, organization of the operators and their shift, and the lack of formal description of the work at the call center. Organization of the department contains how the call centers are located and how they cooperate with each other, and how the organization affects their economy. Organization of the emergency departments concerns the cooperation between the department and how their goals/focus affects the cooperation. It also includes statements regarding a common emergency call center. Finally, inspiration and openness to development of the current state and policies are captured. In summary, the theme is concerned with organization of the call center, and organization inside and between emergency departments.

## 5. Organization of the emergency units

- Organization of the call center:
  - support to other call centers, lack of formal descriptions of tasks at the call center/need for more regulation, time spent solving non-emergency tasks (roles and responsibilities)
  - physical working conditions at the call center, e.g. indoor climate, safety, (physical organization)
  - follow up mistakes/evaluation of near misses at the call center, structures that support learning (organization of learning/development)
  - organization of shifts and influence on availability of operators (organization of resources)
- Organization of the specific department
- Organization of emergency departments: cooperation between the units, different organization of each emergency department, different goals/focus, different procedures and practices, co-location, common emergency call centers
- Organizational development: openness to reorganizing/developing the call center, the departments and organization of emergency departments

**Description:** statements regarding the organization of work at the call center, in the department and in the other emergency departments.

### **Theme 3: Resources and support systems**

The theme comprises the two sub-themes 'Resources' and 'Support systems'. These are conditions that are necessary and make the job at the call center more coherent. The sub-theme 'Resources' contains human and material resources that are available for duty, including both people at the call center and people in the field. Statements regarding strain on resources due to limited resources are also captured by this theme. The second sub-theme 'Support systems' contains technical tools the operators use to support their work, as computer-systems, standard operational procedures and communication network. Strengths, weaknesses, opportunities and threats regarding these tools are also captured by this theme. In summary, the theme is about fundamental conditions necessary to conduct the work at the call center.

#### **6. Resources**

- Availability of resources, human and material
- Number of operators
- Examples of resources
- Strain on resources: replying to unnecessary inquiries, time pressure in the first phase

*Description:* statements regarding the availability of resources that the operators can allocate, the number of operators at the call center and various types of strain on these resources. Examples of resources are also provided during the interviews.

#### **7. Support systems**

- Technical and organizational support systems at the central
- Weaknesses of the systems
- Potential to make work more efficient
- SWOT (involve end users, poor alignment of systems)
- Culture for adapting SOP's and routines\*

*Description:* statements regarding the support systems available at the central. Strengths, weaknesses, opportunities and threats are outlined in this category.

\*General adaptation/development in the organization falls into category 5, specific adaptation/development of routines fall into code 7

#### **Theme 4: Relations**

The theme comprises the sub-theme 'Relations'. This theme contains the importance of relations, particularly the topics trust and chemistry. The operators at the call center develop a relation, in varying degrees, with people they interact with. The theme includes the relations between the operators at the call center, between the operators and others in the department, relations between the emergency departments, and between the operator and the caller. In summary, the theme is concerned with the importance of relations between people.

#### **8. Relations**

- The importance of trust, chemistry and relations
- Relations at the call center – teams at the call center
- Relations in the department – management
- Relations across emergency departments
- Relations to caller

*Description:* the importance of relations

#### **Theme 5: Information and Overview**

The Theme comprises two sub-themes, 'Communication and Information Flow' and 'Overview of ongoing Incidents'. These themes capture statements regarding the following aspects of the work at the central during large scale incidents: Communication between operators, between operators and own department (on site personnel), operator and caller, operator and other emergency agencies and operators and other stakeholders. Further, the theme captures such features as which information to obtain and disseminate, how, why and when to obtain/disseminate it and through whom. The second sub-theme captures topics revolved around maintaining overview of a situation. The content in this sub-theme is concerned with what to maintain overview of, and how to do it. In summary, the theme is concerned with knowing what's going on and knowing what to respond to.

