Turun yliopisto
University of Turku

MANAGEMENT OF MAJOR ACCIDENTS

– COMMUNICATION CHALLENGES AND SOLUTIONS IN THE PREPAREDNESS AND RESPONSE PHASES FOR BOTH AUTHORITIES AND COMPANIES

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Sarja/Series A-7:2014

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The originality of this thesis has been checked in accordance with the University of Turku quality assurance system using the Turnitin OriginalityCheck service.

ISBN 978-952-249-356-9 (print) 978-952-249-357-6 (PDF)
ISSN 0357-4652 (print) 1459-4870 (PDF)

Publications of Turku School of Economics, Series A

Suomen yliopistopaino Oy – Juvenes Print, Turku 2014

ABSTRACT

Management of major accidents – Communication challenges and solutions in the preparedness and response phases for both authorities and companies

In recent years, there have been several major accidents and near-miss incidents in various lines of business, both globally and locally. This thesis focuses on major accidents that may happen to a company or be caused by a company. The dissertation addresses situations where authorities and companies meet in different phases of management of major accidents. The goal is to create an overall picture of major accident management and particularly the challenges in communication and the flow of information by exploiting expert knowledge. The aim is also to find out what improvements experts suggest concerning management processes in the near future, i.e. over a time span of five years.

In theoretical framework the preparedness and response phases were identified, in both of which there are several challenges in communication. The concrete challenges include inter- and intra-organizational communication, communication with general public, and IT systems. The abstract challenges are related to organizational embeddedness and timing.

A three-round Delphi process was carried out, gathering together forty-eight experts representing rescue and regulatory authorities, company personnel and stakeholders. In the first Delphi round, problem domains in communication were identified. In the preparedness phase, these included the operations of the authorities, companies' preparedness planning, and attitude towards preparedness. Correspondingly, in the response phase problem domains included situation awareness, joint authorities-company rescue drills, and IT systems. In the second and third Delphi rounds, the experts gave their ideas for development and assessed the significance of given topics. Development proposals for preparedness included the idea that authorities should shift the focus in their operations more towards advisory and preventive activities, and developing the interoperability of the IT systems between different authorities. As for companies, experts pointed out the need for a change in attitude towards preparedness, development of backup plans to secure business processes, and developing personnel training to take the perspective of company continuity into account. Regarding IT systems, the experts expressed a clear hope that situational picture systems should enable the sharing of one's own situational picture with the other parties involved.

The Delphi method proved to be a powerful tool in achieving the objectives of the research. The Delphi process gathered people from different backgrounds together on a communication platform and inspired solution-oriented mutual

learning. In addition, in the field of futures studies, the Delphi application moved the Delphi method towards a process of building up each round based on information gathered and carefully analyzed material from the previous round.

Keywords: management, communication, major accident, Delphi method, expert view, expertise

TIIVISTELMÄ

Suuronnettomuuksien hallinta – Varautumisessa ja onnettomuustilanteissa esiintyvät kommunikaatio-ongelmat ja ratkaisuehdotuksia sekä viranomaisille että yrityksille

Suuronnettomuuksien hallinta on varsin ajankohtainen tutkimusalue niin kansainvälisesti kuin meillä Suomessa. Onnettomuustilanteet voivat aiheutua ihmisen toiminnasta, luonnon ääritilanteista tai näiden yhteisvaikutuksesta. Tässä tulevaisuusorientoituneessa väitöstutkimuksessa keskitytään sellaisiin suuronnettomuuksiin, joiden aiheuttajana on yritys tai jotka tapahtuvat yrityksessä. Tutkimuksen tavoitteena on muodostaa kokonaiskuva suuronnettomuuden hallinnasta ja siihen liittyvistä kommunikaatiohaasteista sekä muodostaa asiantuntijanäkemykseen pohjautuvia ratkaisuja kommunikaation parantamiseksi lähitulevaisuudessa viiden vuoden aikajänteellä.

Käsitteeseen suuronnettomuuden hallinta kuuluvat varautuminen ja pelastustoiminta. Suuronnettomuuden hallintaan osallistuu yrityksen henkilöstön lisäksi useita viranomaisia. Näiden yhteistyö edellyttää sujuvaa kommunikointia. Teoreettisessa tarkastelussa tunnistettiin useita mahdollisia ongelmia sujuvalle kommunikaatiolle sekä varautumisessa että pelastustoiminnassa. Ongelmia tunnistettiin sekä organisaatioiden sisällä että organisaatioiden välillä samoin kuin tietojärjestelmissä ja kommunikaatiossa suuren yleisön kanssa. Erityisesti varautumiseen liittyen tulevaisuusorientoitumisen havaittiin olevan keskeistä.

Tutkimuksen empiiriset havainnot pohjautuvat kolmikierroksiseen Delfoi-tutkimukseen, jonka asiantuntijoina oli 48 suuronnettomuuskontekstissa toimivan viranomaisen, yrityksen ja sidosryhmän edustajaa. Ensimmäinen Delfoi-kierros toteutettiin haastatteluin ja siinä pyrittiin tunnistamaan asiantuntijoiden havaitsemia kommunikaatio-ongelmia. Verkkopohjaisena toteutettujen toinen ja kolmannen Delfoi-kierroksen tavoitteina oli löytää ratkaisuja kommunikaation parantamiseksi.

Tutkimuksen keskeisinä tuloksina olivat ensinnä varautumisen ja pelastustoiminnan osalta asiantuntijoiden näkemykset kommunikaation ongelmakohdista, joista merkittävimmät näyttävät pohjautuvan viranomaisten ja yritysten välisen yhteistyön niukkuuteen. Toiseksi, parannusehdotukset kommunikaatioon varautumisvaiheessa, joista esille nousivat muun muassa viranomaisten osalta neuvontaan liittyvän osaamisen kehittäminen ja yritysten osalta johdon sitoutumisen kehittäminen. Kolmanneksi, parannusehdotukset kommunikaatioon pelastustoiminnassa, joista esille nousivat muun muassa yhtenäisten termien käytön lisäämiseen ja pelastusharjoitusten pitkäjänteiseen kehittämiseen.

Tulevaisuudentutkimuksessa usein käytetty Delfoi-menetelmä osoittautui tehokkaaksi menetelmäksi myös lähitulevaisuuteen suuntautuvassa

ongelmanratkaisussa. Keskeinen havainto oli myös, että Delfoin avulla saatiin aikaan toimiva kommunikaatioprosessi erilaisten intressiryhmien edustajien kesken niin, että asiantuntijoiden näkemykset onnistuneesti täydensivät toisiaan.

Avainsanat: johtaminen, kommunikaatio, suuronnettomuus, Delfoi-menetelmä, asiantuntijanäkemys, asiantuntijuus

ACKNOWLEDGMENTS

This dissertation was inspired by the grand old man of the Delphi method, Professor Emeritus Murray Turoff, who also has extensive understanding of management of major accidents. In addition to Professor Turoff, I am grateful to several individuals and organizations for their influence on my work.

First, I wish to express my gratitude to my supervisors, Professor Petri Tapio and Professor Pekka Räsänen. Your support and encouragement as well as the ideas for the theoretical framework gave me the confidence to complete this project. I also wish to express my gratitude to Adjunct Professor Mikko Valkonen and Adjunct Professor Toni Ahlqvist for acting as pre-examiners during this doctoral dissertation. It has been a privilege to receive such constructive comments when finalizing my thesis. I also wish to thank Adjunct Professor Mikko Valkonen for accepting the task of opponent.

The empirical part of the thesis was conducted during SAVE, a joint research project between Ahma Engineers Ltd. and Finland Futures Research Centre. I would like to express my deep gratitude to Antti Kuivalainen, CEO of Ahma Engineers Ltd., for this great opportunity to carry out the project at Ahma. I am also grateful to Mrs. Ira Ahokas at Finland Futures Research Centre for her most valuable help during the project. I also want to thank the adept steering group of the SAVE project and especially the group of experts who shared their most extensive expertise during the Delphi process.

The SAVE project was funded by the Accident Investigation Authority, Boliden Harjavalta Ltd., Elisa Plc., FiCom Ry, Finnish Communications Regulatory Agency, Finnish Safety and Chemicals Agency, Fortum Plc., Kemira Plc., Ministry of Finance, Norilsk Nickel Harjavalta Ltd., Luvata Pori Ltd., Meriaura Ltd., Pori Energia Ltd., Prime Minister's Office, Rescue Department of Satakunta, Sachtleben Pigments Ltd., STX Finland Ltd., Technip Offshore Finland Ltd., Teollisuuden ja Työnantajain Keskusliiton (TT) -säätiö, Teollisuuden Voima Plc., Työsuojelurahasto, and VR Ltd. I would like to thank all of them for making the project possible and also the Turku School of Economics Support Foundation for subsidizing the printing of the dissertation.

I am also grateful to Mr. Esko Salo for helpful discussions when I was planning the project as well as to the Director of Finland Futures Research Centre, Juha Kaskinen, for his encouragement when I started the work. Finally, I want to express my heartfelt gratitude to my family for inspiring me to get the thesis completed!

Turku, 12.6.2014

Kimmo Laakso

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1 INTRODUCTION

1.1 Background

Research into the management of major accidents is becoming more vital, given the high stakes involved. The tsunami in the Indian Ocean after the earthquake in 2004 and hurricane Katrina in the USA in 2005 are examples of major accidents of enormous scale causing huge damage to people and property (e.g. Athukorala 2012; Garnett and Kouzmin 2007). Other major accidents include the Seveso chemical exposure in Italy 1976, the Exxon Valdez oil spill in 1989, the BP Deepwater Horizon oil spill in 2010, and the Tepco nuclear accident of Fukushima in 2011. In these major accidents, communication was an important issue in the organization of the rescue actions (e.g. Funabashi 2012; Kurtz 2013; Lagadec 1987; De Marchi 1991; Weiner, Berg, Gerlach, Grunblatt, Holbrook, and Kuwada 1997). People and organizations have to be prepared for possible accidents in all sectors of society and economic life; it is argued that natural and technological major accidents are becoming worse and more frequent (Coleman 2006; McEntire 2009). We can also expect future accidents to be increasingly large in scale due to the complexity of human society and the ever-growing size and density of urban regions and the built environment (Lichterman 1999).

Accidents can be caused either by natural forces or by human activities i.e. they occur from the impact of a variety of natural and technological hazards and their combinations (Shaluf, Ahmadun, and Said 2003). We must be aware that business can cause danger for the business organization itself and possibly for the community in general. In major accidents the impacts can extend even beyond national borders. This research focuses on major accidents which may affect a company or be caused by a company.

Examples of these kinds of accidents or near-miss incidents in Finland include the explosion at Lapuan Patruunatehdas Ltd. in 1976 with 40 deaths and 60 injuries, the sinking of the passenger ferry Estonia in 1994 with 852 deaths, the Hannu and Tapani storms, which together caused severe power outages, and the near-miss incident in Laukaa Vihtavuori at Forcit Ltd. 2013, where the evacuation of the population of a large area was necessary due to the threat of explosion (Onnettomuustutkintakeskus 1976; Onnettomuustutkintakeskus 2013; The Joint Accident Investigation Commission of Estonia, Finland and Sweden 1997; Wikipedia 2013a; Wikipedia 2013b). In addition, for example, any failure in the electricity generation or distributions system, although primarily a problem

for the businesses involved, could lead to a range of potentially dangerous or life-threatening situations in the community (e.g. Boin and McConnell 2007; Liikenne- ja viestintäministeriö 2009; Puolustusministeriö 2006; Sisäasiainministeriö 2010; Laitinen and Vainio 2009).

Usually a major accident brings together individuals representing different organization cultures that may differ in their communication. In this context, terminological differences also play a decisive role in hindering efficient co-operation. Depending on the individual structures and practices of the respective organizations, different terms are used, which can cause several other communicational issues for cooperation (Ley, Pipek, Reuter, and Wiedenhoefer 2012). The basis of reconciliation is that the different parties understand each other, particularly in a major accident scenario. In order to improve management it is essential to anticipate and be ready for cross-sectoral collaboration with different organizations and different fields of operation.

Our environment is changing: the public sector, economic life, and civil societies and their structures are changing due to globalized business, the network economy, and unprecedented technical development, which have changed also our outlook and modes of operation (Freeman 1993; Malaska 1994; Malaska and Holstius 1999; Roberts and Fuller 2010). Examples of these changes can be seen, for instance in multinational companies which serve us over the internet through overseas help-desk centers, and in long chains of sub-contracted responsibilities, which have also reduced the control of authorities in relation to management of major accidents. A new kind of awareness of potential major accidents means better integration of public and private sectors (National Emergency Supply Agency 2013b; PMO 2011; Valtioneuvoston kanslia 2010). These new collaborative forms, e.g. cooperation with power suppliers and telecom companies, are not the same as in the past when they were almost all publically owned institutions in Finland.

The integration can mean strategic partnerships among multiple organizations with similar stakes in the outcome of tasks (Mankin, Cohen, and Fitzgerald 2004). One of the starting points in the integration process is that the actors should cooperate and understand each other. However, different authorities or companies specialized in their own fields may act differently and use different concepts and terms for the same issue, although the object is the same (Hofstede 1980; Hofstede 2001; Galton and Worboys 2011; Lewis 2006).

In responding to major accidents, especially man-made accidents, the first responders are typically company personnel. Therefore their appropriate action in the situation is very significant. It is crucial that these people can communicate and act as effectively as possible in an emergency. Unfortunately, one of the major communicational challenges in accidents is that company personnel and other civilians are not professionals in the safety or rescue field. Hence, their

crisis communication abilities may be limited. Communication problems are a common occurrence where actors communicate across organizational boundaries (Reuter, Pipek, Wiedenhoefer, and Ley 2012).

Communication plays a key role in major accidents (Kwon, Smith-Jackson, and Bostian 2011b; Manoj and Baker 2007). The Chair of the Accident Investigation Authority in Finland, Veli-Pekka Nurmi, has commented on this point as follows:

> "The situation even in a major accident is never so bad that poor communication and flow of information cannot change things for worse" (Nurmi 2011).

Although the concept of an accident is quite clear, there are many definitions of a major accident. The ILO (1991) defines a major (industrial) accident to be an unexpected, sudden occurrence including, in particular, a major emission, fire or explosion, resulting from abnormal developments in the course of an industrial activity, leading to a serious danger to workers, the public or the environment, whether immediate or delayed, inside or outside the installation and involving one or more hazardous substances. Defmin's (2010) definition of a major accident is the following: "a major accident is an accident that is considered to be especially serious because of the number of killed or injured, damage to the environment or property, or the nature of the accident." Although in the literature, terms like disaster, catastrophe, large-scale accident, and major accident are used to describe events with serious consequences, in this research only the term 'major accident' is used and defined according to the Finnish Law on Safety Investigation:

> *"A major accident* is an accident in which, due to deaths or injuries, the extent of harm incurred by the environment, property or assets, or the nature of the accident, is to be deemed particularly serious" (Laki 20.5.2011/525).

A major accident may be for example:

- A nuclear accident in a country or in a certain vicinity
- A major accident involving hazardous materials
- A major disruption in the supply of energy
- An explosion, fire or other severe accident
- A major aviation accident, a railway accident, sea accident involving passenger transportation or a major traffic accident (Defmin 2010; Castren and Ahola 2006; Prizzia and Helfand 2001; Shaluf, Ahmadun, and Mustapha 2003)

In Finland, there are a great number of companies and sites whose nature of business involves a risk for a major accident. There are about 700 large-scale chemical and explosive establishments including chemicals and explosives plants, oil refineries, pulp and paper plants, paint factories, power plants, water purification plants, ports and many other facilities in Finland. In addition millions of tons of hazardous materials are transported on our roads, by trains, or by ships per year; there are two nuclear power plants and other power plants that may cause a major accident. Trains, buses, passenger ships and ferries (with millions of passengers every year) are also risks for major accidents (Finnish Transport Agency 2013; Kumpulainen, Ryynänen, Oja, Sorasahi, Raivio, Gilbert, and Ylva 2013; Malmsten and Loikkanen 2001; Tukes 2012; Tukes 2013). In addition, cyber threats, which may at least indirectly cause major accidents, have nowadays become more common (Dutt, Ahn, and Gonzalez 2013; Turvallisuuskomitean sihteeristö 2013). The listing certainly is not complete, but it shows that every day there is a risk of a major accident somewhere in the country. Even though some features are similar, this research does not deal with conflict type situations such as wars, civil disturbances, riots, and terrorist attacks (Frösen, Parmes, Koivukoski, Liskola, Mäkinen, Piispanen, Ristaniemi, and Söder 2007).

> *Management of a major accident* is defined as a collective term encompassing all aspects of planning for and responding to major accidents, including both pre-accident and post-accident activities.

Typically, major accidents cannot be managed by an organization on normal daily-based preparedness and resources alone. However, this does not make planning useless. On the contrary, when done properly, preparing for the future serves as an important start-up and network-building purpose. It is important to be aware of what has happened, what is likely to happen, and the consequences of an accident in terms of management. It also has to be possible to form a concept of how damage and threats caused by an accident can be prevented and mitigated as effectively as possible. (Leppäniemi 2011; Rantanen 2003.) Therefore learning and understanding what actually happened before, during, and after an accident is also needed for improving the response processes (Kuusisto 2005; Turoff 2002). Nevertheless, in the event of a major accident, each responding organization must be prepared and have trained and competent personnel to respond effectively and efficiently to the event. A multi-agency response requires coordination and cooperation, especially in relation to decision making and actions (Crichton and Kelly 2012).

Recent decades have witnessed significant increases in the number, scope, and complexity of major accidents and near-miss incidents. The industrialized

societies therefore devote greater attention to preparedness, and in particular to the process of planning how to manage major accidents. It is now generally agreed that operations that are significantly vulnerable to hazards should be required to construct rescue plans; this includes both public sector and private institutions like commercial and industrial companies (e.g. Alexander 2005; Laki 29.4.2011/379; Sisäasiainministeriö 2012; Tukes 2010). In the case of hazardous materials, the operator (often a company), also has the obligation to inform the general public about the threats and measures taken in order to prevent accidents (Directive 2012/18/EU; Walker, Simmons, Irwin, and Wynne 1999).

1.2 Research questions and considerations on the research method

In recent years several major accidents and near-miss incidents have occurred in various lines of business, both globally and locally. This thesis focuses on management of major accidents that may happen to a company or be caused by a company. We must be aware that accidents can occur within business organizations that may constitute danger for the organization in question and possibly for the community in general. Emergency management organizations, including company personnel, are responsible for preparedness and reducing vulnerabilities and also for establishing an effective response. In management of major accidents, the identification of hazards, analysis of threats, development of mitigation and response plans, maintaining of situational awareness and support of response and recovery are all complex responsibilities.

Because of international business, the network economy, technological development, and regulation, the approach to accidents has changed, requiring today more collaboration and coordination between the public and private sectors than in the past. This holds true in general and for major accidents in particular, bearing in mind, that at least in case of man-made accidents, the first responders in the situation are typically company personnel and their appropriate action before the rescue authorities arrive at the accident scene is highly significant.

The purpose here is to emphasize the situation where authorities and companies meet in relation to preparedness for and response to major accidents. The goal of this study is to create an overall picture of the challenges in the communication and flow of information both in the preparedness phase and in the response phase of major accidents by exploiting experts' knowledge. The aim is also to find out what improvements experts in the field would be able to suggest that should be made in the near future, i.e. over a time span of five years. The following research questions were formulated based on the goals of the research:

1. In which domains have there been challenges or problems related to communication and the flow of information in the preparedness and response phases of the management of major accidents?

2. What kinds of improvements related to communication and the flow of information can be made in the preparedness phase of the management of major accidents in the next five years?

3. What kinds of improvements related to communication and the flow of information can be made in the response phase of the management of major accidents in the next five years?

This thesis belongs to the field of futures studies. Futures studies seeks to explore the future in a systematic way (Goldingay and Moynagh 1999). The methods of future studies apply economics, statistics, psychology, and other sciences (Gordon 1992). Futures studies is rooted in an understanding of social interaction and culture (Kaivo-oja, Katko, and Seppälä 2004). The purpose of futures studies is to identify and understand the trade-offs implicit in the various alternatives for development and, if possible, to arrive at some balanced approach to decision making (Cole 1990).

The future will never be completely known or even knowable. The systems that determine what is and what will be are simply too complex, too delicately balanced to allow complete knowledge of their workings (Gordon 1992). Yet, as Gordon puts it, partial forecasting is possible; it usually involves limiting the forecast in time or scope, simplifying and modeling the system and learning from history. In a study, the futurist may i) conceive and describe possible paths, ii) examine particular, probable paths in detail, and iii) express preferences for, and work to implement preferable paths (Amara 1981).

In most general sense, futures studies can be of two types: exploratory, that is forecasts of futures that seem plausible; and normative, that is forecasts of futures that seem desirable (Gordon 1992). Explorative methods project futures analyses forward from the past or present situation. In contrast, a normative approach traces backward from a hypothetical future situation to assess likelihood, timing and consequences of a science or technology, thereby identifying a future desired state and determining developments necessary to reach that future. (Vaseashta 2014.) Both exploratory forecasts and normative forecasts can be produced with quantitative and qualitative methods (Gordon 1992).

There are several communicative future-oriented techniques and methods available, such as scenario planning, future workshops, and the Delphi method. They all allow a group of people to share their ideas concerning the future. Scenario planning, also called scenario analysis, is a method that is used mostly

in long-term planning (Börjeson, Höjer, Dreborg, Ekvall, and Finnveden 2006; Jungk and Müllert 1987; Linstone and Turoff 1975b; Schwartz 1996). The future workshop is a futures technique, which enables a group of people to develop new ideas or solutions for social problems. A future workshop is particularly suitable for participants who have little experience with processes of creative decision-making, and it is often used in order to involve citizens in the planning process. (Kuusi, Bergman, and Salminen 2013.)

The Delphi method is a method for collecting experts' knowledge and presumptions on the issue or the development process under study in an interactive and iterative process. The Delphi method has been used in a variety of ways for example in government, business, and education (Stitt-Gohdes and Crews 2004). Delphi is often seen as a forecasting procedure because of its significant uses in that area. A distinction is made between Trend Delphi, Policy Delphi, and Problem-Solving Delphi. (Tapio, Paloniemi, Varho, and Vinnari 2011; Turoff and Hiltz 1996; Turoff 2009a; Turoff 2009b). Policy Delphi works toward discovering the strongest pro and con arguments about differing resolutions for a specific policy issue. Trend Delphi first deals with a specific trend that is of concern to the group, and participants then project where they believe the trend will go in the future. (Stitt-Gohdes and Crews 2004.) There are a variety of application areas for Delphi in problem solving, for example:

- Developing causal relationships in complex social phenomena
- Distinguishing and clarifying real and perceived human motivations
- Exposing priorities of personal values or social goals
- Innovating solutions to the problems
- Delineating the pros and cons associated with future policy options
- Evaluating effects of regulation on certain phenomena or industry
- Clarifying effects of organizational cultures on behavior of institutions (Laakso 2011; Linstone and Turoff 1975b; Lilja 2013).

In order to find the answers to the research questions of the thesis, the method chosen for this research is the Problem-Solving Delphi, because it is widely applied as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem (Gordon 2011; Linstone and Turoff 1975c). In addition to its future orientation, there are other advantages of the Delphi method for finding solutions to communication problems: for example, its ability to take into account tacit knowledge and experiences of the experts. Furthermore, the Delphi offers the experts the possibility to learn from other experts during the iterative process (Linstone and Turoff 1975c; Lilja, Laakso, and Palomäki 2011). The Delphi method is discussed in detail in chapter 3.

1.3 Structure of the thesis

The thesis is composed as follows (Figure 1). Management of major accidents, the phases of management and various concrete and abstract challenges in communication related to management of major accidents are discussed in the theoretical framework (Chapter 2). The features and phases of the Delphi method are discussed in more detail in Chapter 3 and applied to the empirical study of the management of major accidents in Chapter 4. A three-round Delphi study was carried out with interim reports as feedback to the experts between the rounds.

Figure 1 The structure of the thesis

The findings of the first Delphi round of identified problem domains of communication are presented in Chapter 5. The findings of the second and the third Delphi rounds concerning preparedness for major accidents in the future are presented in Chapter 6. Correspondingly, in Chapter 7, the findings concerning

the response to major accidents in the future are presented. The last chapter, Chapter 8, includes a summary of key results of the research, methodological considerations, and the concluding theoretical interpretation of the results.

2 THEORETICAL FRAMEWORK

2.1 Management of major accidents

Extreme events create a need for the command and control of mobilizing and managing several organizations and the need to ensure broad coordination and communication. Diverse organizations must achieve technical and organizational interoperability requiring common understanding, while absorbing and interacting with rescue organizations and company personnel (Harrald 2006). Most major accidents pose recurrent response challenges. Due to the magnitude of the damage or at least potential damage, they are not the sole problem of one agency or organization. On the contrary, the involvement and collaborative effort of a large number of actors is required, whose ways of working may sometimes differ for various reasons (Figure 2).

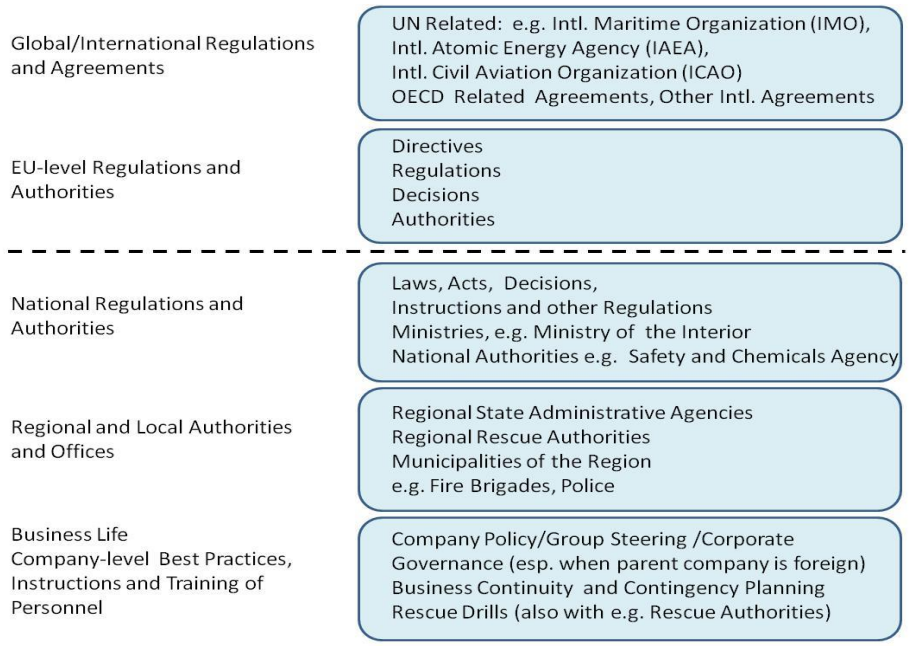

Figure 2 Management of major accidents: Regulations, Agreements, and Actors

In this thesis the following points of Figure 2 are worth noting:

- There may be different types of actors attempting to cope with major accidents.
- Several levels of regulations and agreements, from global to local, have to be followed, some of which are sometimes contradictory, and also all of which use terminology that is not necessarily the same as that used in the others (Alexander 2005; Birkland and DeYoung 2011; Valtonen 2010).
- Several authorities have to be able to share information with each other and with companies and the general public. Difficulties may stem from losses of higher echelon personnel because of over-work, conflict regarding authority over new accident tasks, and clashes over organizational jurisdictional differences (Quarantelli 1988; Taitto 2007).
- Businesses, as well as authorities, need to be able to communicate effectively inside the company and with the authorities, but also with neighboring companies and the general public. In this research, the special focus is on major accidents related to companies. In addition to regulations, companies may have group or company policies to follow, all of which may have a detrimental effect on communication with other actors (Laakso 2012a; Laakso and Palomäki 2013). Business vulnerability to major accidents stems from a variety of interrelated factors that include physical location, the conditions under firms operate, and business and community characteristics. Vulnerability thus has both physical and social dimensions; and just like communities and households, businesses are differentially vulnerable to accident impacts (Tierney 2007).
- In case of major accidents, communication to the general public is also essential (Boin and 't Hart 2010; Palttala, Boano, Lund, and Vos 2012).
- Each organization has its own way of doing things and its own structure of command and responsibility. It is difficult to change this in favor of coordination with other organizations (Palttala, Boano, Lund, and Vos 2012).

These regulations, actors, and various lines of business may have different terminologies, concepts, and ways of doing things, which are clearly seen for example in jargon used only in a certain line of business or even on a certain site of a company (Laakso 2012a; McMaster, Baber, and Duffy 2012; Reuter, Pipek, Wiedenhoefer, and Ley 2012). However, when actors belonging to different organizations communicate with each other, they need to have common procedures at least at some stage and use a common language so that the relevant information can be reliably transferred from actor to actor. This would entail for instance determining a conceptual description of most typical accident situations for locating the overlapping areas of communication between different actors, and the meaning of common linguistic terms related to these situations.

Additionally, critical points and ways to manage them could be found, for example by researching the presumptions and views of organizations and the experts representing the different actors involved. (Comes, Wijngaards, and Schultmann 2012; Galton and Worboys 2011; Laakso and Palomäki 2013.)

It is important to note that accidents always involve the interaction of physical extremes (perhaps tempered by human negligence or carelessness) with socio-technical systems. The relationship between the size of the physical forces unleashed and the magnitude of the human suffering and other losses that result is not always proportionate. Chains of adverse circumstances or coincidences can turn minor physical event into a major accident; see Figure 3. (Alexander 2002.)