#### **9. Communication and Information flow**

- Important information
- Getting the right/sufficient information from callers

- Information overflow
- Managing information flow
- Guidelines for information flow
- Availability of information within the department
- Availability of information across emergency departments
- Information lost in transfer
- Documentation of information
- Communication – getting information, disseminating/providing information
- Communication with the public and press
- How to communicate in a good way

*Description:* descriptions of information and information flow, and statements regarding communication

#### **10. Overview of ongoing incidents**

- Knowing what is going on at the call center and at the incident site – keep updated, listen/read logs
- How to get overview
- What needs to be monitored
- Knowledge of who does what/automatic distribution of tasks at the call center – implicit knowledge of roles and tasks
- Cooperation – creating situation overview together
- Recognizing cues in the situation/information provided –recognizing important aspects
- Detecting new incidents while large incidents are in progress
- Leader has overview – importance of providing the leader with the opportunity to withdraw and monitor

*Description:* statements regarding the importance of gaining situational overview, how it is done and what is done.

#### **Theme 6: Operational goals**

The theme comprises two sub-themes, ‘Operational Support’ and ‘Ability and Preparedness’. ‘Operational Support’ contains statements that regard the specific work to support goal

attainment during incidents, while the second sub-theme, ‘Adaptability and Preparedness’ contain more general goals of maintaining, improving and developing the ability to respond to and resolve threats and incidents. The first sub-theme contains statements regarding the role of the operators as supporters of the personnel at the incident site. More specifically, statements regarding working as one team with the personnel on site, supporting the leader at the incident site (their own leader), as well as supporting the overarching operational goals and maintain flow in the operation by providing various kinds of support and by pushing additional resources when needed. The second sub-theme contains more general goals of maintaining preparedness and ability to respond. Statements regarding the need to be flexible and adaptive, both in a given situation and in general fall into this sub-theme. In summary, this theme is about knowing how to handle situations that arise in order to achieve the goals of the system.

### **11. Operational support**

- Predict – support – prepare - ease
- Predict development – proactivity – come up with novel solutions
- Reply to requests from operational personnel (on-site personnel)
- Support operational personnel – social and practical support
- Examples of proactive/supportive behavior
- Mutual dependence
- Prepare for action before personnel reaches incident site

*Description:* the support provided by the operators to the staff at the incident site, the operators’ role in the handling of the ongoing situation.

### **12. Adaptability and preparedness**

- Overarching goals (strategic goals) guide the actions taken at the call center – respond to as many requests as possible
- Adapt tasks to goals
- Assess – expect – allocate resources – adapt/prioritize – decide
- Flexibility and adaptation
- Necessary freedom to carry out points above
- Cooperate to achieve overarching goals
- Preparedness – maintain overview of available resources – conserve resources
- Always expect a serious incident – low threshold for response

- Prioritize tasks – redistribute/postpone less important tasks

*Description:* statements regarding how operators work to achieve the overarching goal of responding to the needs of the general public.

## **Theme 7: Residuals**

### **13. Residuals:**

- Descriptions of how things used to be
- Descriptions of the work at the incident site (not related to work at the central)
- Unrelated descriptions of work in other emergency units
- Definitions of large scale incidents
- Unrelated topics
- Responses to clarifying questions from the interview

## Appendix E

### Codebook, the required qualities of a resilient system

The model outlined by Hollnagel and Woods in Resilience Engineering: Concepts and Precepts (2006), describe the four cornerstones of resilience that are necessary for a system to be resilient, as well as the factors that influence these abilities. “In order to be in control it is necessary to know what has happened (the past), what happens (the present) and what may happen (the future), as well as knowing what to do and having the required resources to do it” (Hollnagel & Woods, 2006, p. 348).

#### Part 1: the four cornerstones of resilience (processes)

The operationalization of the categories are based on Hansson et al. (2009), Hollnagel, (2008a), Hollnagel, (2011), Hollnagel and Woods (2006), Pariès, (2011) and Wreathall, (2011). The categories are considered to be value free, which implies that statements are coded into the category both when they indicate lack of and presence of the issue of concern.

##### 1. ANTICIPATION (knowing what to expect)

Dealing with the *potential*, that is anticipating what might occur

This category contains statement units that are concerned with anticipating and identifying future risks and threats, as well as anticipating opportunities. Statements regarding expectation of new incidents fall into this category (both in a general and a specific context), together with statements regarding expectations of changes in the future, and risk and vulnerabilities related to the call center itself.

##### Operationalization of category:

- “Anticipation of developments, threats, and opportunities further into the future, such as potential changes, disruptions, pressures, and their consequences. This is the ability to address the *potential*” (Hollnagel, 2011, p. xxxvii)
- Knowing what to expect (Hollnagel & Woods, 2006)
- Identify key aspects of the future (Hansson et al., 2009)



Statement units that fall into this category:

THINGS THAT HAVE NOT YET OCCURRED, BUT THAT MAY OR WILL OCCUR IN THE FUTURE – statements that deal with anticipation of the future

- Expectation of new events at all times, particularly with regard to maintaining ability to respond at all times
- Anticipating threats and opportunities – statements regarding internal and external threats and possibilities that will or may arise
  - Expectation of future threats to the call center, e.g. terrorism and crime aimed at preventing it from carrying out its tasks, and other changes that will pose a threat to the call center’s ability to function efficiently
  - Expectation of future possibilities, e.g. organizing co-location with other call centers/districts, or other emergency departments
- Expecting new types of challenges due to changes in society
- Conserve resources in order to maintain ability to respond, e.g. recognizing that resources are low, and hence being more conservative with regard to what kinds of inquiries to respond to (e.g. helping people with non-emergencies, not possible when there is much strain on resources)

2. **ATTENTION (knowing what to look for)**

Dealing with what is, or could become, *critical* in the near future

This category contains statements that are concerned with monitoring aspects that are essential to the ongoing situation or operation, both internal and external factors.

Statements that fall into this category regard topics such as maintaining overview of the situations in progress, the shift leader’s role/responsibility to maintain overview, assessing incoming information, knowing what to look for, and provide proactive support to the personnel on site. Statements that are concerned with sorting out and making sense of information and cues that are of essence to the ongoing situations also fall into this category, as well as statements regarding the challenges of attention across emergency departments (fire, health and police).

Operationalization of category:

- “To monitor that which is or can be a threat in the near term. The monitoring must cover both that which happens in the environment and that which happens in the system itself, that is, its own performance” (Hollnagel, 2011, p. xxxvii)
- Recognizing “faint signals” (early indications of problems) (Wreathall, 2011)
- Monitoring one’s own performance (Hollnagel, 2011)
- Monitoring external conditions (Hollnagel, 2011)
- Paying attention to factors that are essential to the operation (Hansson et al., 2009)

Statement units that fall into this category:

THINGS THAT HAVE OCCURRED – DEALING WITH THINGS THAT ARE, OR COULD BE, CRITICAL IN THE NEAR FUTURE

- Understanding what is going on, paying attention to the right things
- Cooperation between the operators to make sense of the situation/recognize signals
- Separating what is critical from what is not. E.g. description of situational cues, determining whether information from a caller reflects a true need for assistance or not
- Maintaining overview at the call center and of the ongoing operations (shift leader has a particular responsibility)
- Recognizing “faint signals”, little signs that are of importance to the operation, e.g. details in the information provided by a caller or developments at the incident site
- Understanding possible development, recognize needs that may or will arise (proactivity)
- Monitoring need for resources at incident site
- Knowing where to search for information, and which information to search for
- Challenges connected to ability to monitor the situation, e.g. retrieve information from other emergency departments

### 3. **RESPONSE (Knowing what to do)**

Dealing with the *actual*, that is handling the things that are going on

This category contains statements that are concerned with the actual response to and handling of incidents and accidents, and the ability to respond to events. Matching the response to the current conditions. Statement units that fall into this category concern topics regarding response. More specifically, cooperation, knowing everyone's responsibility and roles, automated responses, following of procedures and adaptation of procedures. Statements that regard when to respond and when not to respond also fall into this category.