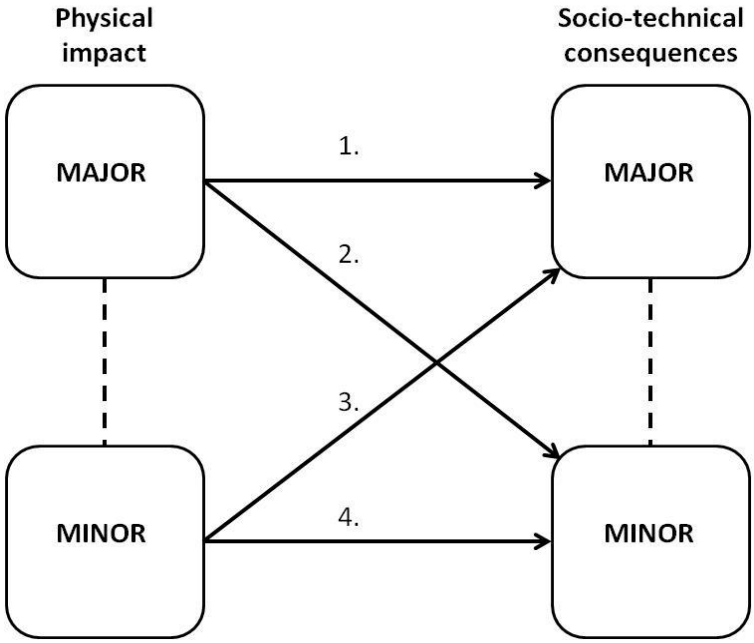

Figure 3 Relations between physical impact of an accident and its socio-technical consequences

The tsunami that occurred in the Indian Ocean after the earthquake in 2004, the earthquake of Sendai and the subsequent tsunami, and the nuclear accident of Fukushima in 2011 are examples of accidents of enormous scale (Arrow 1 in Figure 3). If a minor earthquake causes an unstable bridge to collapse, the consequences will be different if the bridge is unoccupied (Arrow 4) or if vehicles transporting hazardous materials are on it (Arrow 3). On the other hand, a major earthquake in the middle of a desert far from human civilization may have minor consequences (Arrow 2). It is not always obvious at the outset whether a seemingly minor event might be the initial phase of a larger, rapidly growing threat. However, a minor physical event can also lead to a major

accident if circumstances combine unfavorably for instance as a result of human misunderstandings, which is one of the issues highlighted in this research (Arrow 3).

2.1.1 Phases of management of major accidents

Major accidents typically consist of three stages. The stages can be classified into pre-, during and post-accident stages. Management of major accident is a collective term encompassing all aspects of planning for and responding to accidents, including both pre-accident and post-accident activities. (Shaluf 2008.) Given that at least some major accidents tend to be repetitive events, a cycle may be formed that can be divided into the phases of mitigation, preparedness, response, and recovery including reconstruction; see Figure 4 (Alexander 2002; Jaques 2007; Morrison and Oladunjouye 2013; Waugh and Hy 1990).

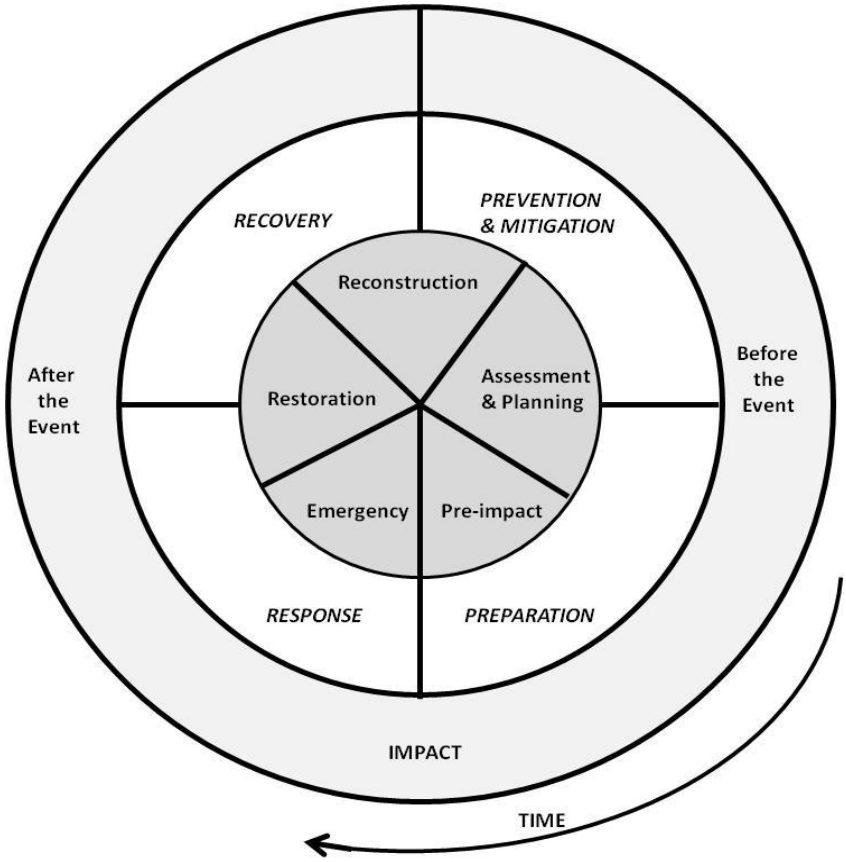

Figure 4 The four phases of management of major accidents

The first two phases occur before the accident and the last two during and afterwards. The cycle of management of major accident is thus an open-ended process.

- *Prevention and Mitigation* comprise actions designed to reduce the impact of future accidents (e.g. land-use planning and evacuation planning)
- *Preparation* here refers to actions taken to reduce the impact of accidents when they are forecast or imminent (e.g. execution of evacuation)
- *Response* refers to actions taken both during the impact of an accidents and the short-term aftermath (e.g. safeguarding human lives and actions of the fire service)
- *Recovery* is the process of repairing damage after accident has struck (e.g. restoring services and reconstructing facilities) (Alexander 2002.)

The four phases are cyclical and overlapping, requiring collaborative participation, and the involvement of diverse expertise and organizational units (Alexander 2002; Walle van de and Turoff 2008). Identifying hazards, analyzing threats, developing mitigation and response plans, maintaining situational awareness, and supporting response and recovery are complex responsibilities.

Major accidents require a coordinated response across agencies and jurisdictions, sectors of society, business, etc. (Department of Homeland Security 2008). In this research prevention, mitigation, and preparation are treated together, and are called preparedness. The preparedness and response phases are both of interest in this research. In particular preparedness is closely linked to futures oriented thought. Although recovery is not the focus of this research, it is also possible to apply some findings of the study in planning for recovery. In a broader view, mitigation, preparation, and prevention are all parts of preparedness. Preparedness within the field of management of major accident can best be defined as a state of readiness to respond to any kind of accident. Preparedness is not only a state of readiness, but also a central theme throughout all the aspects of management of an accident. No accident management organization can function without a strong preparedness capability. This capability is built through planning and training. (Shaluf 2008.)

2.1.2 Preparedness phase

Futures oriented preparedness is essential for an effective response in any community and company likely to be affected by a major accident. Preparedness means determining what preventive and protective measures can and should be

taken before and at the time of an accident (Turoff, Hiltz, White, Plotnick, Hendela and Yao 2011). Preparedness practices are pre-impact actions that provide the human and material resources needed to support active responses at the time of the hazard impact. A step in preparedness for the public sector and businesses is to use threat analysis to identify the threats due to natural forces or business processes, and the geographic areas and population segments at threat. Then, based on the threat analysis, accident plans will be made, facilities and equipment will be acquired, and rescue drills performed (Lindell 2013.)

Planning how to respond to accidents is an integral part of good business practice for all organizations (Office of First Minister and Deputy First Minister 2002). Planning to deal with accidents that primarily affect the ability of organizations to do business is called business continuity planning and it could be argued that there are fiscal, political, and potentially ethical arguments why continuity planning should be performed (Lindstedt 2008). It is a key element in creating a resilient society and is closely linked to wider civil protection arrangements (Northern Ireland Civil Service 2011; OECD 2009). As one of the main parts of business continuity planning, threat reduction involves an examination of the actions necessary to decrease the detected or projected levels of danger and to identify the resources required for implementing those actions (Perry and Lindell 2003).

Business continuity planning involves not only planning to respond effectively when an incident occurs, but also involves identifying critical business processes, reviewing risks to business continuity, reducing those risks, taking steps to reduce the effects on business of events outside the organization's control, and planning to respond to events in such a way as to maintain critical business processes and ensure a quick resumption of normal services (National Emergency Supply Agency 2013a; Pauchant, Mitroff, Weldon, and Ventolo 1990; Tiedemann 1992; Turoff 2009). Nowadays it is more than obvious that most operations are dependent on the electricity and IT networks. Both the authorities and the business sector have to create sufficient backup systems in their contingency plans for unexpected situations like power and telecommunications outages. (Casti 2012; Pauchant, Mitroff, Weldon, and Ventolo 1990; Shreeves and O'Brien 2013.)

Preparation and planning enable the management of the whole life cycle of a potential accident, the determination of capability requirements, and help stakeholders to learn their roles. This includes gathering and analyzing intelligence and information, as well as the developing of policies, plans, procedures, mutual aid and assistance agreements, strategies, and other ways of carrying out tasks. Planning improves effectiveness by clearly defining the capabilities that are required, shortening the time needed to gain control of an incident, and making the exchange of information about a situation easier.

(Department of Homeland Security 2008; National Emergency Supply Agency 2013.; Gillespie and Collignon 1993.) In order to create and maintain sufficient response capabilities, the systematic training of teams and organizations, in both the public and private sector, are needed. It is also important to evaluate and make improvements continuously to existing preparedness plans. Therefore the actions taken in preparedness must be a continuous process (Perry and Lindell 2003; Turoff, Hiltz, White, Plotnick, Hendela and Yao 2011).

One important aspect of preparedness is its close connection with regulation. Planning must be compatible with the legal instruments that mandate, facilitate, or regulate it. (Alexander 2002.) However, regulation itself is often developing gradually and sometimes there has been a severe accident, which fosters the development. For instance in Europe, awareness regarding hazardous materials and concern about major accident hazards grew considerably after the major accident in Seveso in Italy 1976, and encouraged the process for a European framework of regulation. This built on existing initiatives, and is enshrined in the "Seveso" directive and its successors. The regulations are aimed at the harmonization of prevention and protection measures regarding major accident hazards all over Europe, from risk assessment practice, to implementation of safety measures, to public information dissemination, to promotion of public participation, and encouragement of land-use planning. Growing attention has since been paid to social and technical aspects of risk prevention, management, and communication. (De Marchi and Ravetz 1999.)

Regulation of major accidents involving dangerous substances began with the Seveso I Directive in 1982. The objective of the current Seveso II and the new Seveso III directive is to prevent major accidents caused by chemicals and restrict the consequence of such accidents. The directive gives the member states the rules which they should follow when implementing the directive in national legislation (Directive 1982/501/EEC; Directive 96/82/EC; Directive 2012/18/EU). Accordingly there are several national level laws and statutes concerning authorities and the business sector preparedness; in Finland e.g. Law on Rescue, Law on Land-Use and Construction, Act on Preventing Accidents Caused by Dangerous Substances, Act on Supervision of Handling and Store of Dangerous Substances, and Decision on Preventing Workers from Major Accidents (Asetus 21.8.2008/541; Asetus 20.12.2012/855; Asetus 3.5.2011/406; Laki 5.2.1999/132; Laki 29.4.2011/379; Päätös 23.9.1999/922). Changes in directives have also contributed changes to for instance the Act on Chemicals, Law on Transporting Hazardous Materials, Law on Nuclear Safety, Law on Radiation, Law on Land-Use and Construction Act on Land-Use and Costruction, Act on Transporting Hazardous Materials, and Act on External Rescue Plans, to mention a few (Asetus 12.7.1993/675; Laki 2.8.1994/719;

Asetus 10.9.1999/895; Asetus 13.3.2002/195; Asetus 3.5.2011/406; Laki 11.12.1987/990; Laki 27.3.1991/592; Laki 5.2.1999/132).

In addition, lots of lower level regulations exist, e.g. instructions issued by the Finnish Ministry of the Interior, Ministry of the Environment, Safety and the Chemical Agency, Finnish Transport Safety Agency, and Ministry of Transport and Communications (Trafi 2012; Tukes 2010; Tukes 2011; Sisäasiainministeriö 2012; STUK 1996). Accordingly there are corresponding regulations for railway stations and ports (Liikenne- ja viestintäministeriö 2004; Liikennevirasto 2010). Other countries have corresponding regulation and regulative authorities with slight differences (Department of Homeland Security 2008; Crichton and Flin 2001; Laszcz-Davis, Akers, J. Nardi, Buckalew, Gibbs, Jabara, Lebourgeois, McHaney and Pereira 2001; Northern Ireland Civil Service 2011; Waugh and Streib 2006). There is a tiered approach to the level of controls: the larger the quantities of dangerous substances present within an operation (company), the stricter the rules.

The obligations placed on operators are determined according to the scope of their activity. According to regulation e.g. in Finland, companies shall take all necessary measures to prevent accidents and to limit their consequences to people, the environment, and property. The companies also have to make sure that the personnel of other companies working in the production facility area have sufficient information on the operations of the facility, the related threat factors, and preparedness for them. For instance at production facilities where the handling and storage of "hazardous chemicals" may cause a major accident, the company must compile a document in which the operating principles to prevent major accidents are listed or a safety report where the operator indicates the operating principles to prevent and restrict major accidents and provides the necessary information on the organization and safety management system required to implement them.

The principle is that businesses at risk of a major accident are obligated to assess their business, make risk analysis, and prepare rescue plans. In Finnish regulation, a rescue plan prepared by a company is called an internal rescue plan (Tukes 2011). Depending on the quality and quantity of substances processed and stored at the plant, the company is also obligated to prepare a major accident prevention policy (MAPP) or a safety report with possible major accident scenarios and risk analysis, and planned prevention and intervention measures (Tukes 2010; STUK 1996). In these documents a company demonstrates that the major accident prevention policy and a safety management system are in effect, that major accident threats have been identified and adequate steps have been taken to prevent them and limit the potential consequences, and that adequate safety and reliability is incorporated in all aspects of the plant (Gilbert, Aho, Ahonen, Wood, and Lähde 2012, 6).

Based on a company's internal rescue plans and other documentation, rescue authorities are respectively obligated to prepare an external rescue plan (Sisäasiainministeriö 2012). The purpose of these kinds of regulated obligations is to ensure that both industry and local rescue authorities set up appropriate response procedures and plans. Depending on the nature of business, these plans and procedures are subject to observation and assessment, often by independent scrutiny; however, this in itself does not necessarily ensure that the required human factors, or non-technical skills, are practiced (Crichton and Flin 2001). In Finland, for instance the Chemical and Safety Agency makes regular observations on the chemical industry, but also some storage activities, explosives manufacture, nuclear sites and other types of industries, where threshold quantities of dangerous substances identified in the regulations are kept or used (Lax 2012). Correspondingly the Nuclear and Radiation Agency works closely with nuclear power plants (STUK 1996).

The achievement of preparedness takes place through a process of planning, training and practicing accompanied by the acquisition of equipment and apparatus to support necessary actions (Gillespie and Collignon 1993).

In conclusion, sufficient preparedness and inter-organizational communication is fostered by the factors that promote trust in other organizations and familiarity with how they function, including informal contacts, common planning and training, preplanned agreements for the division of responsibilities, and the use of similar terminology, procedures, and performance criteria. It cannot be stressed enough that one of the most important ways in which response organization members can get to know and trust each other and become familiar other organizations work is during shared planning and training activities.

2.1.3 Response phase

The response phase is entered when prevention efforts fail and fateful events trigger an accident. At this point, organizations shift their resources and efforts to minimizing damage to the people, facilities, and environment. Communication in the response phase includes conveying ongoing events to stakeholders, decision making within the accident management team, and organizational decisions regarding whether and what amount of information to share. (Hale, Dulek, and Hale 2005.) Managers need to make decisions, often with important consequences, despite pressures of stress and time. To implement adequate mitigation measures, managers must make sense of the situation even though information may be lacking, uncertain or conflicting. Additionally, managers are confronted with redundant or irrelevant information causing information overload (Comes, Wijngaards, and Schultmann 2012).

Information connected with a place and time and in which the situation is described as reasonably as possible (using an image, voice, text, etc.) in order to know what has happened or is happening and which persons or objects the incidents may concern, is called situation awareness (Leppäniemi 2011; Ashish, Eguchi, Hedge, Huyck, Kalashnikov, Smyth and Venkatasubramanian 2008). Clear situation awareness is a key factor for the effectiveness of rescue operations (Turvallisuus- ja puolustusasiain komitean sihteeristö 2012). Situation awareness is based on the compilation of information collected from the different teams of responders. The building up of such awareness relies on the exchange of information and on providing the right information at the right time. Decision-making in the management of major accidents can be simplified to find the answers to the following questions:

1. What has happened and what is happening?
    a. To whom and to what?
    b. Where and when?
    c. Why?
2. What should be done now and next?
    a. When?
    b. Where?
    c. By whom?
    d. What must not happen?
    e. Why?
3. How can we collect the necessary resources available for the actions required?
    a. When?
    b. Where?
    c. By whom?
    d. What for?

Several different versions of situation awareness concerning the same situation may be needed for different agents (Kuusisto 2005). Situation awareness requires the continuous monitoring of relevant sources of information regarding actual and developing incidents. Kuusisto reports clearly the challenges caused by the parties taking care of different tasks, by the organization cultures, and division of responsibility areas. The content of the information required for situation awareness varies during the accident but also depends on the level of tasks in hand. Figure 5 illustrates the three main levels of tasks of authorities at a major fire accident (Northern Ireland Civil Service 2011).

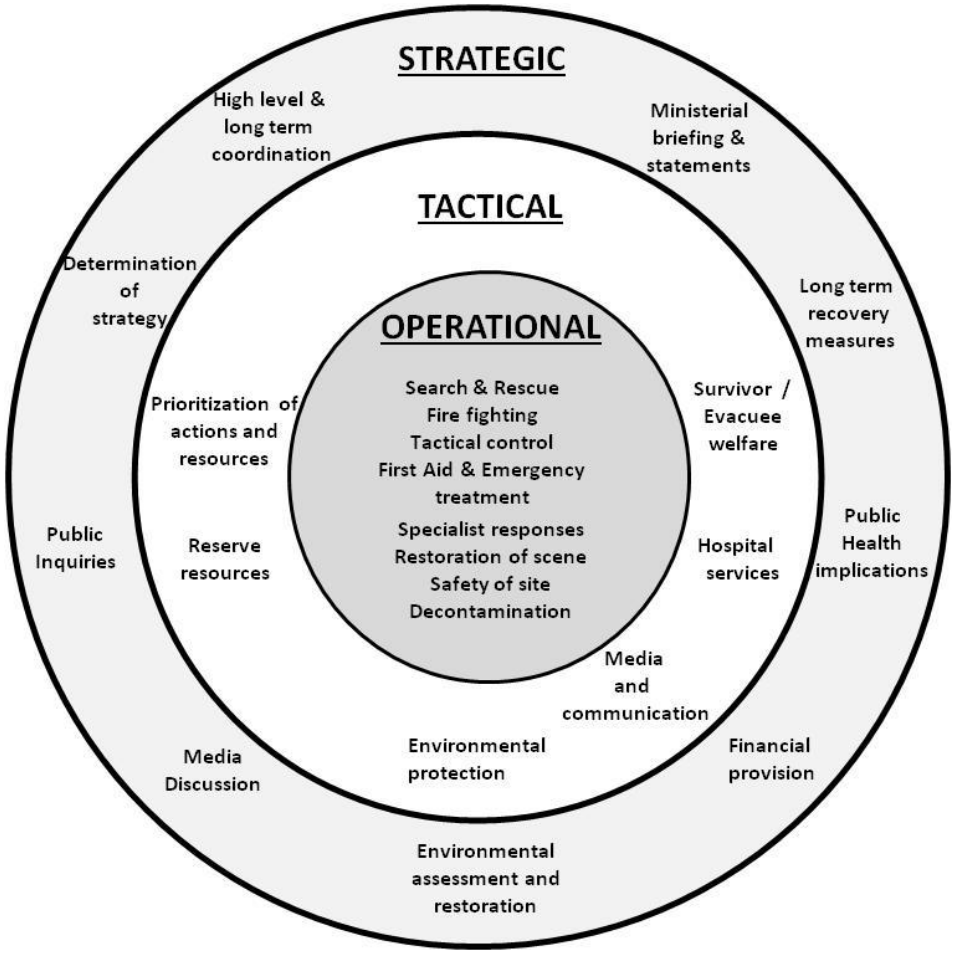

Figure 5 Example of the levels of tasks in a major accident

Strategic level management involves establishing policy, determining strategy, anticipating requirements, and making senior command decisions. In major accidents, strategic management is responsible for coordinating and forging effective communication and collaboration among preexisting and ad hoc networks of public, private, and sometimes international actors. (Boin and 't Hart 2010.) Inter-agency management and coordination at strategic level would include establishing common policy frameworks for tactical and operational level staff, sharing and redistribution of resources, agreeing prioritization of immediate, medium-term and long-term demands for action and resources, joint strategic planning for recovery, review of responses and any follow-up policy action at inter-agency level. This level of management would be needed only in

very large or complex accidents. (Northern Ireland Civil Service 2011.) The strategic functions are focused on the overall higher-level coordination of the accident rather than the lower-level functions of the other control commands. The strategic functions include the longer-term activities, such as the formation of strategy, the assessment of environmental impact, public health concerns, and longer-term recovery measures. The strategic functions include interaction with government and other high-level bodies. (Leppäniemi 2011.)

Tactical level management provides support for the operational response, including administration and staff management facilities, ensuring the safety of operational staff and providing situation reports for senior management and press officers. (Leppäniemi 2011.) Tactical management transmits accurate, timely and actionable information upward, outward and downward within the response structure, as well as to relevant citizens and communities, designed to enable these actors to make informed response decisions within their respective domains of involvement. Inter-agency management and coordination at the tactical level includes managing sets of tasks to which a number of organizations contribute, determining priorities where resources are limited and providing mutual aid in order to address priority tasks. (Boin and 't Hart 2010.) Tactical functions cover the supporting activities to ensure that the tactical operations are coordinated and executed effectively and with consideration to prioritization, efficiency, and safety. Tactical functions also include co-ordination activities and the dissemination of information to the tactical teams, as well as providing briefings to the media. Tactical functions co-ordinate hospital services, compile casualty figures and deal with evacuees from the accident area. Collection of information and evidence is also facilitated by these functions. (Leppäniemi 2011.) A tactical level response is usually only necessary where there is more than one incident or site, where a particularly large or complex response is required or if decisions need to be taken as to priority and the best means of proceeding. (Northern Ireland Civil Service 2011.)

Operational level management deals with the activities being undertaken at an accident site and is primarily task-oriented. It includes mobilizing and organizing, i.e. soliciting the types and levels of operational resources necessary to meet the demands of the situation in a speedy yet orderly fashion, and deploying them in a timely and orderly fashion. Many day-to-day accidents (like small fires) are dealt with at this level, without the need to invoke any other management arrangements. (Northern Ireland Civil Service 2011.) The operational functions cover the immediate response and the longer-term clean-up activities at the location of the accident. Operational control commands the securing of the accident area, provides e.g. the immediate fire fighting and the initiation of the search and rescue tasks. Triage and treatment of casualties are undertaken at the location. Special response teams, including immediate

decontamination and environmental teams, work at the operational level. (Leppäniemi 2011.) Inter-agency management and coordination at operational level ensures that different organizations work harmoniously and safely together and that all priority tasks are addressed using available resources. (Boin and 't Hart 2010.)

The management of a major accident does not follow automatically from planning. Successful management of major accident results primarily from the activities of rescue organizations. In particular, there tend to be management problems with respect to the communication process, the exercise of authority, and the development of coordination. (Quarantelli 1988.) Because of their differences in organizational titles, organizational structures, training, experience, and legal authority, managers frequently experience severe difficulties in communicating with each other and coordinating their responses to the accident (Lindell 2013; McEntire 2002; Seppänen and Valtonen 2008).

Multi-agency rescue drills provide opportunities to learn specific features of other organizations, test plans and improve proficiency in a risk-free environment. Drills also clarify and familiarize personnel with their roles and responsibilities. Well-designed drills improve inter-agency coordination and communications, highlight capability gaps, and identify opportunities for improvement (Department of Homeland Security 2008). Well-designed rescue drills for major accidents should include multidisciplinary, multijurisdictional incidents, and require the participation of both public sector authorities and private sector businesses.

2.2 Concrete challenges in communication

Major accident in a company creates a need for the managing several organizations and the need to ensure broad coordination and communication. Rescue organizations and company personnel involved must have mutual understanding, while absorbing information and interacting with each other. (Harrald 2006). Major industrial accidents, environmental jolts, occupational hazards, and pollution incidents that arise within companies are often characterized by low-probability but high-consequence events and threaten not only one organization but also have external consequences (Mitroff, Pauchant, and Shrivastava 1988).

The nature of major accidents requires managers to conduct decision making in stressful situations involving information overload and a significant level of uncertainty (Schaafstal, Johnstonb, and Oserb 2001). Such situations often call for non-routine, complex problem solving. Communication between the actors involved has a key role in the case of a major accident, i.e. real-time, effective

decisions are required of experts collaborating on management and response, because without effective response, outcomes can be catastrophic, with more dire consequences than expected or experienced previously (Turoff, White, Plotnick, and Hiltz 2008).

Since major accidents are not the sole problem of any one agency or organization, problems associated with challenges in communication are evident in several different categories of organizational behavior. As Quarantelli (1988) describes it, certain intra-organizational behavior and behavior between organizations which cause challenges for flow of information and communication with each other as well as with the public. Nee (2001) and Svedberg (2003) explain the challenges by interrelated rules and norms that govern social relationships, comprise the formal and informal social constraints that shape the choice-set of actors; these will be discussed in the following sections. In addition, IT systems form an essential part of the collection, computing and sharing of information (Dantas and Seville 2006; Leidner, Pan, and Pan 2009).

When organizational communication is considered, the following aspects can be distinguished: firstly, the horizontal level within one organization; secondly, the horizontal level between organizations; thirdly, the vertical levels inside one organization; fourthly, the vertical, or perhaps more accurately, mixed levels between organizations (Laakso and Palomäki 2013). It is important to be able to react promptly in the face of an accident - the members of an organization must know how to alert, trigger the rescue organization, send tactical forces to the scene, take dear decisions, and coordinate (Boin and Lagadec 2000). At their best, well-trained organizations are equipped with quality leadership, plans, and other necessities including communicational aspects (Lagadec 1997).

2.2.1 Intra-organizational communication

The importance of communication is its ability to get people to work together on a common task or to coordinate toward a common goal (Quarantelli 1988). Lanne (2007) emphasizes cooperation and close interaction inside the company between the top management, safety and security personnel, line management, and workers. Especially public organizations tend to prepare for known and expected contingencies, but the administrative toolbox for routine disturbances has only limited use in the face of major accidents (Lagadec 1997). This is not to say that companies would be better prepared; effective management of all organizations depends on the principles and processes that assure flexibility and a smooth flow of information; formal structures play a facilitative role at best (Boin and 't Hart 2010). There is a continual exchange of information in normal

situations within organizations. Communications are normally expected to go through certain channels. In non-accident situations, the flow of information in both public and private organizations follows the usual organizational chain-of-command. However, during a major accident, the flow of information throughout the organization becomes more complex. For example, it is quite common for several individuals to hold a position previously (before the accident) occupied by one person; for officials to take on non-routine tasks; or for officials to be placed in temporary positions within the organization. These factors can result in situations whereby the normal channels of communication are insufficient to ensure that all group members are kept informed of relevant matters. (Quarantelli 1988.)

Totally different situations are the ones where organizations' normal communication channels or internal early warning systems are ignored (Pearson and Mitroff 1993). Murray Turoff (Turoff 2012) gives an excellent analysis of a case when the vertical communication inside an organization went seriously wrong in the management of a major accident using the BP Deepwater Horizon oil spill as an example. The crucial points of Turoff's analysis can be summarized as follows:

1. The top executives in the company did not understand the technologies that the company was dependent upon.
2. The top executives did not listen to the views of the professionals in the organizations who did understand the technologies involved.
3. The top executives claimed they did not influence the decisions of the professionals.
4. The principal advisors to the Chief Executive Officer were made up of lawyers, public relations specialists, and finance specialists.
5. No single person, or organization, was in charge of the decision process that led to the major accident.
6. The responsibilities were not handled properly: passing the buck; passing the risk; passing the blame; subcontracting responsibilities.
7. Organizations ignored problems. "Organizational monkeys: see no problems, speak no problems, and hear no problems."
8. Evidence was ignored where it existed and when it contradicted the chosen views.
9. The organizational history and its contradiction with public pronouncements were ignored.
10. Those who had to execute rescue plans were not included in the group which had created the plans.
11. Plans were not reviewed thoroughly and thus they were not realistic.
12. What happened after the start of the accident was ignored.

The information flow through a line organization in question as described by Turoff can be presented as in Figure 6 below (see Laakso and Palomäki 2013).

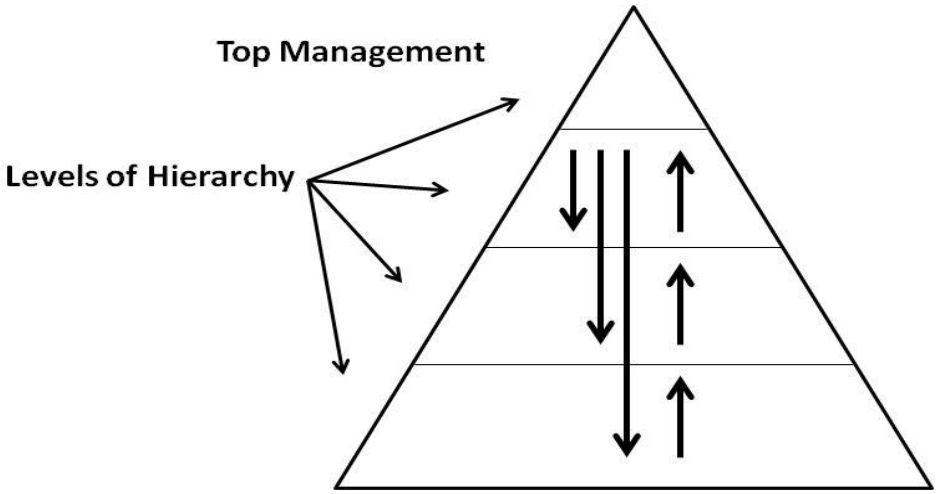

Figure 6 Flow of information through a line organization

Additionally, as Bozeman (2011) points out, in the BP case too, the wide diffusion of responsibility is problematic. While everyone agrees, including BP, that the prime contractor is ultimately responsible for outcomes, how is it possible to exercise effective monitoring when working with another company's technology, leased from a third party, engineered by a fourth?

However, it should be noted that the most important factor in a major accident is that all the actors have reliable situation awareness. Situation awareness is in fact an empirical, psychological phenomenon occurring in the mind of the individual. Several different versions of the situation awareness of the same scenario may be needed for different agents. The forming of situation awareness for the management is a challenge for authorities, companies, and other actors like volunteer organizations. The successful management of a major accident is based both on the existence of practical situation awareness and on rescue operations being carried out in due time. It is possible to be prepared for some accidents as well as practicing for some major accidents beforehand. However, it is not possible to practice for all accidents in advance. (Laakso and Palomäki 2013; Mitroff 1988; Walle van de and Turoff 2008.)

In order to take effective action in a major accident involving different actors who are expected to work smoothly together, more attention should be focused on the situations where their communication takes place (Laakso and Palomäki 2013).

Preparedness planning can be very helpful in alerting and making the relevant officials and company representatives aware of to the kinds of problems likely in intra-organizational informational flow. However, the huge number of potential combinations and contingencies means that managers have to be creative during accidents in working out. Consequently, drills and training on how to be creative and imaginative under such circumstances would be more useful than detailed plans. (Quarantelli 1988.)

2.2.2 Inter-organizational communication

The definition of coordination is to align our actions with those of other relevant actors and organizations to achieve a shared goal. This means effective collaboration between rescue authorities and non-governmental organizations (Granot 1997). However, several research and accident investigation reports have shown that such collaboration is often not achieved; for instance Kapucu (2006) studied the relationships that emerged between public, private, and nonprofit organizations following the 9/11 attacks and he concluded that effective decision making had been hindered by limited coordination and inter-organizational communications. Similarly, the concluding report on the July 22 2011 attack in Norway stated that the rescue authorities were unable to communicate and coordinate their efforts effectively (22. Juli-komisjonen 2012; Eide, Haugstveit, Halvorsrud, and Boren 2013). Also, in networked organizations, shortcomings both in the management systems and inter-organizational communication are reported to be risk factors in the flow of information (Lepistö 2004).

The capacity to coordinate in turn depends on effective communication. Unless the communication processes elicit sufficient shared understanding among the parties to align their priorities for action, the changes of achieving a common action framework among multiple actors will be jeopardized. (Comfort 2007.) Under normal circumstances, employees from different organizations will often communicate informally, since they are often familiar with one another socially or through work. However, when a major accident occurs, especially among authorities formal contacts are to be established often with previously unknown employees within organizations (Quarantelli 1988). A major accident produces the conditions whereby the rate of communication increases, as does the proportion of horizontal task communication; it sometimes creates extreme environmental uncertainty for organizations (Dynes and Aguirre 2008). In fact, it is normal for groups to be interacting with groups whose very existence was unknown before the accident. Given this, a formal flow of information between persons unfamiliar with others in strange organizations, will be difficult to initiate and maintain. (Quarantelli 1988.) There may also be a reluctance to

depend on other organizations, often due to a lack of trust or familiarity, or for various reasons such as jurisdictional, and personal disputes.

Some degree of inter-organizational integration is necessary in order to achieve a common understanding. In this context, integration can be defined as follows: "the making of changes in the functional activity arrangements, organizational structures and systems, and cultures of combining organizations to facilitate their consolidation into a functional whole" (Pablo 1994). As such, integration involves managerial actions taken to secure the efficient and effective direction of organizational activities and resources toward the accomplishment of common organizational goals.

In major accidents, it is often hard to distinguish between communication difficulties and coordination difficulties, and the greatest coordination difficulties are inter-organizational (Quarantelli 1988). Marks and Mirvis provide an integration framework that focuses on the desired cultural "end-state" for the entity and the path to reach this (Marks and Mirvis 2010). They identify different integration approaches, depending on the degree of change required in two organizations. Firstly, when only a minor cultural change between two organizations is desired, it can be considered as a stand-alone or preservation acquisition. In this case, the degrees of change for both organizations are low; they will retain their independence and preserve their cultural autonomy. Secondly, if one of the organizations dictates the terms and the other conforms to them, it is called cultural assimilation. Thirdly, if both organizations find new ways of operating, it is termed cultural transformation. A selective combination of the most appealing features of the two organizations is called cultural integration.

In order to take effective action in an accident involving different actors who are expected to work smoothly together, more attention should be focused on the situations where their communication takes place. There is no point trying to make any great changes to organization cultures and possible different usage of language, except when the communication takes place with actors belonging to another organization. Accordingly, a minimal degree of change for organizations is proposed so that they can retain their independence and preserve their cultural autonomy. Joint authority-company rescue drills may offer opportunities for organizations to learn each other's ways to act in certain situations. In addition, it should be possible to discover possible differences in the terminology used during drills.

When dealing with major accidents, heterogeneity is ubiquitous in management informatics. Major accidents are characterized by their complexity and the diversity of the available information (Galton and Worboys 2011; Comes, Wijngaards, and Schultmann 2012). There are various names for entities, process rules, sensor platforms, information systems platforms, data and

communication formats, organizations, and even languages. Such heterogeneity can hinder an effective response. As proposed by Galton and Worboys (2011), an ontology that can provide unified definitions of entities, their properties and relationships, and thus facilitate improved communication in the presence of heterogeneity, would be one solution to this problem. Valtonen (2010) argues that different authorities often define a given term differently. In Finland there have been attempts in harmonizing terminology like the Preparedness and Civil Defense Glossary, Fire and Rescue Glossary, and Glossary of safety and health at work (Jolkkonen 2006; Sanastokeskus 2006; Sanastokeskus 2009). However, there is no mutual agreement as to who has the responsibility for the collection and dissemination of various types of information, or to whom it should be distributed.

Inter-organizational communication and teamwork relies on information sharing. Networked organizations need to ensure inter-organizational communication through proper instructions for all participants (Lepistö 2004). As well as a common understanding of the situation, those involved need to know when they possess critical information that is needed by someone in another organization, how to get it to the other person, and as discussed above, how to use terminology that the other person will understand. Consequently, rescue drills that involve various agencies serve for obtaining knowledge about how other organizations function and leads to the fostering of communication and coordination between different organizations. (Palttala, Boano, Lund, and Vos 2012; Palttala and Vos 2012.)

2.2.3 General public

In the management of major accidents, the actors involved need to report up, down and sideways. The communicating practice must be resolute; since information search and distribution time is limited and as such, the process should be highly focused and yet comprehensive. Each actor involved in the response needs to take responsibility for specific information needs and then undertake a comprehensive gathering of information. (Leidner, Pan, and Pan 2009.)

Because one of the most important elements to achieve this goal is to make the general public aware of and prepare them for an upcoming situation, information flow from organizations to the general public is essential (Rantanen, Sillberg, Saari, Leppäniemi, Soini, and Jaakkola 2009). After a major accident it is important that authorities inform the general public as soon as possible in order to e.g. prevent the panic reactions (Nurmi 2006, 36-66). Rescue authorities need to communicate with the external environment, directly or through the media

(Boin and 't Hart 2010). Warnings to the broad population in a major accident, irrespective of location and condition, are a public policy responsibility (Pau and Simonsen 2011). In this respect, the mass media are considered an important and fastest channel to inform the public (Palttala and Vos 2012). Until recently, the great communication revolution entailed a shift from secrecy to openness. By now the requirements are well understood and even respected: the media should receive information quickly, press conferences need to be held, and actors must be available and cooperative with the media (Lagadec 1997).

Information flow from the public to different organizations, especially to the authorities, is essential as well. However, too many phone calls, text messages, e-mails, or simply too much information creates information overflow, which particularly at the time of impact may sometimes be overwhelming (Quarantelli 1997).

2.2.4 IT systems

Well functioning IT systems are mandatory in the management of major accidents for rescue personnel in order to achieve situation awareness in response, and require timely connection to data resources from different actors while maintaining security of information that should not be shared (Comfort 1994; Lundberg and Asplund 2011). Major accidents, especially those having macro-level social and economic impacts, typically involve multiple private and public organizations and agencies working together to achieve resolution (Turoff, Chumer, and Walle van de 2004). Therefore the coordination of collecting, synthesizing, interpreting, and communicating information across the multiple organizations becomes a central challenge in response (Dantas and Seville 2006; Leidner, Pan, and Pan 2009).

Despite technological advances, the interoperability of the information and decision support systems of the various parties remains a difficult task (Linna, Leppäniemi, Soini, and Jaakkola 2009). One definition for interoperability is "the ability of systems, units, or forces to provide services to, and accept services from, other systems, units, or forces, and to use the services so exchanged to enable them to operate together effectively" (Kwon, Smith-Jackson, and Bostian 2011a). The fact, however, seems to be that different IT systems are not interoperable (Leppäniemi 2011).

Clear situation awareness is a key factor for effective operations during a major accident. It is based on the compilation of information collected from different teams of responders. Building such a picture relies on exchanging information. The ideal would be to share the same data model and provide a large common database. (Henriques and Rego 2008.) However, the process of

gathering and disseminating information during major accident often results in unacceptable delays in accident resolution: for example, it has been reported that during the response to hurricane Katrina in the United States, key decision makers tergiversated in the presence of information that they felt was too sparse or too difficult to interpret rather than acting quickly to minimize the repercussions of the accident (Dearstyne 2004; Leidner, Pan, and Pan 2009). On the other hand, individuals, under information overload cannot absorb all the required information and sometimes make vital mistakes when performing their primary tasks due to missing important information (Kwon, Smith-Jackson, and Bostian 2011a). This kind of duality of information impedes response. On the other hand decision makers need to gather information to assess the scope and nature of the accident prior to response. And on the other hand they need to reduce information and communication channels in order to respond quickly, often ignoring important information as a result. (Leidner, Pan, and Pan 2009; Turoff 2002.)

Thus, both the absence and the presence of information pose challenges during response, resulting in a tension between the need to act and the need to gather information (Hale, Dulek, and Hale 2005; Leidner, Pan, and Pan 2009).

Decision support systems, carefully designed and implemented, can assist public and private sector managers in reducing the vulnerability of their communities to hazards (Comfort, Sungu, Johnson, and Dunn 2001). Inter-organizational radio networks, common mapping systems, and computer networks contribute to effective communications. However, the communication infrastructure might be damaged or overloaded during accidents, with the additional problem of radio systems of different actors which are not interoperable. (Leidner, Pan, and Pan 2009; Turoff 2002.)

There are also severe external threats, cyber threats, to IT systems, which have to be taken care of (Liikenne- ja viestintäministeriö 2009; Mintc 2011; Turvallisuuskomitean sihteeristö 2013). Cyber attacks may cause disruptions in the normal functioning of computers and the loss of private information in a network due to malicious network events (threats), and they are becoming widespread (Dutt, Ahn, and Gonzalez 2013). For example, hackers and disgruntled employees can exploit both security and application level vulnerabilities and can break into organizational databases and gather confidential information (Mukhopadhyay, Chatterjee, Saha, Mahanti, and Sadhukhan 2013). Controlling cyber threats will require a variety of new networks: networks between different authorities, networks between authorities and private institutions, and networks of authorities across national borders (Broadhurst 2006).

2.3 Abstract challenges - Organizing resources, communication, and timing in management of major accidents

2.3.1 The role of organizational embeddedness

Effective collaboration and communication require making sense of what has happened and what is going to happen; placing things in the right frameworks, comprehending, constructing meaning, interacting in pursuit of mutual understanding, and patterning (Weick 1995, 5). Authorities or companies specialized in their own fields act and communicate differently or use different concepts and terms for the same issue, although the object domain is the same. Some of this may be explained by cultural differences or differences in organization cultures (Carver and Turoff 2007; Hofstede, Hofstede, and Minkov 2010; Lewis 2006). There are numerous studies dealing with the impacts of cultural differences between different countries, religious or ethnic groups on cooperation between two groups (e.g. Hofstede, Hofstede, and Minkov 2010; Kanungo 2006); but less of this research on the differences between two organizations with the same national, ethnic, and religious background.

Coordination difficulties may originate from a lack of consensus among organizations, working on common but new accident-related tasks, and difficulties in achieving overall coordination in major accidents (Department of Homeland Security 2008). Organizations here can be seen as “small societies” or “institutions” with their own particular cultures, influencing the behavior of the members of the organizations (Litwinenko and Cooper 1994; Pauchant and Mitroff 1988; Smelser and Swedberg 2005).

Even though the common goals of the authorities and companies are to guarantee the safety of human beings and to prevent or minimize material damage and help recover the functioning of resources, there may be differences in the interests of each actor. The fundamental interests of authorities may differ from those of companies (Collins 1992; Nee 2001). Individuals’ and organizations’ behavior as part of a larger economic system in certain circumstances may depend on or be influenced by social relations (Granovetter 1985; Granovetter 1992a; Granovetter 1992b).

One concept on behavior on the individuals and institutions has been presented by Burt (2003), who is refers to "structural holes" indicating that it is easier for us to communicate with individuals we feel close to us. The structural hole between two organizations does not mean that individuals in the organizations are unaware of one another. It only means that individuals are focused on their own activities so that they do not attend to the activities of individuals in the other organization. (Burt 2003.)

Granovetter's conceptualizations of social embeddedness and networks offer an ideal basis for understanding relations between the actors involved in the management of a major accident. As Granovetter describes it, there is a distinction between an actor's immediate connections and more distant ones, situations that he also describes with the terms relational embeddedness and structural embeddedness. (Granovetter 1985, 485-510; 1992a; 1992b.)

In the event of a major accident, actors A, B, and C are alarted to work together, i.e. to respond to an accident (Figure 7). Actors A are individuals belonging to organization A having immediate connections with each other, representing Granovetter's relative embeddedness. They also have connections, but more distant ones, with Actors B and C, i.e. individuals belonging to organizations B and C, which here may be referred to as structural embeddedness or organizational embeddedness.

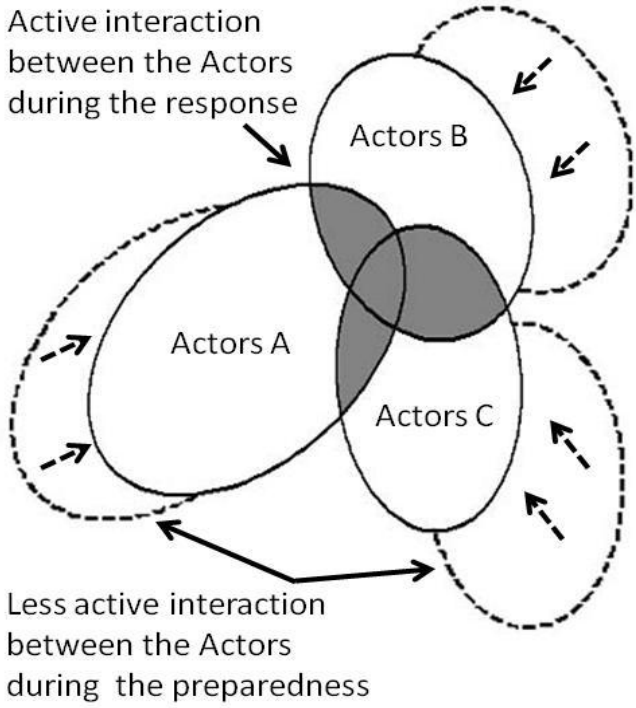

Figure 7 Organizational embeddedness in management of major accidents

In the preparedness phase, individuals of organizations A, B and C do not interact actively although they certainly may know each other and may meet for example yearly during rescue drills. The situation is quite different during response (shaded area in Figure 7), where they need to have active interaction if they want to solve the situation. Based on Granovetter's ideas on social

embeddedness and networks, it is understandable that, during the response phase, individuals within organization A can communicate with each other with fewer difficulties compared to communication with individuals of organizations B and C because those two organizations have different backgrounds, organization cultures and ways of doing things. In summary, in an ideal case, individuals in different organizations would get to know each other and each other's organization cultures enough in the preparedness phase so that the interaction and communication proceeds without difficulty in the response phase where time is often a very scarce resource.

2.3.2 Past, present and future – Concept of time in management of major accidents

Despite all efforts deployed to prevent incidents or accidents, accidents will occur. As defined earlier, management of major accident is a collective term encompassing all aspects of planning for and responding to accidents, including both pre-accident and post-accident activities. Also, effective communication in an accident begins long before an event occurs and continues after the immediate threat has receded, i.e. communication covers all the phases of management of major accident from pre-accident prevention and preparation strategies and response to post-accident containment and evaluation strategies (Dardis and Haigh 2009; Palttala and Vos 2012).

There are several interpretations of the definition of time. McTaggart (1908) presented what he termed the A and B series (Figure 8). Series A events are classified into past and future events that are separated by the present fleeting moment. Series B events are fixed according to time, before and after a certain year or moment of time. (McTaggart 1908; Kaivo-oja, Katko, and Seppälä 2004.)

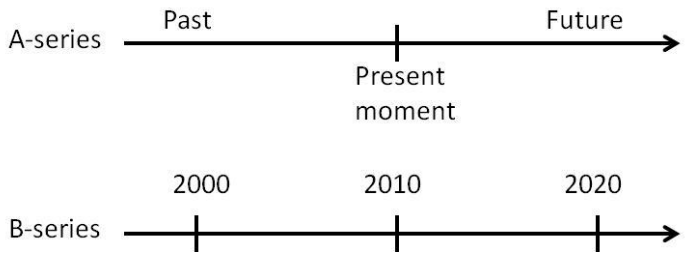

Figure 8 A and B time series

Series A is very suitable for creating an overall picture of the timeframe for management of major accidents, as illustrated in Figure 9; events occur in time before or after other events. In the analysis of major accident management, there

are three time periods and correspondingly three different ways to see actions to be taken:

1. The pre-accident phase requires looking forward in preparedness.
2. The response phase requires doing something at the present moment in response.
3. The post-accident phase requires looking backwards in post-accident analyses.

Understanding the situation is a key priority for rescuers. However, regarding the response phase, there are some theoretical considerations to deal with in order to identify which integration approach would work most effectively in major accidents. In other words, a theoretical framework is needed in which to analyze the accident. Three issues involved in an accident can be identified (Figure 9).

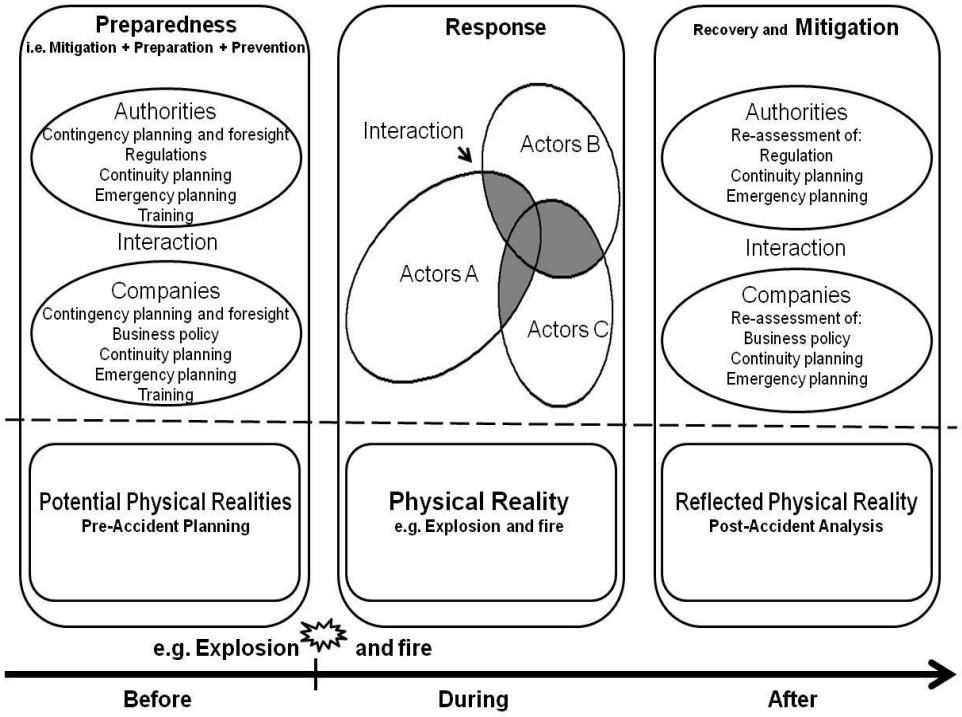

Figure 9 Past, present and future in the management of major accidents

Firstly, there is the accident itself, in the physical reality where the event, like an explosion or fire takes place (in the lower part of the middle section of Figure 9). Secondly, there are the actors involved in responding to the accident. They consist of individuals belonging to different organizations, thus having different backgrounds and organization cultures. For an effective response, the actors need

to gain an understanding of what has actually happened, what is happening at the current moment, and what will happen in the accident in question. Thirdly, communication and interactions between the actors needs to exist, consisting not only of working together but also of communication by linguistic and other means (shaded area). The term communication includes physical marks or signs that can be represented by an image, voice, text, etc. to convey meaningful information. Organizations involved in response face issues of technical, operational, and human interoperability at least to some extent, and yet all actors have to do their best (ESRIF 2009).

Effective response can be complicated by a "variable disjunction of information", which refers to "a complex situation in which a number of parties handling a problem are unable to obtain precisely the same information about the problem, so that many differing interpretations of the situation exist" (Constantinides 2013; Turner and Pidgeon 1997). Response is an action taken immediately before, during, and immediately after an accident. Time is often a very scarce resource in response, and therefore communication and cooperation between the actors are vital.

After the response (and recovery) phases it is time for mitigation. Mitigation includes any activities that prevent an accident, reduce the chance of an accident happening or lessens the damaging effects of unavoidable accidents (Shaluf 2008). In order to be able to gain a solid understanding (and to learn for the future), an accurate view of a real accident is postulated, which is a view that describes exactly what has actually happened. This is also needed for the post-accident analysis, which is a basis for re-assessment of accident-related plans. For instance in Europe, in the case of major accident, official accident investigation procedures also exist for high-risk industries like the process industry and power plants (Roed-Larsen and Stoop 2012). Post-accident analysis is basically looking back, but it certainly has an even more important meaning: it helps us to be able to prepare better for the future. If lessons can be learnt from post-accident analysis and more importantly the lessons absorbed so as to prevent or mitigate future accidents, then the original accident will also have had a beneficial impact on society (Choularton 2001). Unfortunately, this does not seem to be the case for all organizations, as stated clearly by Turoff, Hiltz, Bañuls, and Van Den Eede (2013), Turner (1976), Constantinides (2013), and Oloruntoba (2013) in their research on major accidents all over the world. However, the end of every accident should be the beginning of the preparation step for the next one (Penrose 2000). As well as effective response, proper preparedness requires both committed personnel in all levels of organizations and goal-oriented decision making. However, typically there is more time for actions to be taken in the preparedness phase than in the response phase.

Preparedness is looking forward, as Wilenius (2007) puts it: you have to look ahead and prepare for the future. The organization's future is influenced by both internal and external factors. It is crucial that rather than just extrapolating future development from the past, the organization takes careful stock of any new factors that may impact its future development. Therefore the organization's strategic processes should provide management with the tools they need to prepare for different accident scenarios in future. (Wilenius 2007.)

Future oriented preparedness includes risk assessments based on probabilities and vulnerabilities, and planning how to respond in the event of an accident in future (Aubrecht, Freire, Fröhlich, Rath, and Steinnocher 2011). Accident prevention and mitigation must be based on knowledge of the event probability distributions of key hazards and on the damage probability functions of the different classes of element at risk (Tiedemann 1992; Pauchant, Mitroff, Weldon, and Ventolo 1990; Turoff 2009a). However, at least some technological and natural major accidents contain essential elements of randomness and irreversibility. Preparedness for possible accidents in future is even more complex since many relationships, which may seem to have developed continuously in retrospect, often follow a non-linear pattern in the future (Casti 2012; van 't Klooster and van Asselt 2006). Mannermaa (1991) in the article *In search of an evolutionary paradigm for futures research* suggests that systems have non-linear interactions and a strongly differentiated inner structure. The evolution of these systems consists of stable evolutionary epochs with some degree of predictability, and breaks or chaos phases, which will have unpredictable outcomes and consist of a variety of possibilities for different development paths in the future. (Mannermaa 1991.) Hence, in relation to major accidents, difficulties often stem from the attempts of both individuals and organizations to deal with problems that are, in foresight at least, highly uncertain and ill-structured (Pidgeon and O'Leary 2000).

One way of characterizing such incidents is to view them as wild cards. These are incidents with a very low probability of occurrence but with potentially high impacts for an organization. Usually this kind of event is serious, destructive and in essence not predictable. And, if this occurrence takes place too fast and powerfully for a normal, planned management process to handle it, the organization could be left in a vulnerable position. Even though it is unlikely that wild card incidents will occur, not all wild cards are unimaginable. They may be anticipated for instance as a result of weak signals. (Mendonça, Pina e Cunha, Kaivo-oja, and Ruff 2004; Mendonça, Cardoso, and Caraça 2012.) Weak signals is a term used to refer to observed trends and information that may be incomplete, fragmented or unstructured. This information can be put together, analyzed, and then converted into an indicator of potential change. Weak signals

imply the future eventuality of an unfamiliar scenario that may be ignored, or not given any credit or even interest. (Mendonça, Cardoso, and Caraça 2012.)

In the field of futures studies, Ravetz (1997) proposes the use of 'what-if thinking' as a concept in the practice of risk assessment. He gives an example from chemical plants, where a specific methodology called HAZOP analyzes chemical units' actions in a plant in all their aspects: their existence, their space-time location, as well as the quantity and intensity of the chemicals. All these parameters are then checklisted, and analyzed 'what-if' any one of these parameters lies outside the expected range. In such a case, the consequences might be an incident, accident, or even a precursor to a major accident. By checklisting all the 'what-if' contingencies, this methodology assures the effective management of a chain of unexpected, unanticipated, or unknown circumstances that could ultimately constitute a major accident. (Ravetz 2004.)

Scenarios are descriptions of a future situation and the course of events which allows one to move forward from the actual to the future situation (Amer, Daim, and Jetter 2013; Godet 2000). The terms planning, thinking, forecasting, analysis and learning are commonly attached to scenarios (Bradfield, Wright, Burt, Cairns, and Van Der Heijden 2005). Börjeson et al. (2006) define what-if scenarios as a type of future scenarios that investigate what will happen on the condition of some specified near future events of great importance for future development. This type of scenario and especially the type that Börjeson et al. call probabilistic scenarios, including probabilities of some important outcomes, have some analogy with Ravetz' "what-if thinking". Similar ideas have been proposed by Ducot and Lubben (1980) and van Notten et al. (2003) in their definition of the peripheral scenario in which the scenario maker chooses to allow some parameters to take unlikely and extreme determinations thus having the possibility for disruptive consequences.

Although no organization can prepare for every conceivable accident scenario, it may be able to group accidents according to their underlying structural similarities. When clusters of accidents have been identified, the organization should then prepare for the realistic worst-case scenario in each cluster by considering the best preventive actions. Consequently, preparation for one accident scenario will provide exposure to several other similar or related scenarios. (Mitroff 1988.)

Risk assessments and actions made for preparedness are also to do with money (Hall 1980; Pauchant, Mitroff, Weldon, and Ventolo 1990). The costs and benefits should be analyzed at various points in the future, and should be compared with doing the minimum. Referring to the Aristotelian view of making a good decision, Malaska (2001), distinguishes between three elements in decision making: 1) information of the situation, 2) information of the goals, and furthermore 3) information of the means and resources available, i.e. in the

context of preparedness, how many resources (time, manpower, money etc.) is an organization able and willing to spend on it. Moreover, since plain information is not enough for a good decision, some wise perception of what that information may mean and how it may be interpreted for the future is also necessary. Hall (1980) concludes: "There is a time for doing very little and a time when only positive – even though unpopular – action will be right."

In summary, the ultimate goal of a forward-looking management process is to recognize major accidents that are potentially foreseeable and potentially avoidable (Turner 1976). Organizations with effective plans are able to react more quickly to problems and are able to respond more appropriately to a situation than organizations without such plans (Hall, Skipper, Hazen, and Hanna 2012). Therefore organizations should be engaged in a continuous effort for future-oriented preparedness. This includes continuously learning from experience, running tests and simulations to prepare for destabilizing surprises. Organizations should provide appropriate training and promote learning within and across networks, and personally involve organizational leaders in preparedness. Preparatory efforts should be carefully and progressively scheduled to avoid exhaustion. In addition, the processes for the management of major accidents should be embedded in core organizational processes. (McConnell and Drennan 2006.)