Operationalization of category:

- “Ability to respond to regular and irregular threats in a flexible manner. It is not enough to have a ready-made set of responses at hand, since actual situations often do not match the expected situations” (Hollnagel, 2008a, p. 5)
- “The organization must be able to apply the prepared response such that it matches the current conditions both in terms of needs and in terms of resources” (Hollnagel, 2008a, p. 6)
- Adapt responses to be able to solve unexpected incidents that are not planned for (Hansson et al., 2009)
- Knowing how to respond to regular and irregular disruptions and disturbances either by implementing a prepared set of responses (proactivity) or by adjusting normal functioning (reactivity) (Hollnagel, 2011, p. xxxvii)
- Establish and maintain readiness to respond (Pariès, 2011)

Statement units that fall into this category:

INCIDENTS THAT HAVE OCCURRED – RESPONDING – THINGS THAT ARE DONE

- Not being paralyzed, but take action – examples of actions that are taken
- Knowing how to organize the response – who does what etc.
- Knowing which tools and support systems to use, and how to use them
- Knowing when to follow and when to adapt procedures (when to push additional resources etc.)
- Doing things right, doing things wrong
- Actions taken (entirely or partially) by support systems
- Knowing how to provide callers in need with adequate support and guidance
- Knowing which tasks to prioritize, and which tasks to leave

- Knowing how to back up the personnel on site (information, resources etc.)

#### 4. **LEARNING AND UPDATING (knowing what has happened)**

Dealing with the *factual*, that is incidents and accidents that have occurred

This category contains statements regarding learning and updating of the system, that is the work, best practice, support systems, competencies and knowledge at the call center. This category contains statements related to learning and updating of systems and procedures at the all center.

##### Operationalization of category:

- “The system must constantly update its knowledge, competence and resources by learning from successes and failures – its own as well as those of others” (Hollnagel & Woods, 2006, p. 350)
- “How to learn from experience, in particular how to learn the right lessons from the right experience – successes as well as failures” (Hollnagel, 2011, p. xxxvii)
- “Which data to learn from, when to learn, and how the learning should show itself in the organization – as changes to procedures, changes to roles and functions, or changes to the organization itself” (Hollnagel, 2008a, p. 6)

##### Statement units that fall into this category:

#### EVALUATING AND LEARNING FROM INCIDENTS THAT HAVE OCCURRED

- Updating systems and procedures
- Reviewing accidents and successes in order to improve performance
- Evaluating performance to learn
- Looking out to find new solutions – learning from others
- Updating the system so it stays in sync with the surrounding society/external conditions

RESIDUAL: Factors that do not fit in Anticipation, Attention, Response or Learning or Updating

**Part 2: Factors that influence the system's ability to perform and stay in control (HOW - factors that facilitate the ability to cope with unexpected events):**

The operationalization of these categories is based on Hollnagel and Woods (2006). The categories are considered to be value free, which implies that statements are coded into the category both when they indicate lack of and presence of the issue of concern.

**1. Knowledge**

This category contains statements regarding knowledge at the call center, that is the knowledge of the individual operator and the knowledge contained in the system as a whole. This category contains statements regarding the explicit knowledge contained in the system, and the knowledge of the individual operator.

- The systems “encapsulated experience”, or “model of the world” (Hollnagel & Woods, 2006)
- Requisite imagination; that is the ability to go beyond experience, look for the unexpected and look for more than the obvious (Hollnagel & Woods, 2006)

**Statements that fall into the category:**

- Knowing/understanding what is going on/may happen
- Knowledge of the other operators; skills, strengths/weaknesses
- Knowledge of rules/procedures/actions to take/of the organization/available resources
- Knowledge of the local area
- Knowledge encapsulated in support systems
- Knowledge of typical aspects of emergency situations
- Knowledge of needs/demands at the incident site
- Collected knowledge of the operators

**2. Competence**

This category contains statements regarding the competence held by the operators at the call center, that is statements that concern the operator's abilities to know what to do and how to respond during incidents and accidents. Statements that are coded into

this category are concerned with a) The operators knowing what to do, and b) The operators knowing how to do it.