The relevance of this thesis is in engaging the actors in major accidents in a mutual learning process of how to overcome communication challenges and how to innovate effective management practices. This was performed by inviting the actors' representatives to a specifically tailored Delphi process to fill in the organizational holes and communicational obstacles originating from organizational embeddedness, as pointed out in the literature mentioned above. Therefore, the framework of this study acknowledges the general contributions of economic sociology in organizational behavior. The key academic novelty is in combining views from business organizations and authorities. As for futures studies, the novelty is two-fold. First, the thesis represents applied work for a new content that has been less studied. Second, the thesis develops the Delphi method towards a careful process of building up each round based on information gathered and material analyzed thoroughly in the previous round.

3 THE DELPHI METHOD AS A TOOL FOR ENHANCED COMMUNICATION

3.1 Overview

Delphi is a method in which experts' knowledge and presumptions about the topic or the development process under study are collected in an interactive process. As a data collection method, Delphi falls into the category of both a quantitative and a qualitative study (Tapio, Paloniemi, Varho, and Vinnari 2011). Delphi is especially useful when the research object is complex or when the topic is somehow delicate – difficult to define, awkward to talk about, politically sensitive, etc. (Gordon 2011; Laakso, Rubin, and Linturi 2012).

Group communication processes dealing with complex problems have the following logical phases: The first phase is characterized by exploration of the subject under discussion. The second phase involves the process of reaching an understanding of how the group views the issue. The last phase, a final evaluation and conclusions, is based on all previously gathered information. (Kuusi 1999; Linstone and Turoff 1975b.) Linstone and Turoff defined the Delphi method in the following way:

> "Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone and Turoff 1975c).

To accomplish "structured communication" the process should provide feedback on individual contributions of information and knowledge, assessment of the group judgment or view, an opportunity for individuals to revise their views, and a degree of anonymity for the individual answers (Linstone and Turoff 1975b).

Delphi was developed at the RAND Corporation in the 1950s by Olaf Helmer, Norman Dalkey and Nicholas Rescher and associates under the auspices of the U.S. government (Gordon and Helmer 1964; Linstone and Turoff 2011; Rescher 1998). At first the method was used for military purposes as a tool in creating strategies for the army in cases difficult to define with mathematical models. The meaning of the Delphi process was originally to define the future of a certain phenomenon with the help of experts. The goal was to achieve unanimity on how experts saw the future of the issue in question. Consensus was the ultimate target,

and it was supposed to be gained by iterating opinions and the grounds for them among the experts so many times that unanimity was reached (Bell 1997; Linstone and Turoff 1975b.)

Rather than gaining consensus, Delphi practitioners nowadays often emphasize new and different knowledge, including tacit knowledge, and the aim is to bring this knowledge to the attention of other experts for their evaluation and comments (Steinert 2009). The new Delphi, often known as argumentative, or policy Delphi, as opposed to the older version, consensus Delphi, is more pluralistic and equal by nature. The Delphi process produces different viewpoints, hypotheses and arguments, which are then subjected to open expert testing. The process aims at communicating through personal knowledge and insight to form shared visions, either agreed or disagreed upon. As the future does not exist, all views are considered worth contemplating. There can be disagreement both on arguments and goals, as well as on the probability of various alternatives and their desirability (Kuusi 1999; Linstone and Turoff 1975b; Tapio 2002; Steinert 2009.)

3.2 Selecting experts for a Delphi study

Delphi can be labeled an expert method. In this aspect the Delphi method differs from standard survey methods, where statistical and probability models are used. In statistical sampling, the respondents must represent the target population in the real world. Sample data consists of observed relative frequencies of individuals exhibiting the properties of interest. Statistical models are models of population. A sample is taken from the population so that the occurrence of the feature in the population can be deduced from the sample (in relation to its frequency in the sample) using probabilistic reasoning, within a margin of error. This probabilistic reasoning is done using a probability model.(Miles and Huberman 1994.)

In a Delphi study, experts are selected from among the experts of a field of study, and the aim is to cover all the relevant aspects of the study subject (e.g. Okoli and Pawlowski 2004). Good coverage of views rather than representativeness is called for (Kuusi 1999). The experts are then brought into interaction with the topic and with each other in a way that emphasizes the rationale of the arguments instead of the position or authority of the expert in question. In Delphi studies on technology foresight, large group of experts are usually favored, while, in social issues for example, the number of experts is relatively small. (Gordon 2011.)

The appeal of Delphi as a method is based on its characterization as an expert method. Thus, one of the most critical phases of a Delphi study, according to many Delphi practitioners, is the selection of experts. The Delphi method is well

suited for setting up a communication structure among members who possess the same general core of knowledge and who are already well informed. (Gordon 2011; Kuusi 1999; Laakso, Rubin, and Linturi 2012; Linstone and Turoff 1975b.) The most knowledgeable people in their field of specialization are often also ahead of others in their ideas about the future because of their exceptional understanding (Kuusi 1999). According to Kuusi (1999), an expert fit for a Delphi study should be:

1. At the highest level of his/her field of knowledge/science
2. Interested in a wide range of knowledge (around it)
3. Able to trace connections between national and international, present and future development
4. Able to regard problems from an unconventional point of view as well
5. Interested in doing something new.

The competence of an expert, expertise, may be determined both cognitively and socially. Expertise as a cognitive property refers to the acquired knowledge and skills possessed by an expert, whereas expertise as a social property refers to the possession of expert status in the eyes of others (Varho and Huutoniemi 2014). Varho and Huutoniemi (2014) further explore expertise as follows:

> "From a cognitive perspective, expertise is the possession of substantive knowledge of a domain of activity, including both propositional knowledge and tacit knowledge, and it can be acquired e.g. through education, research, experience, occupation, or any other form of cognitive refinement. Even though the social status of an expert is often gained through demonstrated competence in a given area, the acquisition of expert status is a different social process than the acquisition of cognitive expertise."

Typically social status comes through formal degrees, higher professions, and leading organizational positions that give a person the status of an expert in a particular domain (Saaristo 2000).

It is good to have diversity among experts in Delphi: it generates a variety of opinions, which can then be taken into account by all of the experts (Hussler, Muller, and Rondé 2011). This means that successful realization of Delphi requires the design of an expert group structure that allows many knowledgeable individuals from different disciplines or specialties, who have a different working background and experience, and who contribute information or judgments on the problem area which is broader in scope than the knowledge that any single individual can possess. (Gordon 2011; Kuusi 1999; Laakso, Rubin, and Linturi 2012; Linstone and Turoff 1975b.)

In order to help cover all the desired areas of both cognitive and social expertise when selecting the experts for a Delphi study, one possibility is to use an expertise matrix, recently developed and discussed in Finland among Delphi practitioners, especially by Osmo Kuusi (Kuusi, Ryynänen, Kinnunen, Myllykangas, and Lammintakanen 2006; Kuusi 2013). The matrix is two-dimensional: one dimension describes the desired interest groups of the experts, and the other dimension describes the desired competence areas which the experts should represent (Table 1).

Table 1 The principle of competence a area-interest group matrix

Cognitive expertise	Social expertise		
	Interest group 1	Interest group 2	Interest group n
Competence area 1			
Competence area 2			
Competence area n			

When using the matrix, the Delphi facilitator (researcher) should consider the kinds of organizations relevant to the topic and the research questions of the study. There may be different basic assumptions on the topic, e.g. the public sector may have different views compared to the private sector; these would represent the interest groups. On the other hand, again based on the topic and the research questions, the facilitator should consider which kind of cognitive competences should be represented in the study; e.g. engineering, marketing, management, etc. Finally, by placing selected experts into the matrix the facilitator may ensure that all the desired aspects of expertise are covered. (Kuusi 2013.) For example, in their work on future food consumption, Vinnari and Tapio (2008) defined researchers, non-governmental organizations, politicians, and companies as the form of social expertise and, respectively, politics, economics, social and culture, technology, and environment and ethics as the cognitive competence areas.

3.3 Anonymity

The anonymity of the experts helps avoid the limitations and problems of expression and listening to one another, which is always present in face-to-face expert groups. The position or status of an expert – be it low or high – does not affect the formation and expression of opinions. Furthermore, the experts do not have to fear losing face, even if they give a “wrong” or unsuitable answer or “loose” comment. (Rescher 1998, 92-96.)

The experts also need not be wary of expressing attitudes that their employer might find inappropriate to air in public. In interest or value conflicts, issues do not become personalized in the same way as in face-to-face communication. (Rescher 1998, 92-96.)

3.4 Iteration

The basic difference between ordinary surveys and a Delphi study is its iterative and feedback nature. In contrast to Gallup polls, opinions are not merely collected for analysis, but information about the answers is fed back to the experts. With the help of the feedback information, the experts are guided to give justifications for their choices. Therefore information is built up round by round so that the previous round forms the basis for the next one (Bolger and Wright 2011; Helmer 1967; Linstone and Turoff 2011; Ono and Wedemeyer 1994.)

The first round interview or questionnaire starts the Delphi process. It also orientates the experts to position themselves regarding the Delphi process and each other. In the comments and arguments of the second and third rounds, the experts have the possibility to clarify their opinions and views and may try to convince the others. They also have the opportunity to learn from others' answers and arguments. If this happens, it is a positive sign of listening and genuine dialogue. Between the rounds, the manager (researcher) analyzes the results and formulates the arguments given into new claims for the experts to vote on in the next round (Bolger and Wright 2011; Helmer 1967; Linstone and Turoff 2011; Ono and Wedemeyer 1994.)

Internet-based Delphi allows the possibility of synchronic dialogue between experts. The dialogue may contribute to the communication and problem solving in the group of experts. The experts do not necessarily have to react to all the claims, only to those about which they feel they have something relevant to say. (Linstone and Turoff 1975a; Turoff and Hiltz 1996; Turoff 2009b.)

3.5 Validity and reliability in Delphi studies

This section gives a brief outline of the characteristics that are of particular importance in validating the Delphi method. In general, the term validity means whether a study is able to answer the questions it is intended to answer. The term reliability, in turn, means "repeatability" or "consistency", which means the ratio of all the successful applications of the method to all its applications, in a sufficiently long series of attempts to apply it. For example, a measure is considered reliable if it would give the same result over and over again, assuming

that what we are measuring does not change. (Metsämuuronen 2006; Metsämuuronen 2008; Miles and Huberman 1994.) Usually two kinds of validity can be distinguished: i) external validity, which means that the truth is proved by the findings of other researchers, by the findings of comparative research, or by another researcher using the same material (Silverman 2005, 91, 175-185), bearing in mind that people and conditions may change as time passes; and ii) internal validity, which refers to the degree to which findings are able to map and describe the phenomenon in question (Silverman 2005, 91). Authors writing on validity and reliability issues highlight the fact that the critical path in questions of validity and reliability starts from designing and testing the tools used for data collection (inquiries, interview forms and instructions, etc.). The next stage is selecting the source (cases, participants in surveys, experts, etc.), and the third critical point is the analyzing phase.

To outline briefly the characteristics of particular importance for validating methods, as it concerns the present research (Kvale 1989): Firstly, every method involves a repeatable sequence of operations that bring about, when performed, a repeatable event called the objective of the method. In the case of the Delphi method, it should be made very clear what the objective is, i.e. whether we are basically interested in the experiences and/or opinions of the experts, or the past and/or future situations of which the experts have experience of or opinions about. The Delphi method is based on the supposition that experts know more facts and have more experience behind their views and thus their opinion has more weight than people not accustomed to the area in question.

Secondly, every method requires a person or a class of persons who are said to be familiar with it, or, in other words, who are competent to apply it. The same person may apply the same method several times, and several persons may attain their objectives by applying the same method (Silverman 2005, 91). When the Delphi method is applied to a particular situation, we may think that the more experienced the person using it, and the more he or she has used it in previous situations, the more confident he or she will also be in that particular situation. However, assuming that whoever uses the Delphi method for the same experts would have the same results is not a very plausible supposition, since the user of the Delphi method has a very active role when applying it, which depends on the personal character as well as the knowledge of the user/researcher.

Thirdly, the operations involved in a method may require the handling of a specific set of objects, which does not include the object to which the method is applied. Such a set of objects is called the instrumental equipment of the method, which must meet the requirements of the method. Of course, the objects may vary from application to application, i.e. the very same instrument is not required to be used to attain the object of the research. In the Delphi method, the instrumental equipment consists of the objects used when the questionnaire is

distributed to the experts. One essential requirement for the instrument used is guaranteeing the anonymity of the experts.

Fourthly, an individual application of the method may fail in a certain fraction of its application to realize on some particular occasion the objective of the method. The probability that a single application of a given method chosen at random will successively produce the objective of the research is called the reliability of the method, i.e. the reliability is the ratio of all successful applications of the method to all its applications. The probability that a particular application of a given method will be successful may be affected by the special circumstances under which the method is applied. This probability will then differ from the reliability of the method. The rules that specify the circumstances left undetermined by the description of the method, such as the choice of equipment or the way of handling it, constitute its technique (Kvale 1989). More particularly, for example, the successful application of the Delphi method may depend upon the choice of the person who applies the method, upon the physical, psychological, and social conditions prevailing in his/her environment, upon the choice of the instrumental equipment and questionnaires, and the way of handling them.

Fifthly, in some cases, there is a special theory determining the degree of reliability of a given method and how this reliability may possibly be enhanced through the use of a suitable technique. A theory of this kind may be called the theory underlying the method. In the case of Delphi there are some characteristics which should be carefully considered: the selection of experts, the anonymity of experts and, the iterative data collection process led by the user/researcher (Mitroff and Turoff 1975; Linstone and Turoff 1975c; Linstone and Turoff 2011).

There are two ways the Delphi process differs from traditional surveys: Firstly, the experts are not selected randomly, since they are selected according to their knowledge and experience, that is, because of their expertise (Loo 2002). Secondly, the number of experts can be much smaller than what is usually thought to be sufficient to guarantee the reliability of a survey (Loo 2002). This is why there has been a lot of discussion, occasionally even strong disagreement, on the scientific reliability of results assessed by Delphi. The critics argue that the number of experts in an average Delphi research study is too small to guarantee the reliability of the work (Bell 1997, 261-272). The critics also say that the method by which the experts are selected for the Delphi is not objective or based on probability, and therefore the answers cannot be thought to be reliable in the scientific meaning. The fact that results obtained from different experts may differ from each other has also been seen as a sign of the unreliability of the Delphi method. (Loo 2002; Powell 2003.)

Many sampling methods are available in traditional research surveys, and not all of them are based on probability. For example, in small populations the whole population may be a sample. Other non-randomized sampling methods are for example quota sampling and haphazard methods (Sapsford 1999, 49-100). We must also remember that in surveys, even if a randomized sampling method is used, the research questions always limit the population to a target group from which the sample is picked. The size of the sample in traditional surveys is in many cases large. However, size itself is not significant for reliability but the representativeness of the sample is, that is, how well the sample represents the whole population (Sapsford 1999, 1-48). A greater sample reduces sampling error and enhances representativeness, but does not guarantee it (Sapsford 1999, 49-100).

The reliability of this kind of method is condensed into three items: selection of experts, number of experts, and conducting of the process of setting the questions and organizing communication to reach stability, or as in modern Delphi, shared visions, either agreed or disagreed upon.

The validity of the answers and results is mostly seen to be in the researcher's hands. How well have the questions been formed and set, does the group of selected experts consist of precisely those experts who have the best knowledge and experience, and are the answers collected and analyzed correctly? Ensuring this requires careful planning and testing of research settings. (Hasson, Keeney, and McKenna 2000; Landeta 2006; Lilja 2013; Steinert 2009.)

4 PHASES OF THE DELPHI PROCESS ON THE MANAGEMENT OF MAJOR ACCIDENTS

4.1 Overview

The research began with a desk study on the topic. After formulating the research questions and the expert selection process, a three round Delphi process was carried out on the subject with 48 experts representing rescue and regulatory agencies, company personnel, and stakeholders. The structure of the three-round Delphi study conducted for this thesis is depicted in Figure 10.

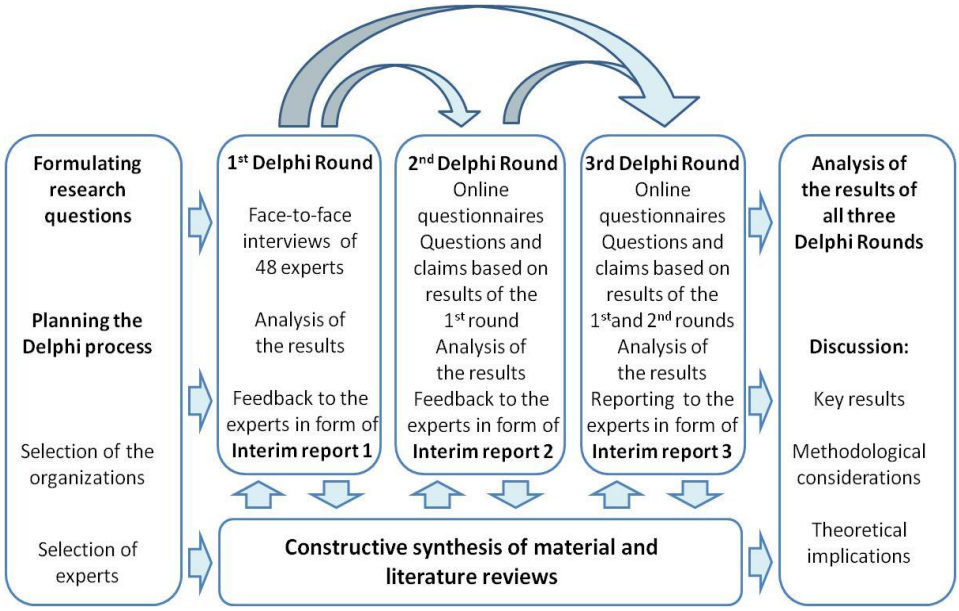

Figure 10 Structure of the Delphi process conducted for the thesis

The Delphi process was conducted between March 2012 and April 2013 during the joint research project SAVE of Ahma Engineers Ltd. and Finland Futures Research Centre coordinated by Ahma Engineers Ltd. (see Laakso and Ahokas 2013d).

4.2 Selection of experts for the Delphi process

Since one of the most critical phases of a Delphi study is the selection of experts, it was carefully considered what kind of expertise would be required to obtain the information needed to answer the research questions. In order to be able to identify and cover the necessary expertise areas, it was decided to apply the expert matrix discussed in chapter 3.2. Based on the theoretical analysis of the topic and the research questions, three competence areas for experts were identified: experts were expected to have knowledge on (1) preparedness for major accidents, (2) responding to major accidents, i.e. the response phase, and (3) regulations related to major accidents. On the other hand, in order to identify possible interest groups, it was considered which kinds of organizations or groups of organizations would employ individuals possessing the desired knowledge on the management of major accidents. In addition to the groups of (1) rescue and regulatory authorities and (2) companies, a group of organizations connected to the management of major accidents i.e. (3) stakeholders, was identified. (Laakso 2012b; Laakso and Ahokas 2013d.) The following matrix was formulated on the desired cognitive competences and social competences in the form of expert interest groups:

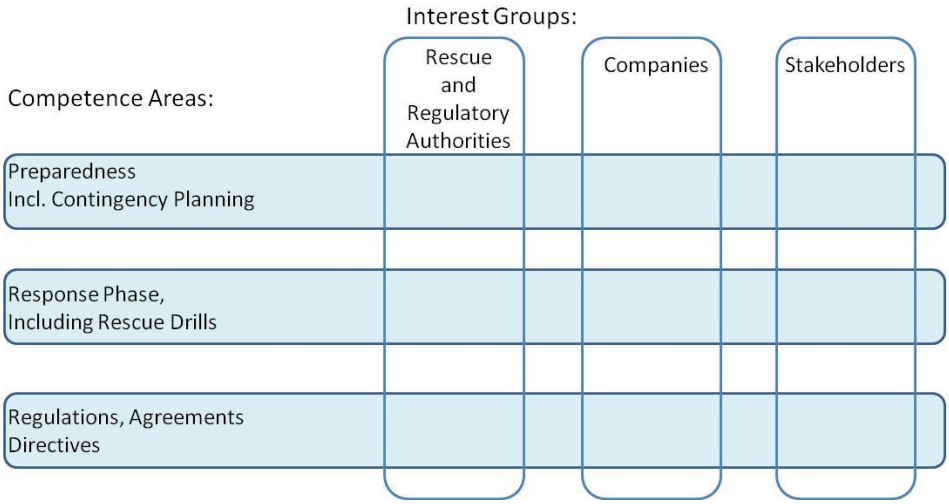

Figure 11 Competence-interest group matrix for the Delphi study

Before selecting any individuals for this Delphi study, attention was paid to selecting authorities, companies, and other organizations that were considered likely to employ people who possess the desired knowledge on management of major accidents. Thirty-nine organizations were visited and invited to join the Delphi study (Laakso 2012b; Laakso and Ahokas 2013a). All the invited

organizations accepted the invitation, including 20 authorities, 16 medium-sized or large companies, and 3 other organizations, and they were grouped as follows (Figure 12):

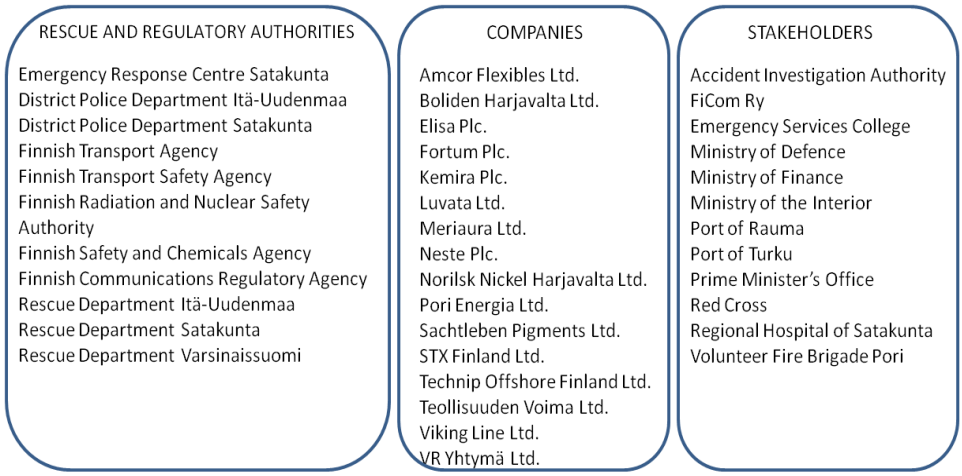

Figure 12 Organizations represented in the Delphi process

Next, top-level managers of these organizations were contacted and asked to recommend persons with the best possible expertise in the research area for this Delphi study. The invited 39 organizations nominated a total of 48 experts for this Delphi study. All the experts had several years of experience in the management of major accidents with backgrounds in different lines of business.

4.2.1 Rescue and Regulatory Authorities

This group was formed by representatives from three Rescue Departments, two District Police Departments, the Emergency Response Centre, the Finnish Safety and Chemicals Agency (Tukes), the Finnish Communications Regulatory Agency (Ficora), the Finnish Transport Agency (Liikennevirasto), the Finnish Transport Safety Agency (Trafi), and the Finnish Radiation and Nuclear Safety Authority (STUK). The experts in this group were:

Hannele Aaltonen, Head of Preparedness, Finnish Radiation and Nuclear Safety Authority
Matti Aaltonen[1], HSE Director, Finnish Transport Agency

[1] Matti Aaltonen replaced Arto Muukkonen in the third Delphi round

Raimo Aarnio[2], Chief Rescue Officer, Rescue Department, Varsinais-Suomi
Leena Ahonen, Senior Inspector, Finnish Safety and Chemicals Agency
Chief Inspector Lars Grönroos, District Police Department, Satakunta
Antti Halmela, Rescue Officer, Rescue Department, Satakunta
Niina Heinonen, Emergency Officer, Emergency Response Centre, Satakunta
Pertti Hölttä, Head of Unit, Finnish Communications Regulatory Agency
Timo Lehtimäki[3], Director Finnish Communications Regulatory Agency
Timo Leppinen[4], Director Finnish Communications Regulatory Agency
Jyri Leppäkoski, Chief Rescue Officer, Rescue Department, Satakunta
Arto Muukkonen, HSE Director, Finnish Transport Agency
Anne Mäkinen, Emergency Officer, Emergency Response Centre, Satakunta
Tomi Pursiainen, Risk Manager, Rescue Department, Itä-Uudenmaa
Päivi Rantakoski, Director, Finnish Safety and Chemicals Agency
Chief Constable Olli Reini, District Police Department, Itä-Uudenmaa
Petri Rönneikkö, Director, Finnish Transport Agency
Marko Sillanpää, Director Finnish Transport Safety Agency
Mika Viljanen, Chief Rescue Officer, Rescue Department, Varsinais-Suomi

4.2.2 Companies

A total of 16 companies were represented in the Delphi study. They were from different lines of business: an oil refinery, transport (railway and shipping), the chemical industry, a foundry, a packaging manufacturer, two nuclear power plants, a regional electricity company, a telecom operator, an offshore yard, and a shipbuilding yard. Most of the companies involved in this Delphi study are the kind that according to regulation (e.g. Law on Rescue) are obliged, due to the nature of their business, to organize rescue drills at least once a year to which the local rescue authorities are invited, and if required, also the official regulatory authority at national level (e.g. the Finnish Safety and Chemicals Agency for the chemical industry, the Radiation and Nuclear Safety Authority for the nuclear industry). The experts in this group were:

Kari Forsberg. Safety Engineer, Fortum Plc.
Ilpo Harju, Managing Director, Sachtleben Pigments Ltd.
Olli Hukari, Site Manager, Kemira Plc.

[2] Raimo Aarnio retired during the Delphi process but participated in all three Delphi rounds
[3] At the time of the third Delphi round Timo Lehtimäki was Managing Director of Suomen Erillisverkot Oy
[4] Timo Leppinen participated in the third Delphi round

Timo Kallionpää, HSE Manager, Norilsk Nickel Ltd.
Caj Karlsson, HSE Manager, Neste Plc.
Vesa Katavisto, Fire Chief, Teollisuuden Voima Ltd.
Jarmo Kivi, HSE Manager, Technip Offshore Finland Ltd.
Tapio Koota, Head of Preparedness, STX Finland Ltd.
Aimo Maanavilja, Research Fellow, Elisa Plc.
Kari Mäenpää, Technical Manager, Luvata Ltd.
Jussi Mälkiä, Managing Director, Meriaura Ltd.
Vesa Nurminen, Fire Chief, Amcor Flexibles Finland Ltd.
Matti Rintanen, Managing Director, Pori Energia Ltd.
Niko Ristikankare[5], Vice President, Neste Plc.
Markku Saha, Head of Planning, VR Ltd.
Reino Sundell[6], Senior Master, Viking Line Ltd.
Tuomo Tikander[7], HSE Manager, Sachtleben Pigments Ltd.
Jaakko Wallenius, Director, Elisa Plc.
Matti Ylander, HSE Manager, Boliden Harjavalta Ltd.

4.2.3 Stakeholders

This group included stakeholders closely connected to the topic of the research, and included representatives from the Ministry of Interior, the Ministry of Defense, the Prime Minister's Office, the Ministry of Finance, a Regional Hospital, the Accident Investigation Board, the Red Cross, a cooperation organization for the ICT, two ports, the volunteer fire brigade, and the Emergency Services College. The experts in this group were:

Markku Heino, Head of Unit, Volunteer Fire Brigade Pori
Timo Härkönen, Head of Security, Prime Minister's Office
Ari-Pekka Laine, Safety manager, Regional Hospital of Satakunta
Timo Laitinen, HSE Manager, Port of Turku
Kalle Löövi, Director, Red Cross
Veli-Pekka Nurmi, Director, Accident Investigation Authority
Hannu Rantanen, Special researcher, Emergency Services College
Tanja Roberts, Deputy Director, Port of Rauma
Rami Ruuska, Senior officer, Ministry of the Interior

[5] At the time of the second and third Delphi rounds Niko Ristikanre was Director of Wega-Advisors Oy
[6] Reino Sundell retired during the Delphi process but participated in all three Delphi rounds
[7] At the time of the second and third Delphi rounds Tuomo Tikander was HSE Director of Metsä Group Oyj

Jukka Uusitalo, Senior advisor, Ministry of Finance
Vesa Valtonen, Secretary, The Security Committee
Kari Wirman, Director, FiCom Ry

4.2.4 Expertise and anonymity

From the reliability point of view, a great deal of attention was paid to the selection of experts for the Delphi study. First of all, it was carefully considered in which organizations there might be the best understanding of the topic of the research. Secondly, top-level managers of these organizations were asked to recommend an expert for the Delphi study. Managers were asked to recommend persons with good expertise in the research area i.e. knowledge of regulation, preparedness, and the response phase. The first Delphi round was carried out by means of personal interviews. This allowed the researcher to become acquainted with the experts. However, before the second Delphi round experts were asked to answer some questions in a background form (APPENDIX 1). The experts were asked about the length of their work experience in major accident matters. More than 40 out of the 48 experts had over ten years' work experience; 24 of them had over twenty years of experience (Figure 13).

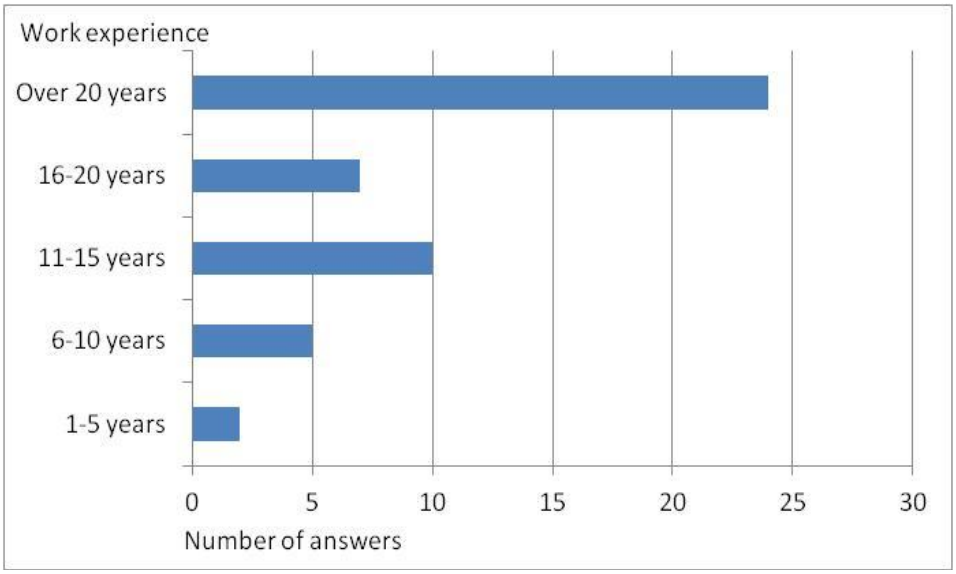

Figure 13 Experts' work experience in major accident matters

There were 4 women and 44 men on the group of experts, which is considered to represent the normal gender distribution of personnel in the management of major accidents.

In addition, in order to ensure the experts' suitability for this research, they were also asked to assess their own skills and competences in the desired three competence areas on a scale of 1 to 5. The averages ($\bar{x}$) and the standard deviations (s) of the answers by interest group were then calculated and are shown in Table 2.

Table 2 Experts' own assessment of their competence

	Rescue and Regulatory Authorities		Companies		Stakeholders	
n	17		19		12	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Preparedness phase of management of major accidents	3.8	0.6	3.7	0.6	4.0	1.2
Response phase of management of major accidents	3.7	0.9	3.6	0.7	3.9	1.2
Regulation on management of major accidents	4.1	0.7	3.8	0.5	4.0	1.1

The averages of the answers ranged between 3.6 and 4.1. Standard deviations were between 0.5 and 1.2; in the group of stakeholders the standard deviations were slightly higher compared to the other two groups. Of course, not all of the experts were expected to have top expertise in all of the three desired competence areas, but nevertheless, the results varied relatively little. This was thought to increase the reliability of the research results. As a whole, this group of experts has extensive work experience in the field of management of major accidents, which was considered to be adequate for the objectives of the study.

In this Delphi application, the complete anonymity of experts was considered unnecessary. At the beginning of the Delphi process, the experts were given the names of all the other participating experts. However, the individual answers and arguments were kept anonymous. This arrangement is called quasi-anonymity (Laakso and Ahokas 2013a). In fact, the eDelfoi-system that was used in the second and third Delphi rounds also keeps the respondent information hidden from the researcher and thus the anonymity of each answer was guaranteed (see eDelfoi 2013).

4.3 Execution of the first Delphi round

The first step in being able to make reasonable decisions about the future is to understand the present, and, by implication, the past (Pill 1971). Therefore the first Delphi round was carried out by means of personal interviews. The experts were interviewed for 1.5–2 hours. The interviewees were asked about their views on the challenges and problems in communication and the flow of information related to major accidents. They were asked to answer not only as a representative of their own organization but also as a representative of their branch.

Interviewees had the possibility to express their opinions on the research subject freely. However, as a guide, the interviewer had some questions in order to keep the interview on topic (see APPENDIX 2):

> *"In major accidents there are often several organizations involved; e.g. companies and authorities. If you think about communication and the flow of information in preparedness, have you noticed any challenges or problems?"*
>
> - *Describe those situations.*
> - *In or between companies?*
> - *In or between authorities?*
> - *Between authorities and companies?*
> - *How would you solve these problems?*
>
> *"Have you noticed any…"*
>
> - *Contradictions in the regulation?*
> - *Difficulties in understanding the regulation?*
> - *Difficulties in following the regulation?*
> - *How would you solve these problems?*
>
> *"Presumably you have been involved in a major accident or participated in rescue drills. Have you noticed any challenges or problems in communication or in the flow of information in the response phase?"*
>
> - *Describe those situations.*
> - *In or between companies?*
> - *In or between authorities?*
> - *Between authorities and companies?*
> - *How would you solve these problems?*

The interviews were recorded, transcribed, and documented. Through personal contact with the experts, the target was also to increase their commitment for the next Delphi rounds.

Since the amount of transcribed material was large (the transcribed data consisted of over 400 pages of written material in MS Word), a computer-assisted analysis was made in order to manage the data, create codes from the data, and handle the material so that everything would be stored systematically on computer (Räsänen 2001; Laakso and Ahokas 2012; Laakso and Ahokas 2013a). This computer assistance made it possible to work as a team even when in different locations; it supported coordination of analysis in teamwork situations. It was also felt that the use of computers increased the openness and transparency of the analytic procedures in general. The software analysis was also felt to increase the reliability of the research since the amount of potential mistakes is decreased by the use of systematic data management. (Räsänen 2001.)

ATLAS.ti is qualitative data analysis (QDA) software that offers tools to manage, extract, compare, and explore meaningful pieces from large amounts of data in systematic ways (see Atlas.ti 2013). With ATLAS.ti it was possible to tag sentences and larger parts of texts, i.e. quotes in the text, and assign codes to these sentences and sections (Figure 14). The software then allowed the utilization of these tagged quotes and the classification of data as well as looking at relationships in the data. Coding allowed the making of different comparisons from the data; for instance all parts of the texts related to a certain theme could be observed simultaneously.

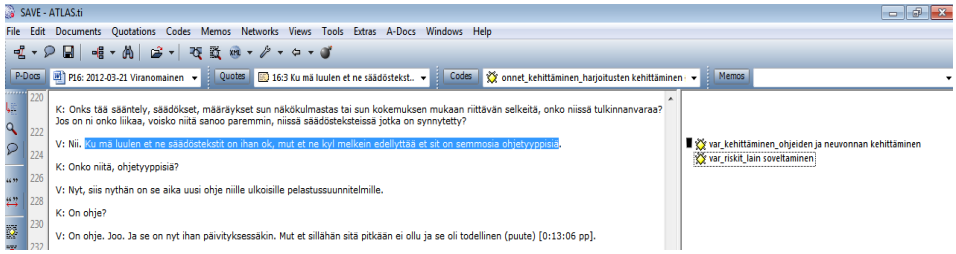

Figure 14 A section of a work window of ATLAS.ti

First, the transcribed texts were read through in order to obtain a sense of the whole and then data was imported to the ATLAS.ti software. Next, the data was read carefully several times and quotes in the text were tagged. Then the quotes were coded and classified. Quotes and codes were used as classification devices at different levels of abstraction in order to create sets of related information units for the purpose of the comparison tool. The quotes were typically short

pieces of text referencing other pieces of text. The purpose of the codes was to classify a large number of textual units. The coded quotes were then exported as an Excel-compatible table. The codes were also grouped into domains in both of the interview themes of the preparedness (including regulation) and response phases; all the codes related to a certain domain were put together. (Graneheim and Lundman 2004; Laakso 2013; Laakso and Ahokas 2013a.)

Although ATLAS.ti facilitates many activities involved in qualitative data analysis and interpretation (particularly selecting, coding, and annotating), its purpose is not to automate these processes. ATLAS.ti software does not produce analyses itself; instead, it is a tool for classifying data and looking at relationships in the data. It provides a good way to discover relationships and interconnections in data. It offers a variety of tools for accomplishing the tasks associated with any systematic approach to unstructured data, i.e. data that cannot be meaningfully analyzed by formal, statistical approaches.

The first Delphi round interviews were held between March and July 2012. As feedback, the results of the first round were reported to the experts in September 2012 (Laakso and Ahokas 2012).

4.4 Execution of the second and third Delphi rounds

The online Delphi software eDelfoi was used in the second and third Delphi rounds. Questions and claims for the online questionnaires were formulated on the basis of the desk study and the analysis of material from the previous round(s) (Laakso and Ahokas 2012; Laakso and Ahokas 2013b; Laakso and Ahokas 2013a).

eDelfoi software has been developed by the Finnish Delphi Community (see https://edelfoi.fi). The first version of eDelfoi was created (1998) in cooperation with the Futures Research Centre of Finland and some other futures research oriented institutes, and was funded by the Finnish Ministry of Education and Culture. The main features of the software are user administration, questionnaire creation, organization of answers and comments, and reporting.

The software can help the Delphi manager, i.e. the researcher, to design, implement, analyze, and report on a research study. In the first stage of the survey, the manager creates a questionnaire or questionnaires, which may include textual and graphic sections (for instance introduction and explanations), quantitative sections (different types of questions), textual answers (qualitative material), and links (Figure 15).

Compared to other questionnaire software, the advantage of eDelfoi is that the software is designed with the needs of the Delphi method in mind. In this software it is possible to select several query types appropriate for Delphi use,

such as various scale queries to evaluate the likelihood, desirability, and/or importance of a certain variable, as well as timeline and time series queries. One of its strengths is that experts also have the opportunity to make an argument to justify their own answer in each query type (Laakso and Ahokas 2013a).

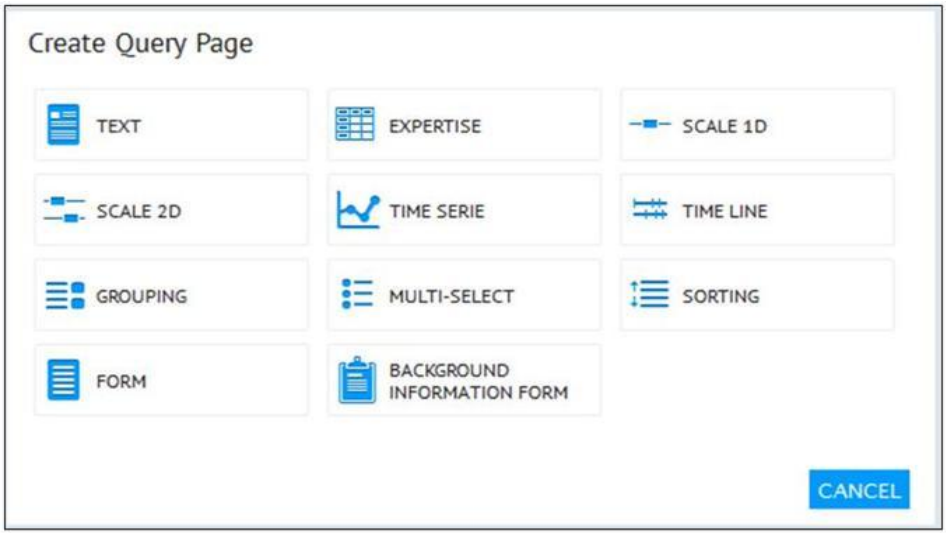

Figure 15 Window for selection of a query type in the eDelfoi system

The second Delphi round was carried out in October 2012. Separate questionnaires were formulated for the preparedness phase (APPENDIX 3) and the response phase (APPENDIX 4). The experts were asked to answer not only as a representative of their own organization but also as a representative of their branch. The aims of the second round were:

- to gain more in-depth information on topics that were raised in the first Delphi round of interviews
- to ask about the probable and desirable development of some topics raised in the first round
- to gain an evaluation of the importance of the development suggestions raised in the first round from the perspective of improved safety.

As feedback, the results of the second round were reported to the experts in January 2013 (Laakso and Ahokas 2013b).

The third Delphi round was carried out in March-April 2013. Again separate questionnaires were formulated for the preparedness phase (APPENDIX 5) and the response phase (APPENDIX 6). The experts were asked to answer not only

as a representative of their own organization but also as a representative of their branch. The aims of the third round were:

- to gain more in-depth information on topics that were raised in the first and second Delphi rounds
- to ask about the probable and desirable development of some of the topics raised
- to gain an evaluation of the importance of the development suggestions raised in previous rounds from the perspective of improved safety
- to gain concrete suggestions for improvement and development in relation to themes raised in earlier Delphi rounds.

The results of the third round were reported to the experts in June 2013 (Laakso and Ahokas 2013c).

5 PROBLEM DOMAINS IN COMMUNICATION IN THE MANAGEMENT OF MAJOR ACCIDENTS

The first round of the Delphi study was carried out by means of face-to-face interviews. The 48 experts representing rescue and regulatory authorities, companies, and stakeholders were asked about their views on the challenges and problems in communication on the preparedness and response phases of major accidents (APPENDIX 2). The aim was to ascertain when and what kinds of problems related to communication and information flow in or between different organizations had been experienced by the interviewees.

The interviews were recorded and then transcribed. After that, the transcribed interview texts were read through in order to obtain a sense of the whole. Then the texts were loaded into software designed for qualitative data analysis. The software used in this research was ATLAS.ti. Using the software's features, meaning units called quotes were tagged. That is to say: words, sentences, or paragraphs containing meanings related to the research questions of the thesis in terms of their content and context, were tagged.

In the next stage the texts were read through again and the tagged quotes were coded. Codes are the researcher's own creations, in that researchers identify and select codes themselves. They are tools to think with. They can be expanded, changed, or scrapped altogether as ideas develop through repeated interactions with the data. A code can be assigned to, for example, discrete objects, events and other phenomena, and should be understood in relation to the context. Finally, by creating categories, which is the core feature of qualitative content analysis, it is possible to group content that shares a commonality. (Coffey and Atkinson 1996; Graneheim and Lundman 2004; Krippendorff 1980.)

As Graneheim and Lundman (2004) suggest, abstraction of the text was used in order to emphasize descriptions and interpretations on a higher logical level. Abstractions enabled the researcher to create codes for the quoted sentences and finally to group codes into upper categories, which in this research are called domains (Graneheim and Lundman 2004).

As a result, a total of 683 quotes from the interviews were identified in relation to problems in the flow of information and communication in the management of major accidents. Table 3 illustrates examples of how quotes were coded and finally how the codes were grouped into domains.

Table 3 Examples of coding of quotes and grouping of codes into domains

Part of Interview	Quote	Code	Domain
Preparedness phase in management of major accidents	There is a difference in cultures between authorities and business life. One never knows how the authorities will react to a request	Problems in cooperation between authorities and companies	Cooperation between companies and authorities
	…if you ask an authority how to do something, nowadays their answer is "look at the regulations, there is a paragraph for that…"	Problems in cooperation between authorities and companies	
	In an industrial park the companies should have much more common in their safety policies.	Problems in cooperation between companies	Safety collaboration of companies
	…separate and different IT systems… some kind of portal, where everyone could be identified and get the right information…	Development of IT systems	IT systems and data security
	… you get information from the IT system but you can't know when the information was updated nor is it still valid… This is a big problem.	Development of IT systems	
	It is not only the traditional systems that are threatened. Nowadays when industrial ERP systems are functioning over the Internet, they are also in danger…	Problems in data security	
Response phase in management of major accidents	…it is only trace follow-up… but the background reasons for accidents could be emphasized more…	Accident investigation and analysis	Analysis of accidents
	…the reason why company expertise cannot be utilized sufficiently is because the dialogue between business life and rescue authorities does not work…	Lack of utilization of company expertise	Co-operation between organizations at the site
	It is important that the experts of company have more courage to state their opinions at the rescue management center at the site.	Lack of utilization of company expertise	
	Rescue authorities should more frequently ask the company personnel about the actual/different risks at the site	Lack of utilization of company expertise	
	…it is clear that the cooperation between authorities is not good…because their tasks as defined in regulations are not clear.	Cooperation between authorities at the site	
	In case of e.g. a fire, the company personnel do call 112 (911), but they do not necessarily remember to warn the neighboring companies.	Cooperation between companies at the site	

5.1 Problem domains in the preparedness phase

One part of the Delphi study dealt with preparedness related to major accidents. As a result of the analysis of the transcribed interview material, a total of 351 quotes mentioned in the interviews were identified in relation to problems in the flow of information and communication in preparedness. All the quotes were coded; 46 codes were created out of which 39 were grouped into 13 domains. The remaining seven codes, which could not easily be grouped, included 15 quotes (4 % of the quotes related to preparedness). The codes and the number of quotes connected to them and the domains are shown in Table 4 on page 80.

In the following sections, a presentation is given of the most frequent domains with regard to preparedness.

5.1.1 Operations of authorities

The most frequent domain includes quotes and codes related to the operations of the authorities, with nine codes including 72 quotes representing 21.5 % of all quotes related to preparedness. The experts highlighted the lack of cooperation between the authorities and the need for better coordination between different authorities.

The experts believe that collaboration between the authorities could be developed by planning operations better, so that operations of other authorities are taken into account. For instance, in preparedness planning, the viewpoints of rescue authorities and regulatory authorities could be more compatible. It was considered that the current situation is such that many authorities have overlapping functions, which may cause issues in the flow of information. This could be avoided through better planning.

At present, safety documents issued by the authorities and those supplied to them by companies are fragmented and saved in such a way that they cannot be utilized properly. In the view of the experts, there are plenty of these documents in existence, also in electronic form. One major challenge was seen to be firstly the fact that data is collected in a disjointed fashion, secondly that the authorities do not have sufficient knowhow to utilize the documents, and thirdly that the management of data access rights prevents the smooth search and utilization of this data. One proposed option was to establish a common data bank.

Another point that was highlighted was that the authorities are not good at disseminating their safety knowhow to companies, although they possess a lot of knowledge of good practices. The hope was clearly expressed that authorities would act in more of an advisory or briefing role in relation to preparedness than they do at present.

Table 4 Problem domains in the preparedness phase

Code	Number of Quotes in Code	Domain
Lack of cooperation between authorities	27	**Operations of authorities**
Improving counseling and dissemination of information	10	
Personalization of cooperation	8	
Improve skills of authorities	7	
Coordination of authorities' work	6	
Problems in cooperation with companies	6	
Need for advisory work	6	
Contingency planning	1	
Problems in quality of work	1	
Number of Quotes in Domain	**72**	
Necessity of improving regulations	15	**Laws and other regulation**
Difficulties to apply regulations	15	
Strict group policies of international companies	11	
Regulation and emergency supply	11	
Need for unified regulations	4	
Need for more specific guidelines for external rescue plans	2	
Number of Quotes in Domain	**58**	
Development of backup systems	16	**Companies' preparedness planning**
Development of contingency planning	9	
More unexpected situations to be taken into account	5	
Audits for preparedness	4	
Lower quality of contingency planning of small companies	4	
Low quality of risk analysis	2	
Need for competence of certain personnel	1	
Number of Quotes in Domain	**41**	
Education and training of company personnel	16	**Education and training**
Education and training of authorities' personnel	16	
Number of Quotes in Domain	**32**	
Attitude towards preparedness	15	**Attitude towards preparedness**
Development of motivation towards preparedness	13	
Number of Quotes in Domain	**28**	
Safety collaboration between companies involved	17	**Safety collaboration**

Problems in cooperation between companies	3	**of companies**
Number of Quotes in Domain	**20**	
Need for improvements in cooperation between companies and authorities	12	**Cooperation between companies and authorities**
Problems in cooperation between authorities and companies	6	
Number of Quotes in Domain	**18**	
Development of IT systems	10	**IT systems and data security**
Development of data security	3	
Problems in data security	2	
Number of Quotes in Domain	**15**	
Prioritization of resources	14	**Prioritization**
Number of Quotes in Domain	14	
Lack of resources	14	**Resources**
Number of Quotes in Domain	**14**	
Norms and instructions from insurance companies	10	**Insurance companies**
Number of Quotes in Domain	**10**	
Best practices in safety management	9	**Best practices**
Number of Quotes in Domain	**9**	
Safety risks in outsourcing	5	**Outsourcing**
Number of Quotes in Domain	5	
Land use planning and requirements for planning sites	3	**Other Codes**
Language skills	3	
Consultancy companies	3	
Internalization	2	
Chemical risks in occasional use of chemicals	2	
Changes in personnel	1	
Climate change	1	
Total Number of Quotes Related to Preparedness	**351**	

5.1.2 Laws and other regulation

Laws and other regulation was the second most frequent domain with 58 quotes in six codes, which represented 16.5 % of all quotes related to preparedness. In some cases it was considered problematic that the regulation is too open to interpretation. This may cause problems, for example if a company interprets the regulation differently from the regulatory authority. In many cases, attempts have been made to reduce problems of interpretation by collaborating with the

regulatory authority to find an interpretation that satisfies both parties. The role of the authorities was identified as a challenge in certain cases; officials should not act as consultants.

Although several regulations (e.g. EU directives or international regulations) cover the whole of the EU, it came to light, particularly concerning companies that operate globally, that laws are interpreted differently in different countries.

An external rescue plan was mentioned as an example of the difficulty of applying the regulations. On a general level, there is an EU directive that decrees that an external rescue plan should be made, as does the Finnish Law on Rescue. However, they do not specify in detail how it should be done. For this reason, the content and scope of the external rescue plan are in some cases deficient. To clarify the matter, the Finnish Ministry of the Interior has compiled guidelines for making an external rescue plan, for saving it on the database maintained by Tukes (the Finnish Safety and Chemicals Agency), and so on. By and large, it was found that guidelines for interpreting regulations should be drawn up by the authorities and be generally available e.g. on the authorities' websites. Clear guidelines could also help avoid potential differences in interpretation between authorities.

With regard to regulation, it was felt that mostly it had been drawn up without any contradictions between different regulations. However, in exceptional cases, individual contradictions in regulation were identified in some sectors. Particularly in fast-developing sectors, the development of regulation was found to be too slow in some instances. In certain cases it might be good for a regulatory text to mention some factors in such a way that they could be prescribed by law. It would thus be possible to speed up processes related to regulation, for example in situations where a sector is developing quickly.

On a general level, it was felt that regulation related to safety should always be written in binding form, not for example in the form of a recommendation. Thus there could be explicit sanctions for failing to comply, for instance. Likewise it was considered that without mandatory regulation, sufficient contingency measures would not be taken.

One issue that arose was IT systems and data security, which are currently regulated by a special act, the Act on Data Privacy (Laki 16.6.2004/516). The point was raised that the data and cyber security perspectives could also be taken into account in general safety-related regulation.

One example mentioned concerning the development of regulation to improve the flow of information was the reform of the regulation governing the operations of the Prime Minister's Office situation center.

In many sectors, contingency planning is not enshrined in law. In broad terms, it was found that when regulation develops in future it should take into account disruptive situations (floods, storms, etc.) and preparedness for them so that the

preparedness obligation is made to cover all parts of society, including the public and business sectors.

5.1.3 Companies' preparedness planning

The third most frequent domain was companies' preparedness planning. It included 41 quotes in 7 codes representing 11.7 % of all quotes. For example, different backup systems, contingency planning itself, as well as the development of operations for a variety of unexpected situations were at the top of the list, and also the fact that regulations and group policies are sometimes contradictory.

More and more operations are dependent on the functioning of electricity and IT networks. It was the view of the experts that companies in general and electricity and IT network companies in particular should develop or add back-up systems, in order to minimize potential outages. In planning for longer disruptions, companies should also pay more attention to the availability of other critical resources.

Nowadays, many companies operate in cooperation with other companies in networks or via long chains of subcontractors. It was felt that corporate preparedness planning should take into consideration more not only their own operations but also the ability of the whole network to operate during disruptions. This should also be taken into account in companies' internal rescue plans and the authorities' rescue plans.

According to the experts, corporate quality and management systems as such are on average at a satisfactory level in normal operating processes. As far as quality and management systems are concerned, there is room for improvement in the fact that they have not sufficiently taken into account major abnormal situations. Instructions in the event of a major accident may be deficient or, in the worst case, non-existent.

5.1.4 Education and training

The fourth most frequent domain, with 32 quotes in 2 codes, was education and training, which represented 9.1 % of all quotes. The experts highlighted the need for instance for increasing safety training extensively for all company personnel.

In the experts' opinion, both companies and authorities should train their personnel more. For example, increasing knowhow regarding chemicals was mentioned in this regard. It was particularly felt that the rescue authorities that come to the plant area should improve their knowhow about chemicals. As for companies, it was considered important that the entire network of subcontractors

should also be trained. In particular, concern was expressed about companies that do not deal with chemicals on a daily basis, but only in relation to repairs, expansion work, or annual maintenance, when the quality or quantity of substances to be handled deviates from normal.

Another significant issue related to improving training was leadership. Especially in major accidents where there are several actors, the view was that leadership knowhow should be improved, on the part of both companies and authorities. One reason for this is the fact that, since major accidents are rare, there is not sufficient practical experience of leadership situations involving many actors.

5.1.5 Attitude towards preparedness

The fifth most frequent domain was the attitude towards preparedness. It included 28 quotes in 2 codes, representing 8.0 % of all quotes. Generally speaking, the importance of preparedness is recognized in organizations in the event of power outages, exceptional natural conditions, or major accidents, for example. It is worth stressing here that the above-mentioned situations are termed incidents (i.e. they do not mean any kind of military state of emergency in this context). It could be said that at least some degree of effort is being put into making plans related to different kinds of preparedness.

Regarding attitude towards preparedness the greatest shortcomings would seem to be in implementing the plans throughout the organization. The reason for this would appear to be a lack of the right attitude, because management often allows itself to believe that “in any case this will not happen to us.” It was felt generally that only the commitment of the highest management to adequate preparedness enables an attitude change throughout an organization. It is also the case that in organizations where the disclosure of even small errors and incidents are seen as ”losing face” or as some other kind of threat, the attitude towards preparedness seems to be weaker than in other organizations. In contrast, in organizations where people strive actively to highlight the weak or vulnerable points in operations, the attitude seems to be better throughout the organization, also reaching the operational level.

It was also felt that contingency plans were partially made in order to comply with the letter of the law, rather than to ensure the continuity of the organization’s own operations. One observation was that the attitude towards preparedness was sometimes even better in companies under foreign ownership than in Finnish-owned companies.

5.1.6 Safety collaboration between companies

Safety collaboration between the companies involved included 5.7 % of all quotes in 2 codes. Collaboration between companies working in the same area or close to each other is already partially mandatory, but it was felt that increased cooperation brings many benefits. Awareness of the risks faced by another company assists a company in its own risk management and these risks can be taken into account in contingency planning. Knowing another company enables the creation of the right kind of email groups for instance and other warning systems.

One form of corporate collaboration mentioned was participation in the rescue drills or in the compilation of the rescue plan of another unit in the same group.

Particularly on the basis of experiences related to the electricity distribution problems caused by recent major storms, it was felt that collaboration between electricity and telecommunications utilities should be developed. Thus organizations would get to know each other's operating procedures and if necessary develop them together.

For example, among nuclear power utilities, an observer from one company is allowed to monitor the rescue drills of another company. Could the same kind of system work in other sectors? Correspondingly, could companies work in active safety collaboration with their competitors?

5.1.7 Cooperation between companies and authorities

One challenge to workable cooperation was felt to be the inadequacy of authority resources to engage enough with companies in branch field of industry. This domain included 5.1 % of all quotes in three codes. In some cases, cooperation was seen as being too dependent on a particular individual. Dependence on individuals was seen as a risk to "homogeneous" cooperation. Companies did not feel that enough active effort was being put into cooperation by all the authorities.

One way to develop cooperation that was mentioned was for the rescue authorities to allocate more of their human resources to higher risk areas, so that they could actively participate in compiling corporate plans and information cards together with the company, for example. It was also considered important to have better opportunities to have time to interact with a company, e.g. when compiling major accident scenarios. It was felt that this would improve the level of rescue drills etc., so that they would be able to simulate real situations better.

In addition, unofficial meetings between different players were felt to be a good way to promote cooperation between the business sector and the

authorities. Unofficial meetings could also take place so that they would be attended by the authorities and several companies working in a particular area. The business sector felt that the authorities could actively present for instance near-miss situations or real accidents that had occurred elsewhere, so that people would know how to act effectively and correctly in similar situations.

5.1.8 IT systems and data security

The domain of IT systems and data security represented 4.2 % of all quotes in three codes. When developing IT systems, one significant alternative was regarded to be the capability for several players, from both the authorities and the public sector, to utilize the same IT systems. Such systems could contain information regarding preparedness that would be useful/necessary for everybody. The objective would not be for every player to see all the data, but for each to be also able to get the information they required about incidents and resources at other organizations, for instance by means of a user ID. Naturally, the challenge is which party is able to define the necessity of the information to be given to another or, on the other hand, which information may be handed over to another party. Another challenge is managing the accuracy and timeliness of the data. In order to implement interoperable IT systems, the widest possible representation of different authorities and the business sector should be involved in the requirements specification work.

Data protection was widely felt to be an issue in the development of interoperable information systems, and the reason for the rejection of otherwise workable solutions.

External threats to IT systems (or cyber threats) have increased. Provision can be made against cyber threats in relation to vital operations in many ways. Increasingly, threats to data security are also being directed to other authorities and business sector players. For example, they could disable a company's ERP system (Enterprise Resource Planning System) or a related security system or the drainage system of a hydropower plant. All parties should develop their own data security solutions. It was felt that the need for data security advice from the Finnish Communications Regulatory Authority was growing and the hope was also expressed that it would receive the necessary resources.

5.1.9 Other domains

The interviewees also raised the following issues in relation to preparedness: prioritization, resources, and regulatory issues related to the security of supply.

One view expressed in the domain of prioritization was that regulatory control should be focused more on the risk level of the sector of the company concerned. In addition, some of the experts felt that, in future, the resources of the authorities should be prioritized more based on the significance of the target in terms of security of supply and the regional significance from the aspect of employment and tax revenue for the local municipality and the whole of society.