- Knowing what to do and how to do it (Hollnagel & Woods, 2006)

Statements that fall into the category:

- Experience
- Competence
- Knowing what to do
- Knowing how to do it
- Having the necessary skills to do it
- Examples of how things are done

### 3. Resources:

This category contains statements regarding having the necessary abilities to respond to incidents and accidents. Statements that are coded into this category contain topics such as the availability and importance of resources, both human and material. This category also contains descriptions of resources as assets, e.g. how technological support systems assist in picking out the most readily available resources at all times.

- Actual ability to respond to incidents. Merely recognizing that something is about to happen or happening is not sufficient, the system must also have the necessary resources to respond (Hollnagel & Woods, 2006)

Statements that fall into the category:

- Human Resources, technical resources, material resources, economic resources – availability and dependence
- Examples of resources
- The contribution of resources
- Pressure/relief on resources
- Examples of resources and their use/contribution

**Fourth, independent factor that influence the system's ability to perform and stay in control:**

#### 4. Time

This category contains statements regarding how time influences the work at the call center. Statements that are captured by this category contain information about how issues regarding time are influencing the work at the central, and how it is dealt with.

- Lack of time (Hollnagel & Woods, 2006)

#### Statements that fall into the category:

- References to things that must be done quickly due to time pressure
- The influence of time on work and decision making
- Examples of situations when time is of the essence
- Actions that are taken to “buy” time, adaptations that allow for quicker response

RESIDUAL: Factors that do not fit in any of the influencing factors, Knowledge, Competence, Resources or Time

## Appendix F



### Informasjonsbrev masterprosjekt, november/desember 2012

Takk for at du har vist interesse for å delta i dette forskningsprosjektet. Vi er to masterstudenter innen Arbeids- og Organisasjonspsykologi ved Universitetet i Oslo som skriver oppgaver for SINTEF. I forbindelse med våre masteroppgaver ønsker vi å intervjuere operatører ved sentralen om hvordan de arbeider på sentralen ved større hendelser.

*BRIDGE-prosjektet:* BRIDGE ledes av SINTEF, og er et EU-finansiert prosjekt som har som mål å øke sikkerhet gjennom å utvikle tekniske og organisatoriske løsninger for å forbedre håndtering av kriser og katastrofer. Fokuset ligger blant annet på samarbeid på tvers av etater og landegrenser ved store krisehendelser som terroranslag, naturkatastrofer og industriulykker. Prosjektet skal medføre økt sikkerhet og trygghet for befolkningen i Europa gjennom fler-faglig nødetatskoordinering og ledelse ved storskala akutthendelser. For mer informasjon om BRIDGE-prosjektet, se <http://www.bridgeproject.eu/>.

*Mål med forskningen:* Vi vil se på hvordan du i samspill med dine kollegaer jobber på sentralen ved større hendelser. Formålet er å vurdere prosedyrer og «best practice» og hvordan vitenskapelige modeller passer med disse.

*Hvordan du kan forberede deg:* Vi er interessert i dine personlige meninger og erfaringer når vi intervjuer deg, ikke andres tanker. Vi ber deg forberede deg på følgende spørsmål:

- *Hvilke styrker ser du ved måten dere på sentralen jobber på ved større hendelser i dag?*
- *Hvilke svakheter ser du ved måten dere på sentralen jobber på ved større hendelser i dag?*
- *Hva mener du på sikt kan være utfordringer knyttet til måten dere jobber på ved sentralen ved større hendelser?*
- *Hvilke muligheter ser du for måten dere arbeider på ved sentralen i fremtiden?*

*Deltakelse:* Intervjuet vil foregå på norsk. Vi vil begge være tilstede ved intervjuet, der en intervjuer, og den andre observerer og kommer med eventuelle oppfølgingsspørsmål. Intervjuet vil bli tatt opp på bånd, og deretter transkribert. Dette vil gjøre det lettere for oss å analysere data i ettertid og sikre



korrekt gjengivelse av det du sier. Deler vil også oversettes til engelsk. Vi regner med at intervjuet vil ta ca. 30-45 min

Din deltakelse i studiet frivillig og du kan når som helst trekke deg fra intervjuet og studiet uten å oppgi noen grunn. Du har også rett til å be om at lydopptaker blir stoppet/startet, samt om å slette deler av lydopptaket hvis dette er ønskelig. Sletting av data vil gjennomføres så langt det er mulig. Samtykkeskjema vil bli utlevert til leder torsdag 22.11.12 og distribueres videre til operatørene. Samtykkeskjema signeres i forkant av intervjuene.