One of the risk factors regarding preparedness was identified as a lack of resources. For the business sector, this was identified as a risk that in some cases company contingency plans suffer from the fact that, in practice, not all companies have the extra resources required for developing preparedness activities to the extent that they would wish. A lack of resources was also identified on the authorities' side as a limiting factor for the development of preparedness actions. For instance, it was felt that increasing regulation and implementation at company sites was desirable from a safety point of view, but many considered that the development of this kind of activity was restricted by a shortage of resources.

In addition, the development of regulation was mentioned as an issue related to preparedness, particularly from the viewpoint of security of supply. It was felt that various disruptive factors are increasing in society, thus regulation should oblige critical companies in terms of security of supply to take disruptive situations into account more than earlier. For example, the electricity supply was felt to be something that should be ensured in accidents better than at present by means of regulation.

5.2 Problem domains in the response phase

The other part of the first Delphi round interviews addressed the response phase of major accidents. As a result of the analysis of the transcribed material, a total of 332 quotes were identified in the interviews related to problems in communication in the response phase. All the identified quotes were coded; 55 codes were created, out of which 45 were grouped into 15 domains. The remaining seven codes, which were not easy to group, included 27 quotes (8 % of all quotes related to the response phase). The codes and the number of quotes connected to them and the domains are shown in Table 5.

In the following sections a presentation of the most frequent domains with regard to response is given.

Table 5 Problem domains in response phase

Code	Number of quotes in code	Domain
Special vocabulary and terminology	22	**Situational awareness and flow of information**
Problems caused by multi-organizational situations	13	
Development of situation awareness systems	11	
Different systems of different authorities	8	
Jargon and nicknames	6	
Failures of situational picture due to technical problems	4	
Failures of situational picture due to other reasons	8	
Number of Quotes in Domain	**72**	
Development of rescue drills	21	**Joint authorities-company rescue drills**
Analysis of rescue drills	10	
Rescue drills do not correspond to real situations	6	
Absence of some authorities	6	
Poor attitude towards rescue drills	4	
Number of Quotes in Domain	**47**	
Instruction given to arriving authorities	9	**Communication at the time of accident and immediately after**
Rescue authorities' insufficient prior knowledge	6	
Inadequate reaction of rescue authorities	4	
Action taken by company during alarm	4	
Communication when alerting emergency centre	4	
Slow alarm process	2	
Risks because rescue authorities do not have proper site ma	2	
Improvements in access control	2	
Lack of sufficient instructions for company personnel	1	
Number of Quotes in Domain	**34**	
Importance of proper communication	23	**Communication at the accident site**
Risks caused by wrong communication	6	
Development of communication between companies	2	
Number of Quotes in Domain	**31**	
Lack of utilization of company expertise	8	**Cooperation between organizations at the site**
Cooperation between authorities at the site	5	
Cooperation between authorities and companies at the site	5	
Cooperation between companies at the site	4	
Number of Quotes in Domain	**22**	
Development of IT systems	9	**IT systems**

Common IT systems for authorities	8	
Risks caused by communication systems	4	
Number of Quotes in Domain	**21**	
Accident investigation and analysis	13	**Analysis of accidents**
Analysis of deviations	5	
Number of Quotes in Domain	**18**	
Development of VIRVE agreements	6	**Use of VIRVE**
Poor skills in using VIRVE	6	
Number of Quotes in Domain	**12**	
Utilization of companies' cameras	6	**Use of live camera**
Barriers to using companies' cameras	2	
Risks in using companies' cameras	1	
Number of Quotes in Domain	**9**	
Poor level of managerial skills	4	**Managerial skills**
Development of management of major accidents	4	
Number of Quotes in Domain	**8**	
Need for and benefits of plant fire brigades	6	**Plant fire brigades**
Number of Quotes in Domain	**7**	
Development and standardization of command centers	7	**Actions taken in command center**
Number of Quotes in Domain	**7**	
Area knowledge of rescue authorities	4	**Knowledge of accident area**
Development of area instructions	2	
Number of Quotes in Domain	**6**	
Lack of knowhow of rescue authorities (e.g. chemicals)	6	**Specific skills of rescue authorities**
Number of Quotes in Domain	6	
Language skills	5	**Language skills**
Number of Quotes in Domain	**5**	
Lack of resources of authorities	4	**Other Codes**
Avoiding loss of organization image	4	
Subcontracting / Substitutes/ Deputies	4	
Overall understanding of risks in an area	3	
Use of symbols	3	
Development of process charts	3	
Protection of privacy	3	
Developing of reward systems	1	
Utilizing a technical interpreter	1	
Project nature of the business activity	1	
Total Number of Quotes related to Response	**332**	

5.2.1 Situation awareness and flow of information

Situation awareness and flow of information was the most common domain. It included 7 codes, with a total of 72 quotes. It represented 21.7 % of all quotes related to the response phase. The experts had often experienced problems with special vocabulary and terminology as well as jargon. Additionally, the lack of a proper system for collecting and sharing situation-related information was very often mentioned in this domain.

According to the experts, there is plenty of potential for improvement in the information systems required to obtain the right kind of situation awareness. One of the most significant single factors that arose was the lack of interoperability between the IT systems used by the authorities. This causes problems, particularly in the management of major accidents, where units from various authorities are performing rescue operations simultaneously. In addition, some organizations did not have a decent information system available, and some tasks were handled in the traditional way with pen and paper, which is why the information transmitted to others was not real-time. According to the experts, although there had been an intention to invest in situation awareness systems, for various reasons some good development ideas had had to be shelved, not only because of money, but also due to limited human resources. One challenge facing projects to develop common information systems is the view of individual authorities that information cannot be shared with other authorities, let alone with companies, for reasons of data security.

Another challenge in designing interoperable IT systems is posed by the varied terminology used by different actors. Firstly, differences were observed between the interpretations made by actors from the authorities and business life. Each sector and branch of administration has its own special words related to its own field, but nevertheless the majority of special terms could be combined and simplified in a coordinated way and by creating nationwide guidelines. Secondly, numerous examples came to light where corporate staff had not been able to express themselves clearly when making the emergency call, nor were they able for instance to guide the rescue authorities adequately when they arrived at the plant site. According to the experts, this issue could also be eliminated at least partially by means of ground rules and guidelines compiled by companies and the authorities together.

5.2.2 Joint authorities-company rescue drills

The second most frequent domain was joint company-authorities rescue drills. This domain had 5 codes with a total of 47 quotes representing 14.5 % of all

quotes. The companies involved in this Delphi study are all the kind that are obliged, due to the nature of their business, to organize accident/rescue drills at least once a year where the local rescue authorities are invited, and if required, also the official regulatory authority at national level (e.g. the Finnish Safety and Chemicals Agency for the chemical industry, the Radiation and Nuclear Safety Authority for the nuclear industry). The experts were quite dissatisfied with the rescue drills they had attended and above all with the execution of the development ideas arising from the drills. The experts also argued that the planning of rescue drills was very often poor and also that the commitment of attendees could have been better.

According to the experts, even though drills were organized, they tended to concentrate on only the most typical or small-scale accidents. It was considered that there was a lack of drills concerning major accidents and the most serious cases in particular. This results in the fact that insufficient attention is paid in the drills to situations where, for example, there would be several units from different authorities carrying out rescue operations at the same time.

Shortcomings were found in the analyzing of rescue drills. The most significant focus for improvement was considered to be documentation of the progress of the rescue drill, the analysis of the drill, and the feedback discussion between company representatives and the authorities. One could easily argue that these findings related to rescue drills indicate potential difficulties in the management of real accidents.

5.2.3 Communication at the time of the accident and immediately after

Communication at the time of the accident and immediately after was the third most common domain, with 34 quotes in 9 codes. It represented 10.2 % of all quotes. The poor level of information, and inappropriate or inadequate information given to the authorities (e.g. fire service) at the site was one of the most frequently mentioned issues. The lack of sufficient instructions and to-do lists for company personnel was also often mentioned.

According to the experts, company instructions for raising the alarm have been inadequate. One problem was felt to be that there was often a tendency in companies to underestimate the seriousness of the situation initially. This may lead to the rapid deterioration of the situation and to the complicating of the management of a major accident and an increase in the damage caused. Another issue raised was the situation where a company employee alerts the emergency center, but does not inform people inside the company of the incident in the appropriate manner. This may result in a situation where, for example, the rescue authorities that arrive on site cannot be guided to the right place in the plant. The

consequence of this may also be that the expertise within the company cannot be utilized immediately in support of the rescue operations.

One deficiency was felt to be the fact that the rescue authorities did not have sufficient prior knowledge available of the risks of the companies in the area they are responsible for. One factor that could improve the situation would be that at least all command level authorities should visit the company and thus get an overall understanding of the processes of the company and the plant area including e.g. fire extinguishing system diagrams, which also should be made available to the rescue authorities in electronic form. This would enable more efficient rescue operations, because the rescue authorities often have computers in their fire trucks. As a minimum, firms should have up-to-date drawings, process flow sheets, and fire extinguishing system diagrams printed on paper to give to the rescue authorities arriving on site.

5.2.4 Communication at the accident site

Communication at the accident site including the media was the fourth most common domain with 31 quotes in three codes representing 9.3 % of all quotes. In addition to internal communication, the experts also emphasized the importance of good communication outside the accident site (e.g. via radio, press and Internet). They also knew of cases where poor communication and flow of information had changed things for the worse.

Communication is crucial, especially with regard to major accidents, since they often have consequences beyond the actual accident site, e.g. for local residents and other companies. Therefore, it is important that it is clear who has the responsibility for disseminating information in terms of briefings. Part of a rescue plan should be a pre-compiled operating model of who is responsible for disseminating information and for giving information to all necessary parties about the accident that has occurred.

It is the authorities' responsibility to inform and warn the public via the media and also inform them of the steps taken to minimize damage. In turn the company takes care of its internal safety communication and also to inform the public what kind of damage the company's facilities have suffered, as well as whether the accident has affected production. If an industrial estate or industrial park is affected where several companies operate, it is extremely important that the company where the accident has occurred informs the other firms in the area about the accident. This allows the other companies in the area to warn their staff, if necessary start their own rescue operations, and take into account the effects of the accident on their own production.

It seems that the authorities bear responsibility for disseminating information about the immediate danger posed by the accident to the local people and environment. A crucial part of any briefing by the authorities together with a company is to communicate the steps that have been taken and when the situation is expected to normalize. Adequate communication also has the effect that the emergency center will not receive any further unnecessary calls about the same incident, which in the worst case could lead to overloading the emergency center personnel and IT systems.

5.2.5 Cooperation between organizations at the site

Communication problems caused by cooperation between organizations at the site were the fifth most common domain with 22 quotes in four codes. This represents 6.6 % of all quotes. This domain included issues related to cooperation between companies and the authorities, between different authorities, and also between different companies.

In major accidents that occur inside a company or on a company site, it should be ensured that the expertise and local knowledge of the company representatives regarding the special features of the plant are brought to the knowledge of the rescue authorities. This is even more important for instance in production facilities where dangerous substances are handled. It cannot be assumed that the properties of each chemical substance are clear to every member of the rescue authorities who arrives on site; each chemical has certain characteristics, and rescue operations should be designed accordingly to minimize additional damage. Therefore, more attention than before has to be paid to the preparedness of corporate personnel and the authorities to co-operate at the accident site.

Particularly during major accidents, representatives from several authorities will be present. The point was raised that the lack of seamless cooperation between the authorities was visible in the difficulty of communicating, especially in operations requiring quick decision-making. In the the experts' view, matters of jurisdiction between the various authorities may sometimes crop up, but this occurs less often nowadays than earlier.

It is worth noting that, in industrial parks where several companies operate, it is important to warn neighboring firms of the risks they are exposed to and if necessary to work in cooperation to prevent damage from the accident. In particular, problems with the flow of information to other companies may cause additional hazardous situations.

5.2.6 IT systems

Issues related to communication systems were the sixth most common domain (6.3 % of all quotes). In particular, the experts expressed a desire for greater interoperability of organizations' management and communication systems in accidents. However, the experts involved in the study argued that one has to be aware of the vulnerability of electronic IT systems, for example as a result of an IT systems failure or a prolonged power outage.

One of the most frequent comments was that the IT systems used by the authorities did not communicate with each other. One reason for this was the fact that the data in the systems was considered to contain confidential information. Changing the existing systems into systems that, for example, at login could give each member of the authorities a "view" pertaining to him/her, was proposed as a solution, but it was thought too difficult and expensive. One alternative would be an open discussion on which information really is confidential and which could be shared with other agencies. Overall, the experts felt that it is difficult to make IT systems compatible.

The same reasons were mentioned with regard to corporate IT systems. There is a lot of information in corporate IT systems that could be utilized in rescue operations related to major accidents. However, putting the information into such a form that it could be utilized by the authorities was regarded to be sensitive in terms of data security or too complicated and expensive. Even information such as for instance up-to-date company layout drawings and the hazardous substances in each area or the quantities of these substances was sometimes considered to be too confidential.

5.2.7 Post-analysis of accidents

Generally speaking, the post-analysis of accidents and near-miss situations was considered important, but according to the experts analyzing was nevertheless not done sufficiently. This was the seventh most common domain with 5.4 % of all quotes. Even though analyzed information does exist, it is not exploited enough (cf. repeated incidents of the collapse of buildings such as shopping malls, sports halls, and riding schools).

Analyzed information on accidents that have occurred is available from insurance companies, international business associations, and authorities. The authorities expressed a wish for more active information sharing of analyzed accidents in addition to their being posted on companies' own websites - for example, in the form of a briefing on the accident situation supplied to companies in the same sector and other authorities.

In some organizations, examining incidents and near-miss situations is part of a preparedness-related business culture and this was considered good practice. It was felt to be important that this way of working be increased. The violent storms experienced in Finland in recent years have played a part in increasing the analyzing of incidents and the experience gained has been utilized in the development of operating processes. For instance, analysis related to accidents in multinational corporations could be exploited, and indeed is already being exploited to some extent, at other sites of the same company worldwide.

5.2.8 Use of VIRVE

The use of the VIRVE network and handsets was mentioned, with 3.6 % of all quotes. (VIRVE is the Finnish authorities' nationwide network. It is a secure voice communication network with dedicated handsets for users.) VIRVE is mainly used by authorities but in some cases companies may also apply for it. It can for example be used to maintain a direct connection in the field from one phone to another, or to groups of phones.

The utilization of VIRVE handsets, particularly in companies at risk of a major accident, was believed to be a factor that increased safety, since the flow of information between the company and the authorities would remain unbroken during the incident, even if the normal phone networks are not working for some reason. On the other hand, some of the interviewees found the use of VIRVE problematic, as they had observed in practical situations that the VIRVE network does not always work, and that not enough people know how to use the VIRVE handset properly. Training in the use of VIRVE handsets was considered one area for improvement in the future.

5.2.9 Other domains

The interviews also raised other issues in relation to rescue operations. Utilization of camera images was one of the technologies supporting rescue operations also mentioned as one factor that may improve the situational picture and flow of information in the response phase. In particular, the use of corporate surveillance cameras during major accidents was seen as something that could be exploited more in future to improve the situational picture in command center operations. On the other hand, the danger in using camera images was that monitoring them continuously in real time could reduce concentration on the incident itself, which could hamper the anticipation of where a fire could spread, for example.

Issues related to leadership in the response phase were also brought up during the interviews. One issue that was highlighted in particular was the fact that major accidents are multi-authority situations and in such cases the management relationships may be unclear. Another issue related to leadership was felt to be that there is no major accident management expertise in some companies in real situations. Major accident management training was seen as a key target for development to improve managerial skills related to the response phase. In addition, development of command center operations was seen as an important issue in developing management in response situations. It was especially pointed out that it would be vital to specify in advance the roles and division of tasks between the parties involved in command center operations, so that everyone would know how to operate in the right way from the very beginning of an accident. The development of the standardization of command center operations was also raised. It was felt that it would be good to define generally what kind of group should be present in the command center. In particular, it was thought that the role of company personnel required additional specification.

Another theme raised in the interviews in relation to the response phase was that of plant fire brigades, i.e. independent fire brigades operating within a company. Mentions of plant fire brigades mostly related to how they were regarded as necessary for the safety and contingency planning of the company. One particular benefit of plant fire brigades was considered to be the fact that they are able to respond quickly in an accident and their knowledge of the company's critical production processes was felt to be better than that of the authorities. They were also believed to improve the flow of information between the authorities and the company, since plant fire brigades were felt to have the expertise to provide the rescue authorities with the right kind of information in terms of the situational picture.

One point for improvement that was identified regarding plant fire brigades was the development of better collaboration between the rescue authorities and plant fire brigades in accidents. For example, in some cases the plant fire brigade was said to have been in the way of the rescue authorities during the accident, so that cooperation did not go smoothly. It was felt that expertise in plant fire brigade management was one matter that could help develop collaboration between the rescue authorities and the plant fire brigade in the response phase.

Another point that was mentioned concerning the response phase was the inadequacy of the authorities' knowhow, particularly in chemical expertise and fire fighting. Also, development of the authorities' local and area knowledge was seen as something to be improved in connection with response.

5.3 Summary of problem domains

The first Delphi round focused on problem domains in communication and the flow of information. This first Delphi round was carried out by means of themed interviews. The problem domains that were identified were presented in this chapter. A total of 13 problem domains were identified in preparedness and 15 in response.

1. Problem domains in the preparedness phase

Problem domains in preparedness referred to most often by the experts included:

- Operations of authorities
- Laws and regulation
- Companies' preparedness planning
- Education and training
- Attitude towards preparedness
- Safety collaboration between the companies involved
- Cooperation between companies and authorities
- IT systems and data security

The most frequent problem domain in preparedness was the operations of authorities. The experts highlighted the lack of cooperation between the authorities and the need for better coordination between different authorities. Also, safety documents issued by the authorities and those supplied to them by companies are fragmented and saved in such a way that they cannot be utilized properly. It was highlighted that the authorities are not good at disseminating their safety knowhow to companies, although they possess a lot of knowledge of good practices. The hope was expressed that authorities would act in more of an advisory or briefing role in relation to preparedness than they do at present.

In some cases it was considered problematic that legislation is too open to interpretation. In general, it was felt that guidelines for interpreting legislation should be drawn up by the authorities and that they would be generally available e.g. on the authorities' websites. Clear guidelines could also help avoid potential differences in interpretation between authorities. However, with regard to legislation, it was felt that mostly it had been drawn up without any contradictions between different regulations. In general, it was found that when legislation develops in future it should take into account disruptive situations (floods, storms, etc.) and preparedness for them so that the preparedness obligation is made to cover all parts of society, including the public and business sectors.

In companies' preparedness planning for example, different backup systems, contingency planning itself, as well as the development of operations for a variety of unexpected situations were at the top of the list, and also the fact that regulations and group policies are sometimes contradictory. Corporate preparedness planning should take into consideration more not only their own operations but also the ability of the whole network, including subcontractors, to operate during disruptions.

In the experts' opinion, both companies and authorities should train their personnel more. For example, increasing knowhow regarding chemicals was mentioned in this regard. It was particularly felt that the rescue authorities that come to a plant area should improve their knowhow of chemicals. Especially in major accidents where there are several actors, the view was that leadership knowhow should be improved, on the part of both companies and authorities.

The greatest shortcomings in attitude towards preparedness seem to be in implementing the plans throughout the organization. The reason for this would appear to be a lack of the right attitude, because management often allows itself to believe that "in any case this will not happen to us." Also, it was felt that contingency plans were partially made in order to comply with the letter of the law, rather than to ensure the continuity of the organization's own operations.

Safety collaboration between companies working in the same area or close to each other was felt to be important. Awareness of the risks faced by another company assists a company in its own risk management and these risks can be taken into account in contingency planning. Also cooperation between companies and authorities was felt to be sometimes inadequate. It was considered important for authorities to have more have time to interact with a company, e.g. when compiling major accident scenarios.

External threats to IT systems, or cyber threats were recognized. Provision can be made against cyber threats in relation to vital operations in many ways. All parties should develop their own data security solutions. It was felt that the need for data security advice from the Finnish Communications Regulatory Authority was growing and the hope was also expressed that it would receive the necessary resources.

2. Problem domains in the response phase

Problem domains in response referred to most often by the experts included:

- Situation awareness and flow of information
- Joint authorities-company rescue drills
- Communication at the time of the accident and immediately after
- Communication at the accident site

- Cooperation between organizations at the site
- IT systems
- Analysis of accidents
- Use of the authorities' network (VIRVE)

Situation awareness and flow of information was the most common domain in response. The experts had often experienced problems with special vocabulary and terminology as well as the lack of a proper system for collecting and sharing situation-related information. One of the most significant single factors that arose was the lack of interoperability between the IT systems used by the authorities. One challenge facing projects to develop common information systems is the view of individual authorities that information cannot be shared with other authorities, let alone with companies, for reasons of data security. Another challenge in designing interoperable IT systems is posed by the varied terminology used by different actors.

The experts were quite dissatisfied with the rescue drills they had attended and above all with the execution of the development ideas arising from the drills. The experts also argued that the planning of rescue drills was very often poor and also that the commitment of attendees could have been better. Shortcomings were also found in the analyzing of rescue drills.

The poor level of information, inaccurate or inappropriate information given to the authorities (e.g. rescue authorities) at the site was raised as well as the lack of sufficient instructions and to-do lists for company personnel. Company instructions on raising the alarm have been inadequate. One problem was felt to be that there is often a tendency in companies to underestimate the seriousness of the situation initially. One deficiency was felt to be the fact that the rescue authorities did not have sufficient prior knowledge available of the risks in the companies. Electronic and up-to-date information cards would help in this. In addition to internal communication, the experts also emphasized the importance of good communication outside the accident site (e.g. via radio, press and Internet). In major accidents that occur inside a company or on a company site, it was considered important that the expertise and local knowledge of the company representatives regarding the special features of the plant were brought to the knowledge of the rescue authorities.

The experts expressed a desire for greater interoperability of organizations' management and communication systems in accidents. However, the experts argued that the vulnerability of electronic IT systems has to be borne in mind, for example, as a result of an IT systems failure or a prolonged power outage.

The analysis of accidents and near-miss situations was considered important, but analyzing was nevertheless felt to be insufficient. Even though analyzed information does exist, it was not exploited enough. The authorities expressed a

wish for more active information sharing of analyzed accidents. The utilization of VIRVE terminals, particularly in companies at risk from major accident, was believed to be a factor that increased safety, since the flow of information between the company and the authorities remains unbroken during the accident, even if the normal phone networks are not working for some reason. Training in the use of VIRVE devices was considered one area for improvement in the future.

6 POTENTIAL IMPROVEMENTS IN THE PREPAREDNESS PHASE

Preparedness and potential improvements in communication and the flow of information were one topic of the second and the third Delphi rounds. The questionnaires on preparedness are presented in APPENDIX 3 and APPENDIX 4.

6.1 Findings in the second Delphi round

6.1.1 Prioritization of authority operations

The experts were asked to assess the future of target prioritizing in connection with the preparedness planning of the authorities. The experts were asked to evaluate the following claim:

In the future, the authority operations will be prioritized by the target's local relevance more than before.

The prioritizing point of view stood out from the answers in the first Delphi round because the resources available for the authorities were seen as one of the challenges connected to preparedness and some of the interviewees raised at this point the importance of the new kind of focus of prioritizing. At the moment, target prioritizing is primarily defined by personal risk (schools, hospitals, apartment houses and the number of people at the facility) and the dimension of material costs but some of the experts also thought that the target's local relevance should be taken into account more, for example from the point of view of employment and taxation. A target might be critical in terms of local significance; the target might be for example an important employer in a small municipality.

6.1.1.1 Probability of prioritizing authority operations by the target's local relevance

The experts were asked to assess the probability of prioritizing development (-3 = highly unlikely … +3 highly likely). Forty-two answers were received (Figure 16).

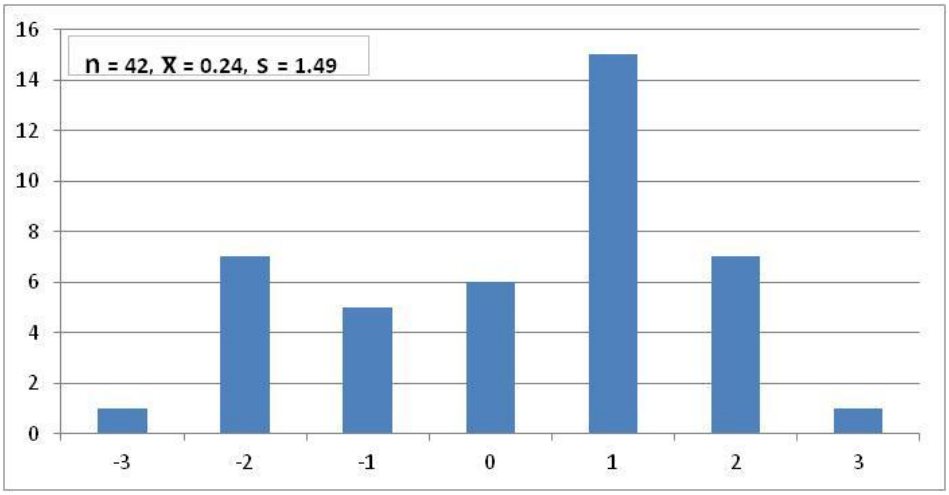

Figure 16 Probability of prioritizing authority operations by the target's local relevance

The average of the answers was 0.24, i.e. according to the experts' view it is slightly more likely than unlikely that the employment and taxation point of view will be increasingly emphasized in authority operations in future. However, views on the probable development diverged somewhat (the standard deviation of the answers was 1.49). The claim was considered unlikely by 13 experts and likely by 23 experts. Six experts did not foresee any changes to the current situation.

The company representatives considered the development more likely than the two other respondent groups, as their average answer was 0.69 (Table 6). The answers of the company representatives also had the lowest divergence (standard deviation was 1.04). Representatives of the rescue and regulatory authorities viewed the significance of the employment and taxation point of view being emphasized more in the future as fairly likely. The most critical towards the kind of development represented in the claim were the stakeholders, who considered the claim to be somewhat unlikely (average answer -0.45).

Table 6 Probability of prioritizing authority operations by the target's local relevance, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1	2	1	3	5	2	1	15	0.27	1.61
Companies		1	1	3	8	3		16	0.69	1.04
Stakeholders		4	3		2	2		11	-0.45	1.63

Those who considered the realization of the claim to be unlikely argued that the probable focus of the authority operations would be so-called civilian targets (shopping centers, schools etc.). The responsibility was not only seen as an issue for the authorities, but the actors in the private sector should also be asked to take greater responsibility. Also, the kind of prioritizing mentioned in the claim was seen as not belonging to an egalitarian welfare state. One expert argued the following:

> *"Employment and taxation aspects should not be treated at all in relation to safety. Authorities should not let these affect their judgment. Safety should be guaranteed equally for everybody in all parts of the country."*

On the other hand, the prioritizing mentioned in the claim was viewed as likely because it was felt that in future, the target's local or even national effectiveness would be emphasized in the risk analysis, for example when considering a long-term suspension of activities caused by a major accident at the target. Because resources are limited, it is vital from the perspective of the continuity of local and national operations that the important targets are protected. Many issues are affected by money, and it is also believed that this will affect the prioritizing of authority operations in municipalities. In addition, some of the experts felt that prioritizing based on local relevance, as described in the claim, will be done more and more in future but that further maintaining the vital operations of a certain area or a whole country will lie behind the prioritizing, rather than the employment or taxation perspective

6.1.1.2 Desirability of prioritizing authority operations by the target's local relevance

The experts were also asked to assess the desirability of prioritizing (-3 highly undesirable … +3 highly desirable). Forty-two answers were received (Figure 17).

The average of the answers on the desirability of prioritizing authority operations was 0 and the answers diverged quite a lot (standard deviation 1.68). 13 experts viewed the realization of the claim as undesirable and 18 as desirable. Eleven experts answered neutrally towards the claim.

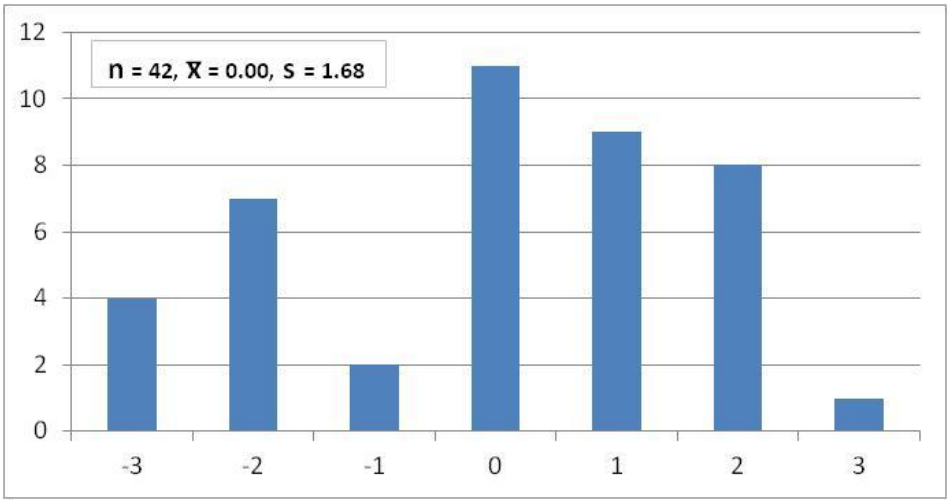

Figure 17 Desirability of prioritizing authority operations by the target's local relevance

The company representatives regarded prioritizing the authority operations as more desirable, but they also evaluated the increase in prioritizing as only somewhat desirable (Table 7). The representatives of the rescue and regulatory authorities and stakeholders evaluated the development of prioritizing as somewhat undesirable, but the answers of the respondent groups diverged widely.

Table 7 Desirability of prioritizing authority operations by the target's local relevance, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	2	3		6	1	2	1	15	-0.27	1.77
Companies		3	1	3	5	4		16	0.38	1.41
Stakeholders	2	1	1	2	3	2		11	-0.18	1.83

It was seen as an undesirable development that human lives would be put in unequal positions based on where they live, whether they happen to live in an area that is important or unimportant for the economy. The employment and taxation perspective should be kept separated from the safety perspective, and the

safety authority should not let anything other than safety issues affect the targeting or treatment of actors. One expert argument was:

> *"The operations of the authorities should only be based on risk-assessed thinking, taking into account probabilities and vulnerabilities."*

The justification for the desirability of prioritization was that the availability of the operational services should be taken into account in all fields, i.e. societal influence should be taken increasingly into account. It was also seen that from the point of view of the vital operations of society, the target's relevance should be taken more strongly into account in risk analysis alongside the traditional personal and accident risks.

6.1.2 Changing the implementation of regulation

As the second issue concerning preparedness, the experts were asked to assess the development of changing the way regulation is implemented. The experts were asked to assess the following claim:

In the future, the authorities will collaborate more with companies in interpreting the regulation, taking the special needs of the company more into account.

The development of the type represented in the claim was raised in the interviews of the first Delphi round as one development possibility, because the interviewees brought up the point that many companies feel it challenging to implement the regulations concerning safety in their companies at the moment. The current regulation was considered to leave a lot of room for interpretation on how the aspects concerning safety should be taken into account in the company's operations.

It was seen as a problem and an issue for development that the demands from the authorities concerning preparedness are executed only to obey the regulation and are not felt to be useful from the perspective of the continuity of company operations.

6.1.2.1 Probability of changing ways of implementing the regulation

The experts were asked to assess the likelihood of changing the way of implementing the regulation (-3 = highly unlikely…+3 highly likely). Forty-one

answers were received (Figure 18). The experts thought development of this type to be somewhat likely, the average being 0.88. The assessments on development diverged somewhat (standard deviation 1.55). Ten experts gave a neutral answer to the claim.

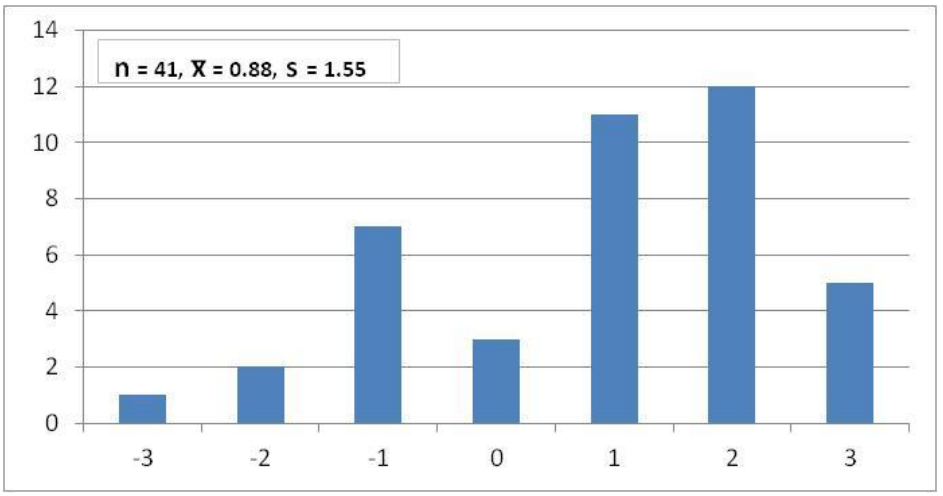

Figure 18 Probability of changing the ways to apply the regulation

When compared by respondent group, the representatives of the rescue and regulatory authorities considered it more likely that in the future the authorities will cooperate more actively with companies in interpreting the regulation (Table 8). The company representatives and stakeholders agreed less with the claim but they also considered the development to be more likely than unlikely (average of the answers 0.88 and 0.64).

Table 8 Probability of changing the ways to apply the regulation, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities		1	2		4	6	1	14	1.07	1.39
Companies		1	3	1	5	4	2	16	0.88	1.45
Stakeholders	1		2	2	2	2	2	11	0.64	1.86

The reasons given for considering the development unlikely were that in recent years the operations of the authorities have shifted in exactly the opposite direction. It was considered that advising by the authorities might even lead to the endangering of objectivity. One argument was:

"Resources are decreasing on both sides and there is no time for active cooperation."

On the other hand, the claim was considered likely based on the fact that the cooperation of the authorities and the rest of society will increase, as will service-mindedness. This is a precondition for the real development of the safety culture in both authority and company operations. The role of companies in the basic functions of society is increasing, so this development is inevitable.

6.1.2.2 Desirability of changing the ways to apply the regulation

The experts were also asked to assess the desirability of the claim (-3 highly undesirable… +3 = highly desirable). Forty-two answers were received (Figure 19). The experts considered it desirable that in the future the authorities collaborate more actively with companies in interpreting the regulation (average answer 1.64). The experts were almost unanimous on the desirability of the development (standard deviation 1.3). Approximately 85 % of the experts considered the development of the type described in the claim desirable and 5 experts had a neutral view. Only one expert considered the claim undesirable.

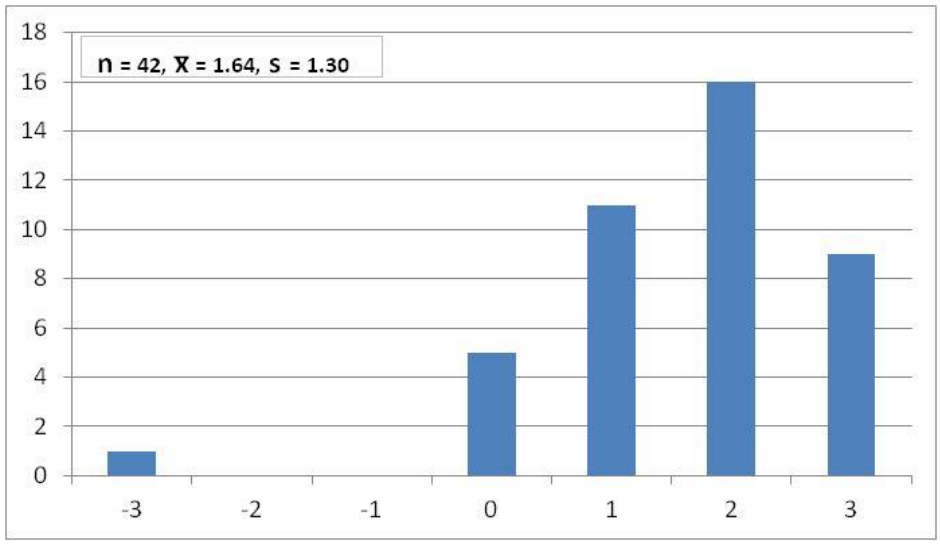

Figure 19 Desirability of changing the ways to apply the regulation

When compared by respondent group (Table 9), the company representatives were by far the group that considered the development of the type described in the claim most desirable (average answer 2.13), although all the respondent

groups considered changing the way of implementing the regulation so as to emphasize more the cooperation between the authorities and the companies as desirable.

The claim was considered desirable because cooperation between the authorities and the private sector creates a base for more efficient safety operations and development of preparedness. Authority operations based on guiding and training helps to increase the consciousness and ability of the company representatives on issues concerning preparedness.

Table 9 Desirability of changing the ways to apply the regulation, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities				1	7	5	2	15	1.40	0.61
Companies				1	4	7	4	16	2.13	1.22
Stakeholders	1			3		4	3	11	1.27	1.85

An optimal result can be achieved with good cooperation: no over- or under-preparedness and the resources of the company can be targeted cost-effectively. One expert argument was:

> *"The cooperation between authorities and companies forms the basis of effective preparedness. However, because of limited authority resources, the ways of cooperating with companies must be carefully considered, bearing in mind equality. For instance, preference for large companies should be avoided."*

The one expert who considered the claim undesirable argued that objectivity and equality would suffer if there were more cooperation.

6.1.3 Development of preparedness attitudes in companies

As the third question regarding preparedness, the experts were asked to assess the development of attitudes towards preparedness. The experts were asked to assess the following claim:

In the future the attitudes of the whole personnel towards preparedness will not improve because the company personnel are not motivated enough towards preparedness.

The claim relates to the observation raised by the experts in the interviews that, at the moment, preparedness skills depend on the expertise of a few people, for example shift managers or the person in charge of safety in the companies, and emphasizes prevention and the protection of employees from accidents. For example, safety manuals and other safety instructions are made in companies but it seems that the will to really disseminate preparedness skills to the whole personnel and for preparedness to be seen as a part of everyday activity is lacking. In order to get the experts to possibly give strict arguments along their answers, this claim was formulated in negative form. However, because the experts had challenges in interpreting the claims regarding negative development, this kind of claim was avoided as far as possible in the next round of questioning.

6.1.3.1 Probability of development of preparedness attitudes

The experts were asked to assess the probable development of preparedness attitudes (-3 = highly unlikely … +3 = highly likely). Forty-two answers were received (Figure 20). The experts considered that, on average, preparedness attitudes would develop somewhat compared to the current state (average answer -0.48). However, the answers diverged to some extent (standard deviation 1.58). Slightly over a half of the experts considered it unlikely that attitudes to preparedness would not improve in the companies and a little less than a third of the experts considered this likely. Six experts answered neutrally towards the claim.

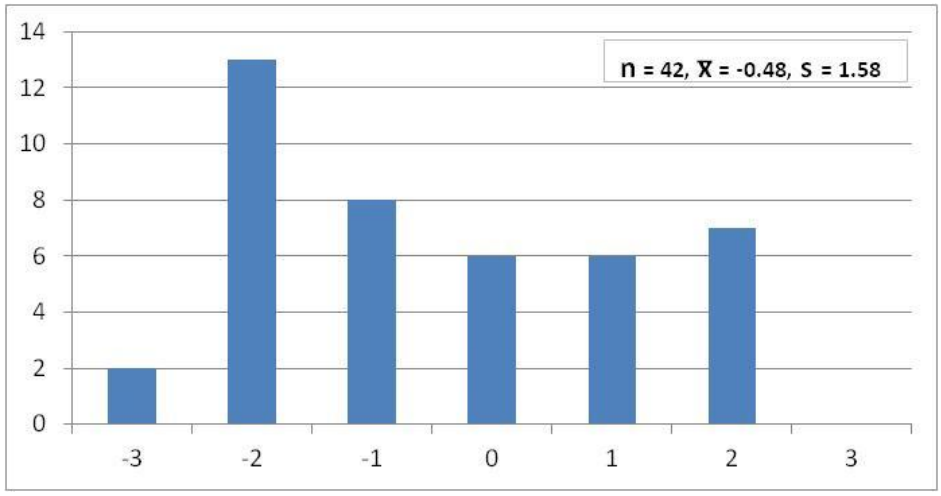

Figure 20 Probability of development of preparedness attitudes

When compared by respondent group (Table 10), the representatives of the rescue and regulatory authorities considered it more unlikely that the attitude towards preparedness in companies would not improve in the near future. The differences between the respondent groups were very small though, and all the respondent groups considered the lack of development in preparedness attitudes of companies to be slightly less unlikely than likely.

Table 10 Probability of development of preparedness attitudes, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1	5	2	3	2	2		15	-0.60	1.54
Companies		5	3	3	3	2		16	-0.38	1.41
Stakeholders	1	3	3		1	3		11	-0.45	1.86

The experts who disagreed with the claim mentioned among other things that companies have continually improved their attitude, expertise, drills, and preparedness operations. Good safety expertise is beginning to be found in the companies and it has already become a significant strategic success factor. It was also seen that in certain companies the safety culture is further advanced than among some public sector actors. The personnel are becoming committed through incentives to identify safety deficiencies and risks. Preparedness supports the continuity of the company's business, which is an asset for the whole personnel. The only challenge lies in the fact that preparedness is seen as a separate issue and not as part of everyday activity.

The experts who agreed with the claim argued that issues regarding preparedness have not received much attention because nothing serious has happened for such a long time. For this reason even people working with this issue do not necessarily take preparedness issues seriously enough. Unless demands for the personnel to take part in training and or rescue drills become obligatory, attitudes to preparedness will most likely not improve at least in the near future. Also the fact that the "it's not my job" attitude is becoming more common was seen to undermine the positive development of preparedness attitudes.

6.1.3.2 Desirability of development of preparedness attitude

The experts were also asked for their view on the desired development of attitudes to preparedness (-3 = highly undesirable … +3 = highly desirable). Forty-two answers were received (Figure 21). The experts considered on average that it was slightly undesirable that the preparedness attitude will not change in

companies in the near future (average answer -0.38). However, the answers diverged significantly (standard deviation 2.07). Slightly over a half of the experts considered the claim undesirable and 40 % desirable. Three experts answered neutrally.

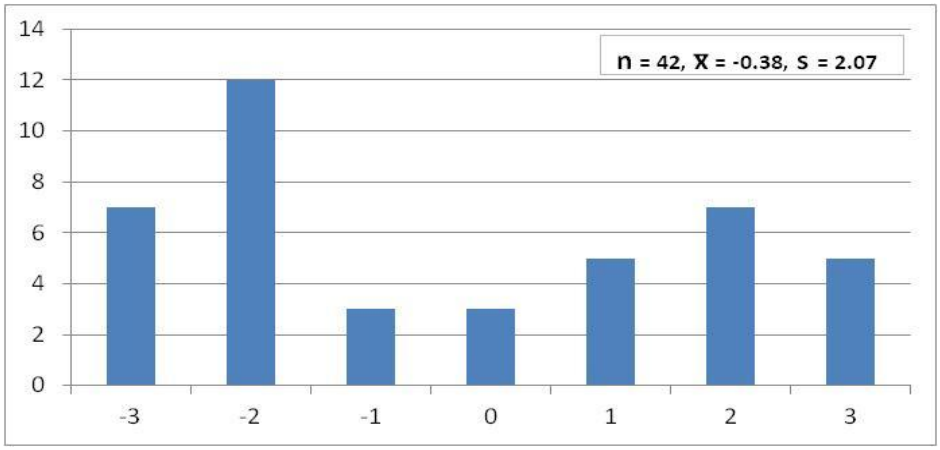

Figure 21 Desirability of development of preparedness attitude

When analyzed by respondent group (Table 11), the representatives of the rescue and regulatory authorities considered this claim slightly undesirable. The companies considered on average that it was slightly more desirable than undesirable that the attitude towards preparedness will not improve from its current state. The stakeholders considered it clearly more undesirable that the preparedness attitude of companies will not change in the next five years.

Table 11 Desirability of development of preparedness attitudes, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	2	5	1	1	2	3	1	15	-0.64	1.99
Companies	1	4	1	2	2	4	2	16	0.25	1.95
Stakeholders	4	3	1		1		2	11	-1.27	2.00

The development of the type described in the claim was considered undesirable because getting the whole personnel to participate is important in securing the continuity of business operations. The key issue that arose was how the highest management level recognizes its own role in controlling the continuity of the company and in the process of developing its operational reliability; the highest management level is that which shares out and assigns responsibilities and allocates the resources. Only when everybody understands

the process hazards of her/his actions, besides the occupational safety issues, can preparedness issues move forward. The management must take care of expertise and thus motivation.

Based on the comments of the experts who considered the development of the claim to be desirable, it was observed that they also thought the negative development described in the claim to be negative; for example “I believe that the attitude towards preparedness will remain at a good level but of course one must work hard for it all the time.”

6.1.4 Tightening regulation on major accidents and incidents

In the fourth question concerning preparedness, the experts were asked to assess the development of regulation on major accidents and incidents. The experts were asked to assess the following claim:

In the future the regulation will oblige all actors to take major accidents into account more.

The claim concerns the trend that was raised in the interviews that society is more vulnerable than before because different kinds of natural major accidents such as storms and floods, for example, are likely to increase. At the moment when planning, organizations do not take into account enough the fact that operational processes planned for the normal state do not function in accidents.

6.1.4.1 Probability of tightening regulation on major accidents and incidents

The experts were asked to assess the probability of increasing preparedness for major accidents (-3 = highly unlikely … +3 = highly likely). Forty-two answers were received (Figure 22). Tightening the regulation on emergencies was considered likely as a rule (average answer 1.31). The experts were fairly unanimous regarding the development as 3/4 of the experts considered the development likely. Only 3 experts considered the development stated in the claim to be unlikely and 8 experts answered neutrally (standard deviation 1.37).

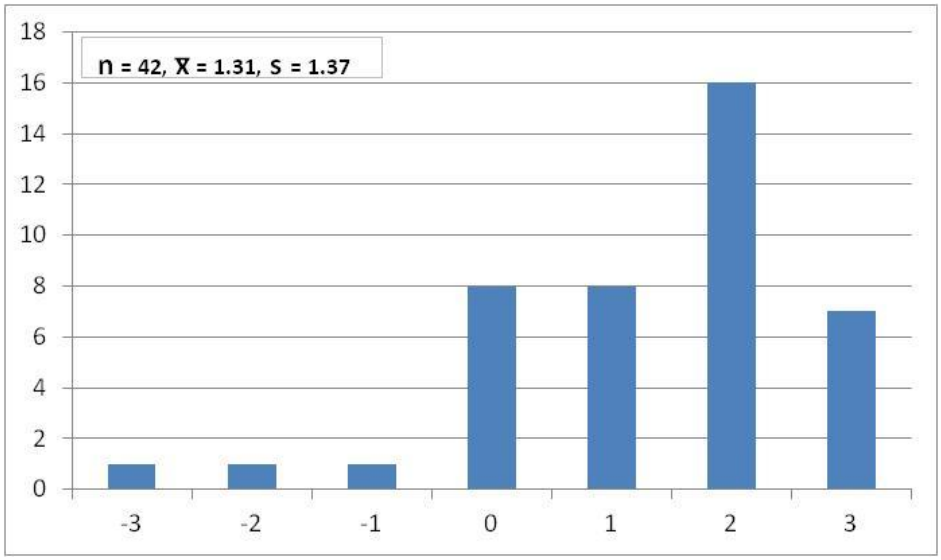

Figure 22 Probability of tightening the regulation on major accidents and incidents

When analyzed by respondent group, the company representatives considered tightening the regulation on major accidents to be more likely (Table 11). None of the company representatives considered the development unlikely. The stakeholders and the representatives of the rescue and regulatory authorities also considered the development fairly likely. Among the stakeholders and the representatives of rescue and regulatory authorities a few individual experts assessed the development as unlikely but on average the experts were quite unanimous on tightening the regulation on major accidents and incidents.

Table 12 Probability of tightening the regulation on major accidents and incidents, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1			3	4	7		15	1.00	1.32
Companies				3	2	7	4	16	1.75	1.03
Stakeholders		1	1	2	2	2	3	11	1.09	1.70

Reasons for considering the development unlikely were simply because the experts did not believe the regulation would tighten in the near future. In contrast, the majority of the respondents considered the development stated in the claim likely because society was seen to be more vulnerable than before as e.g. exceptional weather conditions seem to be increasing and society is nowadays more dependent on technology. One expert argument was:

> *"Because of the decreasing possibilities of authorities to safeguard all functions of society, regulation will develop in the direction of obliging companies to prepare independently for various kinds of major accidents more than before."*

Especially the company representatives emphasized that the vulnerability of society will force the tightening of regulation. Some of the experts believed that the more important the field of business is for the functioning of society, the more likely it will be to set down obligations regarding preparedness.

6.1.4.2 Desirability of tightening regulation on major accidents and incidents

The experts were also asked to assess the desirability of the claim (-3 = highly undesirable … +3 = highly desirable). Forty-two answers were received (Figure 23). The development of regulation on major accidents was considered on average likely (average answer 1.62). The experts were almost unanimous (standard deviation 1.32). About 85 % of the experts considered the development described in the claim to be desirable. Only three experts considered the development undesirable and three answered neutrally.

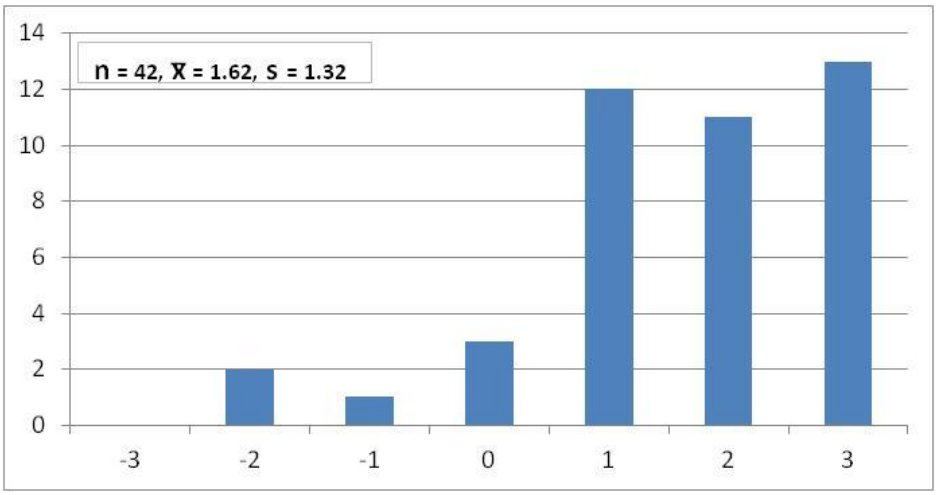

Figure 23 Desirability of tightening the regulation on major accidents and incidents

When analyzed by respondent group (Table 13), of all the respondent groups, the stakeholders and the company representatives considered tightening the regulation on emergencies to be clearly more desirable. These respondent groups were also fairly unanimous on the desirability of the development.

Table 13 Desirability of tightening the regulation on major incidents and incidents, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities		2		1	6	2	4	15	1.20	1.56
Companies			1	2	1	7	5	16	1.81	1.18
Stakeholders					5	2	4	11	1.91	0.94

According to the experts, concerning tightening the regulation, companies should themselves consider the continuity of their processes without regulatory sanctions. On the other hand, according to those in favor of increasing regulation, regulation should be developed but it should be done in good cooperation and in open dialogue with companies. However, when preparing the regulation, a thorough impact analysis must be done because the regulation will most likely lead to stiffer structures and an increase in costs. One expert argument was:

> *"This is very desirable. Preparedness for exceptional conditions is not the duty of the public sector alone. Companies should invest more in preparedness. On the other hand, all the actors should have better knowledge of each other's risks and preparedness plans."*

It was seen that the binding power of regulation is the only way to make different actors invest in preparedness for major accidents. In addition, the companies emphasized the fact that the development described in the claim is desirable because control of the business continuity would improve when there are fewer accidents.

6.1.5 Development of preparedness collaboration in companies

In the fifth question concerning preparedness, the experts were asked to assess the development of preparedness cooperation. They were asked to assess the following claim:

Company cooperation linked to preparedness (e.g. benchmarking) will not increase because companies are afraid that the motive for some companies (e.g. competitors) is trade secrets rather than developing preparedness.

The claim is connected to the development suggestion that arose in the interviews that company cooperation should be developed and that companies in the same field of business could learn from each other's rescue drills. On the

other hand, some of the experts doubted if companies, even these days, understand the benefits of cooperation enough.

6.1.5.1 Probability of development of preparedness cooperation in companies

The experts were asked to assess the probable development of preparedness cooperation (-3 = highly unlikely … +3 = highly likely). Forty-two answers were received (Figure 24).

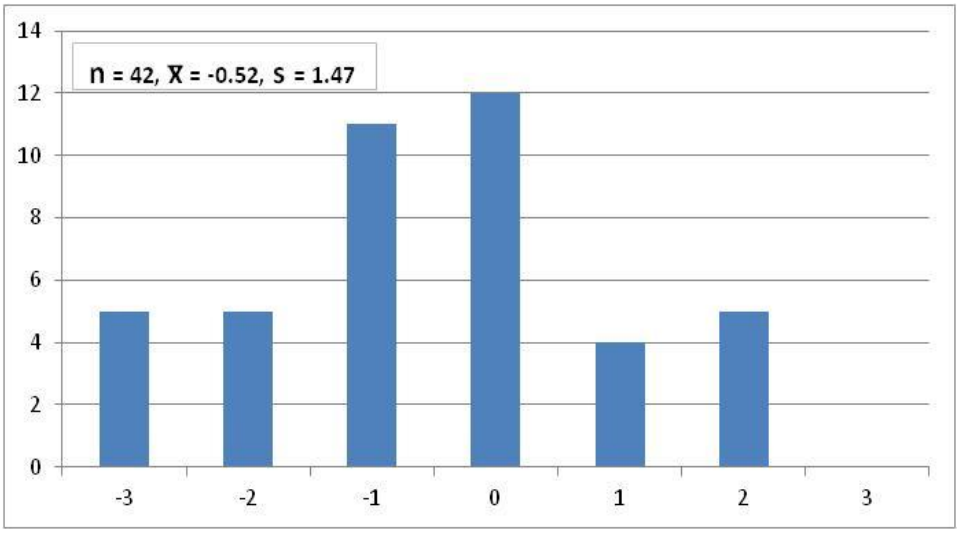

Figure 24 Probability of development of preparedness cooperation in companies

The experts considered the stagnation of cooperation linked to preparedness to be slightly unlikely (average answer -0.52). Assessments on the development diverged slightly (standard deviation 1.47). Half of the experts considered the development unlikely and one in five likely. A little over a quarter of the experts answered neutrally.

Out of all the respondent groups, the stakeholders considered the lack of development of company cooperation to be more unlikely (Table 14). The company representatives' average answer of -0.13 is close to neutral, i.e. the company representatives did not foresee a big change in the development.

Table 14 Probability of development of preparedness cooperation in companies, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1	1	6	4	2	1		15	-0.47	1.20
Companies	1	2	2	7	1	3		16	-0.13	1.41
Stakeholders	3	2	3	1	1	1		11	-1.18	1.66

The experts who considered the development of the type described in the claim unlikely argued that companies already undertake a lot of cooperation on preparedness and the risk of trade secrets is not considered in the desire for knowledge on safety issues. Trade secrets can be secured, even though lessons on preparedness are taken. One argument was:

> *"The network I have shares safety information with an open-mind. I have often received valuable safety information, e.g. safety instructions or procedures, from colleagues in other companies. I would like to say: safety matters are not subject to copyright."*

One justification mentioned was a view, according to which safety is more important than economic competition. It was also felt that networking and cooperation would increase in the future, which would also increase cooperation connected to preparedness.

6.1.5.2 Desirability of development of preparedness cooperation in companies

The experts were also asked to assess the development described in the claim (-3 = highly undesirable … 3 = highly desirable). Forty-one answers were received (Figure 25). On average, the experts considered the development described in the claim to be slightly undesirable (average answer -0.12). The assessments of the claim diverged strongly (standard deviation 2.29). Slightly less than half of the experts considered the development undesirable and a little less than half desirable. Six experts answered neutrally.

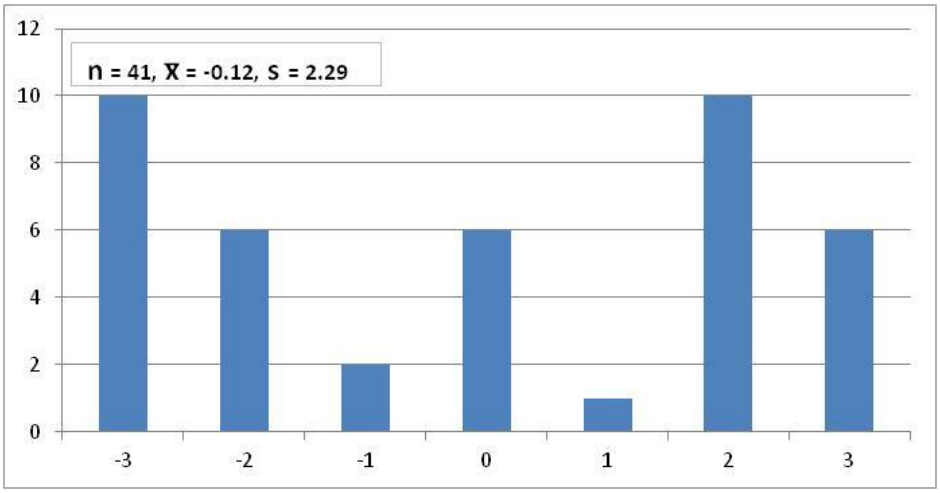

Figure 25 Desirability of development of preparedness cooperation in companies

The stakeholders considered the development described in the claim to be more undesirable (Table 15). Also, the representatives of the rescue and regulatory authorities considered the development to be slightly more desirable than undesirable. In contrast, the companies considered the claim to be slightly desirable. The justification for the undesirability of the claim was that the companies have the chance to benefit from the safety sector's good shared practices and it would be undesirable if corporate espionage would prevent fruitful cooperation. With the help of safety cooperation, the business could improve its expertise and development.

Table 15 Desirability of development of preparedness cooperation in companies, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	3	3	1	1	1	5	1	15	-0.13	2.16
Companies		3	1	5		4	2	15	0.47	1.71
Stakeholders	7					1	3	11	-0.91	2.91

From the comments of those who considered the development desirable, it was observed that they also thought the development described in the claim to be negative; for example "Benchmarking on safety issues is a good thing. It only has to be clearly limited to factors that do not jeopardize trade secrets." Because there were challenges in interpreting claims concerning negative statements, these kinds of claims were avoided as far as possible in the next round of questions.