Personvern og databehandling: Alt datamaterialet vil bli behandlet konfidensielt i overensstemmelse med det Europeiske databeskyttelsesdirektivet (95/46/EF 1998). Prosjektet har blitt meldt inn til den Norske Samfunnsvitenskapelige Datatjeneste (NSD), personvernombudet for forskning i Norge, og godkjent med referanse 28066. Merk at personopplysninger vil bli behandlet fortrolig og kun vil bli delt mellom BRIDGE-medlemmer tilknyttet SINTEF. Datamaterialet vil bli anonymisert før bruk i analyser. Data vil bli oppbevart på-, og delt gjennom sikre serverløsninger, og tilgang til dataen vil kun bli gitt til medlemmer av BRIDGE prosjektet. Under ingen omstendigheter vil tilgang til den innsamlede dataen gis til utenforstående som ikke er involvert i prosjektet. Data vil bli anonymisert før bruk i rapporter, presentasjoner, publikasjoner, samt i de to masteroppgavene, slik at de ikke inneholder noen opplysninger som kan identifisere enkeltpersoner. I noen tilfeller kan publikasjoner og presentasjoner gjøre bruk av anonymiserte sitater. Ved prosjektslutt i 2015 vil personidentifiserbar data bli slettet. Anonymisert data kan beholdes på ubestemt tid.

Hvis spørsmål angående intervjuene eller masterprosjektene, vennligst ta kontakt med masterstudentene Hilde Brennsund (hildeeb@student.sv.uio.no / 91695703) eller Karoline Etholm (karoliet@student.sv.uio.no / 47482368), eller vår veileder ved Psykologisk Institutt, Universitetet i Oslo, Cato Bjørkli (c.a.bjorkli@psykologi.uio.no / 91609044).

Hvis spørsmål i forhold til BRIDGE-prosjektet og behandling av dataene, vennligst ta kontakt med prosjektleder Jan-Håvard Skjetne (jan.h.skjetne@sintef.no / 22067871 / 93409191)

Vennlig hilsen Karoline Etholm og Hilde Brennsund, på vegne av BRIDGE forskningsteam.

## Appendix G

### Samtykkeskjema for deltagelse i masterprosjekt tilknyttet EU-prosjektet BRIDGE

Ved å signere dette skjema bekrefter du at du har mottatt informasjon om prosedyrene og detaljer rundt prosjektet, at du har fått tilstrekkelig mulighet til å vurdere denne informasjonen, og at du frivillig vil delta i prosjektet. Du vil motta en kopi av dette samtykkeskjema.

- Jeg bekrefter at jeg har lest og forstått "Informasjonsbrev masterprosjekt, november/desember 2012".
- Jeg har hatt muligheten til å vurdere denne informasjonen, og fått tilfredsstillende svar på spørsmål vedrørende forskningen.
- Jeg sier meg villig til å delta i forskningsprosjektet og forstår at min deltakelse er frivillig.
- Jeg forstår at jeg når som helst kan trekke meg som deltaker, uten å måtte oppgi noen grunn for dette.
- Jeg er inneforstått med at informasjonen jeg gir kun vil bli delt mellom medlemmer av prosjektet.
- Jeg er innforstått med at informasjonen jeg gir vil bli behandlet konfidensielt av alle forskerne.
- Jeg tillater at mine svar blir tatt opp på lydbånd.
- Jeg forstår at all data som samles inn vil bli behandlet anonymt.
- Jeg tillater at dere refererer til meg som «operatør ved nødsentral».



NAVN (vennligst bruk blokkbokstaver):

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ADRESSE:

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SIGNATUR til deltaker: \_\_\_\_\_

DATO OG STED: \_\_\_\_\_