6.1.6 Improvements in the operations of authorities in relation to company preparedness

In the interviews of the first Delphi round, many development suggestions arose with the help of which, the experts estimated that the authorities would be able to improve their operations in relation to company preparedness. It was attempted to test the importance of these development suggestions from the perspective of improving safety.

The experts were asked to assess the importance of 12 different factors in developing authority operations regarding preparedness to major accidents in the short- and long-term. The experts chose 3 out of the 12 factors that they thought were the most important development suggestions in both the short-term (1–2 years) and long-term perspective. The 12 development suggestions raised for assessment are listed below:

- Developing the interoperability of the IT systems of different authorities
- Backup system development
- Increasing the authorities' resources
- Improving the area knowledge of authorities on industrial sites
- Securing the quality of the cooperation between the authorities and the companies so that cooperation is not bound to personal relations
- Authorities to take a more active part in company rescue drills
- Improving expertise of the authorities with the help of training (e.g. chemical knowledge)
- Readiness of the authorities to utilize municipal IT systems from the perspective of companies' hazardous situations
- Improving the preparedness of the authorities to make use of companies' IT systems
- Securing the cooperation between the authorities in a way that successful cooperation is not bound to personal relations
- Shifting the focus in authority operations more to advisory and preventive activities
- Taking into account the local relevance of the companies when prioritizing preparedness

6.1.6.1 Improvements in the operations of authorities in relation to company preparedness, short-term

According to the view of the experts, the most important factors to develop regarding authority operations in the short term (Figure 26) were:

1. Authorities to take a more active part in company rescue drills (51 % had ranked this in their top three)
2. Securing the cooperation between the authorities in a way that successful cooperation is not bound to personal relations
3. Shifting the focus in authority operations more towards advisory and preventive activities
4. Developing the interoperability of the IT systems of different authorities
5. Developing backup systems
6. Improving the area knowledge of authorities on industrial sites.

In the short-term development of authority operations, the experts emphasized the increase and improvement of cooperation between authorities and companies. Effective collaboration was considered vital because good results are not achieved in safety if only one of the parties improves safety operations.

The experts raised especially the issue of common rescue drills as a natural and an important way of improving cooperation. With the help of rescue drills, maintaining critical operations from the perspective of society can be practiced. Also the effectiveness of different kinds of preparedness operations can be tested.

Securing cooperation between the authorities in a way that successful cooperation is not bound to personal relations was the second most important issue and shifting the focus in authority operations more towards advisory and preventive activities the third most important.

Another important theme that should be developed in the short-term perspective was felt by the experts to be developing the interoperability of the authorities' IT systems because interoperability is important from the point of view of both safety and cost.

Two themes arose as the fifth most important for development in the short term: Backup system development and improving the regional knowledge of authorities on industrial sites. Both themes were mentioned 11 times.

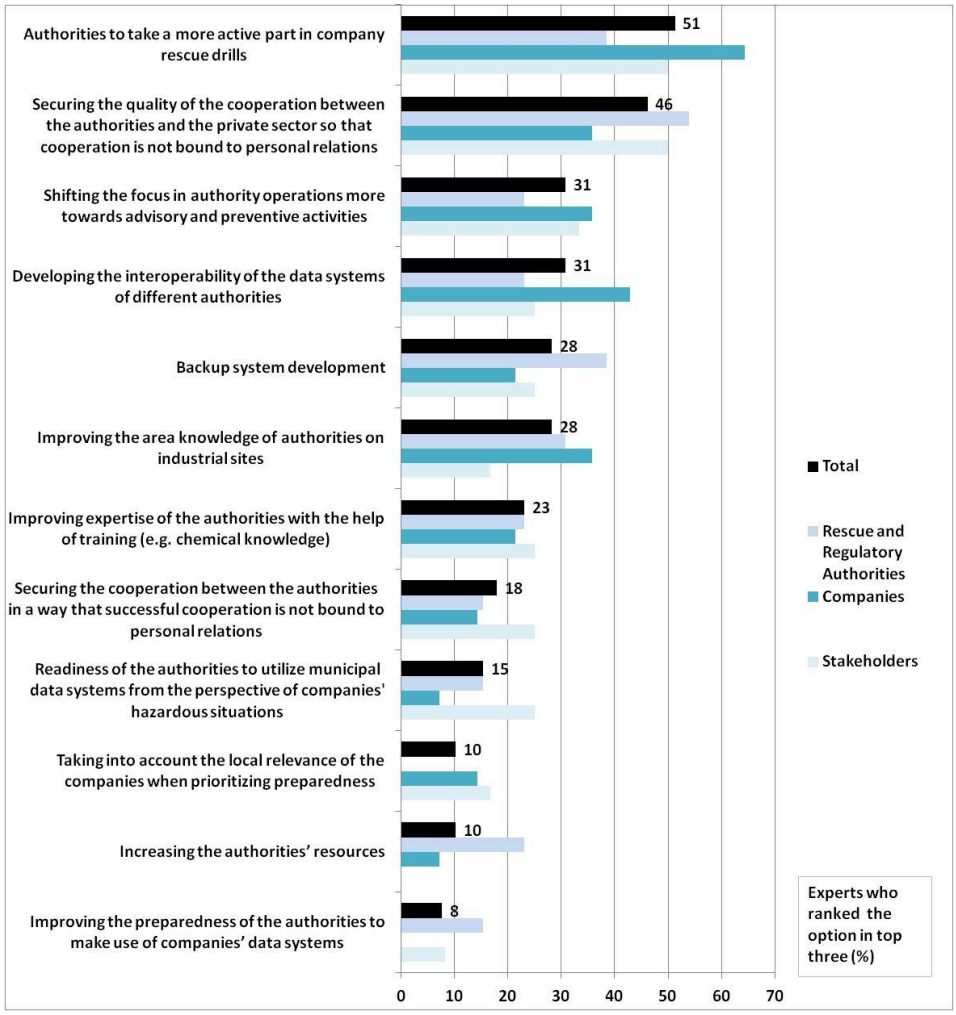

Figure 26 Improvements in the operations of authorities in relation to company preparedness, short-term

When assessed by respondent group, it is clear that the representatives of the rescue and regulatory authorities placed more stress than the other respondent groups on ensuring the quality of cooperation in particular between the authorities and the companies so that it was not person-dependent (53 % of representatives of rescue and regulative authorities). One expert argued:

> *"Scarce resources are leading to increased cooperation between authorities and companies. Resources of either sector are not sufficient alone, therefore reasonable allocation of resources is essential."*

The rescue and regulatory authorities were also the group that placed most emphasis on the development of backup systems (38 % of their representatives). In contrast, regarding development of authority operations, they placed less emphasis than the other groups on more active participation in company rescue drills, although over a third of this group also placed active participation among their top three themes for improvement. One argument was:

> *"There must be backup systems at all levels. Also, personal substitutes are necessary: Too often there is a situation where the necessary expertise is not available."*

The companies put a strong emphasis on more active participation by the authorities in company rescue drills (64 % of company experts) as one of the most important themes for improvement in the operations of the authorities. The company representatives also pointed to the development of the interoperability of various authorities' IT systems more than other respondent groups as a key theme for improvement (42 % of company experts). In contrast, companies felt slightly less strongly than the other respondent groups about ensuring quality of cooperation between authorities and the companies so that successful cooperation was not person-dependent. Nevertheless, ensuring quality of cooperation between the authorities and business life was the fourth most important development theme among company experts regarding the operations of the authorities.

The stakeholders' answers were distributed on the whole much the same as the average answers for all the respondent groups. Out of the five development themes with the most mentions, the stakeholders placed slightly less emphasis than the other groups on improving the authorities' local knowledge of the plant site. The theme for development that the stakeholders emphasized slightly more than the other groups was ensuring that successful cooperation between authorities was not person-dependent (25 % of stakeholder experts).

Stakeholders also placed slightly more emphasis than the other groups on the readiness of the authorities to utilize existing municipal IT systems in relation to dangerous situations (25 % of stakeholder experts).

6.1.6.2 Improvements in the operations of authorities in relation to the preparedness of the companies, long-term

The experts were also asked to assess the same development suggestions concerning preparedness for major accidents in the long-term perspective. According to the experts, the most important factors that would develop authority operations in the long term (Figure 27) were:

1. Shifting the focus in authority operations more to advisory and preventive activities
2. Securing the cooperation between the authorities in a way that successful cooperation is not bound to personal relations
3. Developing the interoperability of the IT systems of different authorities
4. Readiness of the authorities to make use of the IT systems already existing in the municipalities from the point of view of companies' hazardous situations
5. Backup system development
6. Securing the quality of the cooperation between the authorities and the companies so that cooperation is not bound to personal relations

Also in the long-term perspective, the experts emphasized development of the cooperation between the authorities and the companies and improving preventive activities.

The experts emphasized especially shifting the focus in authority operations more towards advisory and preventive actions and developing the cooperation between different parties in a way that successful cooperation is not bound to personal relations. The cooperation must be open and aimed at a common goal.

In the long-term perspective, the experts also emphasized development work on IT systems. Both the interoperability of IT systems between different authorities and the readiness of the authorities to make use of the IT systems of municipalities was raised as an important theme on developing preparedness for major accidents.

Backup system development was highlighted as the fifth most important theme to be developed. It was raised as an important theme both in short- and long-term development work. For example, deputy personnel systems can be developed in a very short-term perspective and cost-effective technical solutions can be developed in a long-term perspective.

In particular, the representatives of the rescue and regulatory authorities emphasized development activities related to information systems development in the longer term. They felt that the interoperability of IT systems between authorities was an important development theme (57 % of representatives of the rescue and regulatory authorities) and this group also placed more emphasis than

the other respondent groups on increased utilization of municipal IT systems (42 % of representatives of the rescue and regulatory authorities). In addition, in their answers, these representatives emphasized more than the other groups the development of the expertise of the authorities via training (28 % of the representatives of rescue and regulatory authorities).

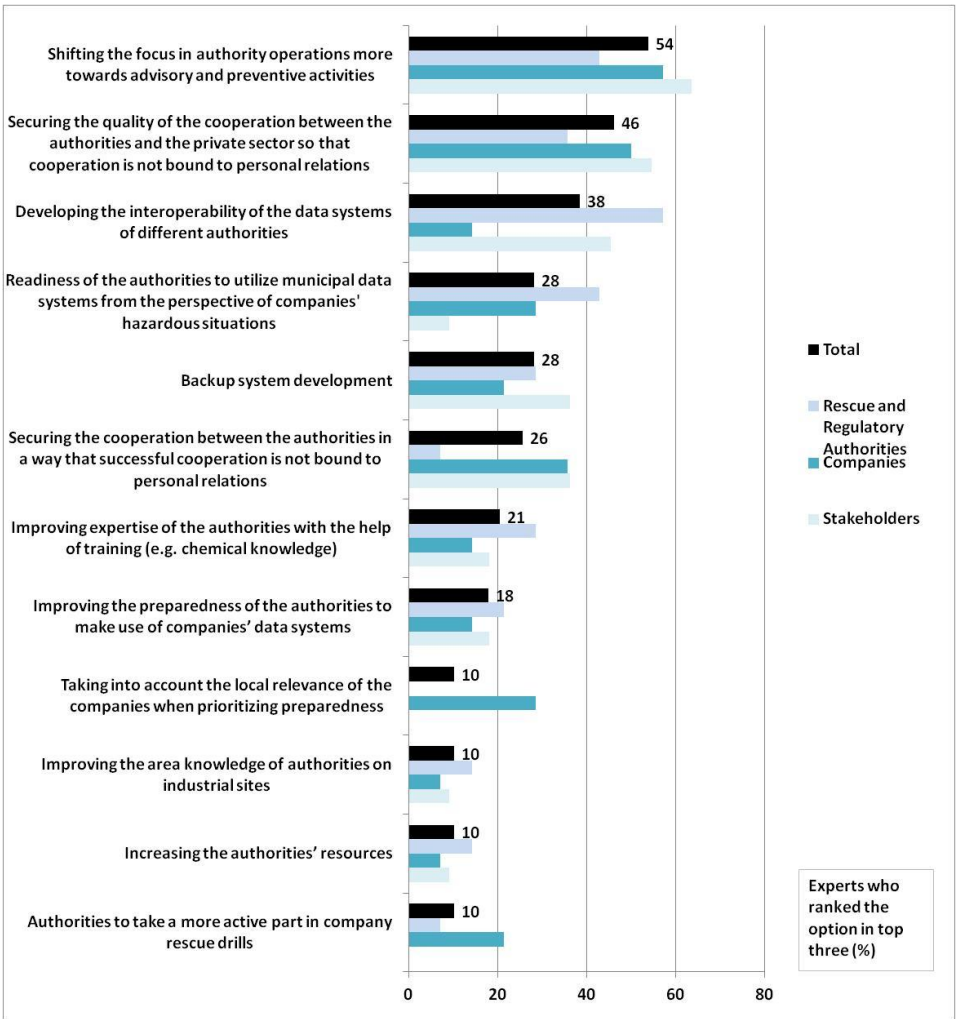

Figure 27 Improvements in the operations of authorities in relation to company preparedness, long-term

Unlike the other respondent groups, in terms of long-term development, the representatives of the rescue and regulatory authorities did not especially believe that the theme of ensuring that successful cooperation between authorities was not person-dependent was particularly important. Only 7 % of the representatives

of the rescue and regulatory authorities ranked this development work in the top three themes for improving the operations of the authorities.

These representatives also placed less emphasis than the other respondent groups on shifting the focus of the authorities' work to a more advisory and preventive function and on ensuring the quality of the cooperation between authorities and companies so that it would be not be person-dependent, although these issues were ranked by the representatives of the rescue and regulatory authorities in the four top themes for development.

The answers of the company respondent group in terms of developing the operations of the authorities were largely in line with the average of all the answers. Unlike the other respondent groups however, the company representatives emphasized the regional significance of the company in the prioritizing of preparedness activities. All those experts who considered the regional significance of the company to be an important development theme belonged to the company group. Company representatives also emphasized more than the other groups the more active participation of the authorities in company rescue drills. On the other hand, companies considered the interoperability of the IT systems of the authorities and development of backup systems to be less important development issues.

In terms of the long-term development of authority operations, the stakeholders ranked two of the development themes much higher than the other respondent groups, i.e. the shifting of the authorities' focus towards a more advisory and preventive function, and ensuring the quality of the cooperation between the authorities and companies so that successful cooperation is not person-dependent.

Almost 2/3 of the stakeholders' group ranked the shifting of the authorities' focus in the top three long-term development themes in terms of authority operations. Over half of the stakeholders' experts also felt that ensuring the quality of cooperation between the authorities and companies was one of the three most important development themes regarding authority operations. In addition, the stakeholders placed more emphasis than the other groups on the development of backup systems. On the other hand, the stakeholders considered the readiness of the authorities to utilize municipal IT systems to be significantly less important than the other groups did, since less that 10% of the stakeholder experts ranked this in the top three themes for improvement of authority operations.

6.1.7 Improvements in the operations of companies

In the interviews of the first Delphi round, several development suggestions were raised, with the help of which the companies, according to the experts, could improve their preparedness operations. In the second round, the importance of these development suggestions was evaluated.

The experts were asked to assess 13 different factors that would improve the preparedness of companies for major accidents. The experts chose 3 out of these 13 factors that were in their opinion the most important factors to be developed in the short-term (1–2 years) and in the long-term perspective. The 13 development suggestions to improve the preparedness of companies which were raised for assessment in the questionnaire are listed below:

- Change in attitude: e.g. the rescue plan in the companies is not made so much for the authorities as for securing the continuity of one's own organization
- Development of backup plans to secure business processes
- Development of personnel training in companies to also take the companies' continuity perspective into account more
- Safety management development in companies
- Maintaining up-to-date information cards in cooperation with the rescue authorities
- Increasing advice on preparedness available from the authorities
- Decreasing the safety risks caused by outsourcing
- Increasing company cooperation on preparedness (e.g. benchmarking of companies in the same field of business)
- Taking incidents into account better in preparedness (e.g. increased risk of floods)
- Development of IT systems in companies to serve the preparedness of the companies better
- Making better use of open information (e.g. the notifications from the Finnish Meteorological Institute or the flood warnings of a municipality)
- Making better use of information from insurance companies
- Speeding up law-making

6.1.7.1 Improvements in the operations of companies in relation to preparedness, short-term

In the short-term perspective (Figure 28) the most important development themes raised were:

1. Change in attitude: e.g. the rescue plan in companies is not made so much for the authorities as for securing the continuity of one's own organization (43 % of the experts had ranked this in their top three)
2. Development of backup plans to secure business processes
3. Personnel training development in companies to take also the companies' continuity perspective more into account
4. Safety management development in companies
5. Maintaining up-to-date information cards in conjunction with the rescue authorities
6. Increasing company cooperation on preparedness (e.g. benchmarking of companies in the same field of business)

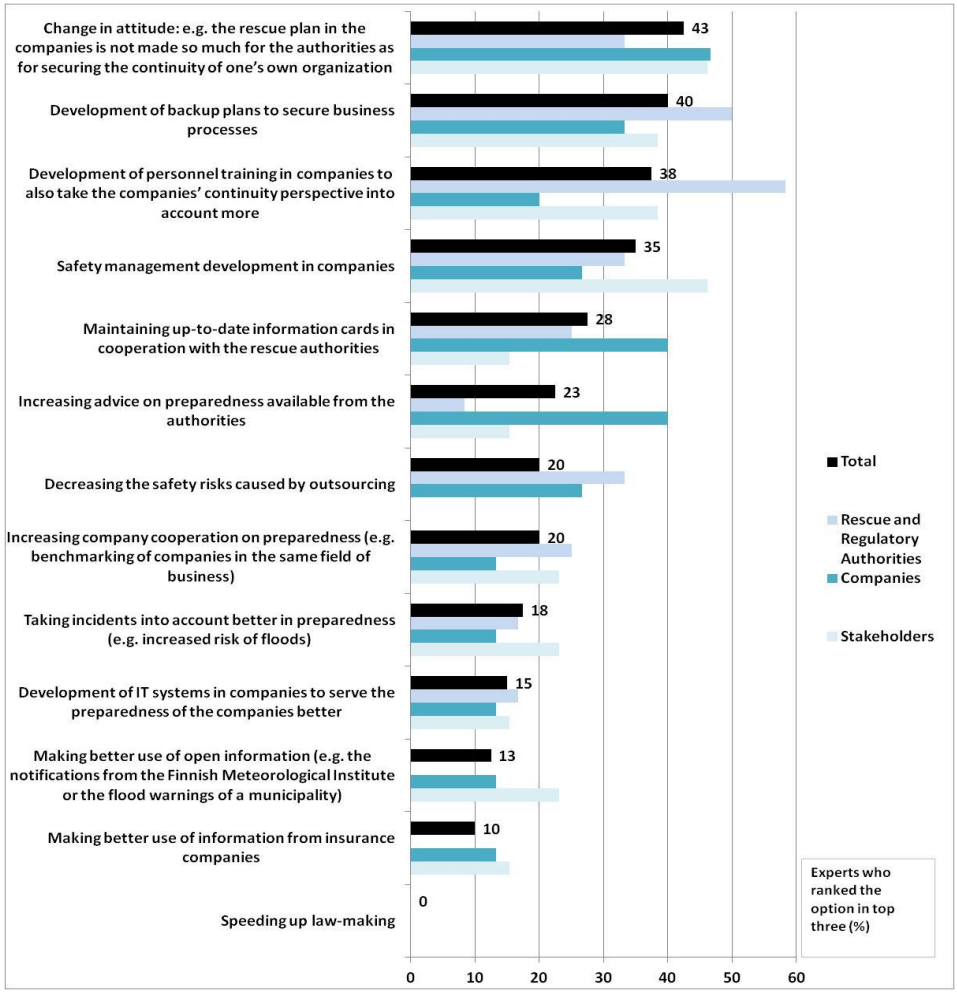

Figure 28 Improvements in operations in companies in relation to preparedness, short-term

Developing an attitudinal climate towards preparedness and companies' operational reliability was emphasized the most. The attitudinal climate towards preparedness should be developed by increasing personnel training in companies and improving safety management.

However, the experts pointed to the better operational reliability achieved through the preparedness plans of the companies as the most important factor. Companies should invest in risk management and develop backup systems so that the continuity of the processes of the company can be ensured.

The maintenance of up-to-date information cards in conjunction with the rescue authorities was raised as the fifth target to be developed regarding company preparedness. Also, systematic updating and information card development are important ways to develop the operational reliability of companies.

In particular, regarding the short-term improvement of company preparedness, the representatives of the rescue and regulatory authorities highlighted paying more attention to the development of company employee training in terms of the continuity of company operations. This theme was ranked the most important point for development among the representatives of the rescue and regulatory authorities. 58 % of this group ranked this theme in the top three in relation to company preparedness.

In addition, the representatives of the rescue and regulatory authorities placed much more emphasis compared to the other groups on themes concerning developing backup systems and reducing safety risks created by outsourcing. On the other hand, the representatives of the authorities placed much less emphasis than the other respondent groups on increasing advice related to preparedness from the authorities. Only 8 % of the representatives of the rescue and regulatory authorities ranked increased advice from the authorities in the top three themes concerning development of company preparedness.

The answers of the company representative' group were mostly in line with the average answers. However, in their answers, the company representatives placed more emphasis than the other groups on themes related to improving cooperation between authorities and companies. The companies considered it important to have more advice related to preparedness from the authorities and keeping information cards up-to-date in cooperation with the rescue and regulatory authorities. 40 % of the company experts ranked both of the above points in the top three themes in terms of the short-term development of company preparedness. In contrast, the company experts evaluated the development of company personnel training as far less important than the average from the point of view of company continuity. One fifth of the company respondent group

considered taking company continuity into account when developing personnel training, whereas 38 % of the all experts ranked it in the top three themes.

The stakeholder group pointed to a change in company attitude regarding the short-term development of company preparedness; preparedness is done to ensure the continuity of one's own organization, not for the authorities. In addition to this, the stakeholders particularly stressed the development of company safety management as one key issue for improvement in terms of company preparedness. The views of the stakeholders on the reduction of safety risks due to outsourcing also differed from those of the average estimate of the experts in that none of the stakeholders included this issue in the top three themes for development. The stakeholders also ranked the keeping of information cards up-to-date in cooperation with the rescue and regulatory authorities as a less important development theme for company preparedness than the average for all the answers.

6.1.7.2 Improvements in the operations of companies in relation to preparedness, long-term

The experts were also asked to assess the development work on preparedness in a long-term perspective. In the long-term perspective (Figure 29), the experts considered the most important development themes to be as follows:

1. Taking incidents better into account in preparedness
2. Change in attitude: e.g. the rescue plan in the companies is not made so much for the authorities as for securing the continuity of one's own organization
3. Increasing company cooperation in preparedness (e.g. benchmarking of companies in the same field of business)
4. Personnel training development in companies to emphasize the companies' continuity perspective
5. Safety management development in companies

Securing the continuity of company's operations was also emphasized in the answers concerning long-term development work. Taking incidents into account better in a longer period of time was given special emphasis. In the longer perspective, it is important to take into account different kinds of incidents, such as floods. This is important especially in companies that produce critical infrastructure and service operations from the perspective of society. One expert commented the following:

"Especially companies in the field of critical infrastructure services should create preparedness procedures to safeguard their functions, not only for their own continuity plans, but also for the whole society. They should organize drills and related training on the basis of these plans."

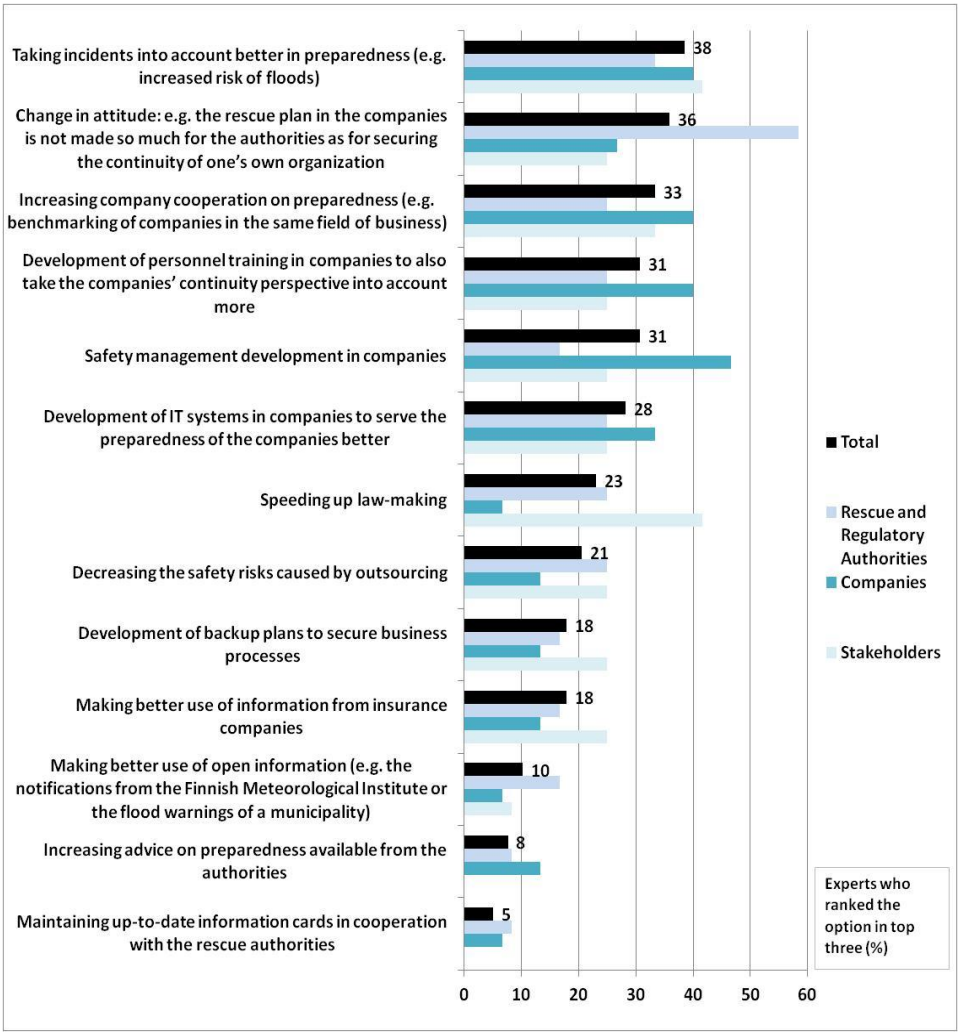

Figure 29 Improvements in the operations of companies in relation to preparedness, long-term

Preparedness can also be developed through increasing company cooperation on preparedness. It is for example important to practice and develop together the cooperation between companies in incidents.

Shaping attitudes and opinions was also emphasized in long-term development. Attitudes towards preparedness change slowly over time. An

attitudinal climate for preparedness must also be developed in a longer time perspective because maintaining safety culture at a good level demands continuous investments in safety management.

In particular, the representatives of the rescue and regulatory authorities emphasized an improved attitude in developing company preparedness in the long term. On the other hand, the representatives of the rescue and regulatory authorities placed less emphasis than the other groups on developing company safety management in this aspect. The views of the representatives of the rescue and regulatory authorities on this theme for development clearly differed from those of the companies, since the company respondents considered company safety management to be much more important with regard to company preparedness.

The theme of speeding up regulation also divided opinion by respondent group. The stakeholders identified the speeding up of regulation to correspond to the changing business environment as an important theme for development together with greater consideration of incidents (accidents) in company preparedness. In contrast, only 6.7% of the company respondent group included the speeding up of regulation in the top three themes for development.

6.1.8 Preparedness collaboration between authorities and companies

The experts were asked to give concrete examples of how the cooperation between authorities and companies could be improved concerning preparedness for major accidents. The experts answered this question with open answers.

Knowing each other well was emphasized in the answers of the experts. They especially raised the importance of organizing common rescue drills as often as possible and doing the post-drill analysis together in cooperation with the companies and authorities. One comment on collaboration was:

> *"Lots of rescue drills related to major accidents have been organized in our region. However, very little detailed information about them has been distributed. I would urge for more collaboration. Collaboration would save money if for example plans of drills could be circulated from company to another."*

Also, other ways to get to know the other party better and at the same time to develop preparedness operations were raised in the answers. For example, the experts mentioned organizing different kinds of common events: in different kinds of seminars, regional cooperation forums and events, "best practice" knowledge could be shared and training on preparedness organized. In addition,

doing preparedness planning and risk analyses together and the resulting action plans were seen as factors that would improve cooperation. Whatever the form of cooperation, the long-term and systematic nature of cooperation was the desired focus of emphasis concerning the forms of cooperation. Cooperation is increased with the help of regular and frequent meetings.

Other individual remarks on preparedness cooperation development were auditing different kinds of safety and management systems and developing a common information bank.

Also, shifting the focus of authorities' activities in a more consultative and advisory direction was brought up. There should be a common goal in advisory operations: finding ways in cooperation to help interpret legal texts in an understandable form and based on that, the best practices for companies to execute preparedness procedures.

Furthermore, other parties that should be included in cooperation were mentioned. These parties were the municipalities and the Emergency Supply Agency.

6.1.9 Development of IT systems from the perspective of preparedness

In the interviews of the first round, it was proposed that IT systems for preparedness should be developed. Some additional clarification was requested on this and, for this reason, the experts were asked to give examples of how the IT systems should be developed from the perspective of preparedness.

Based on the answers of the second round, the experts recognized that IT systems linked to preparedness are challenging. The challenge is that the life span of various kinds of IT systems is very short and the procurements of IT systems are made specifically for a certain field of business and/or company. Also the interoperability of the IT systems was seen to be challenging, because all the users had slightly different kinds of needs. Some experts recognized that many good systems are already in use but they are not used well enough and one person cannot handle every one of them.

Also, concrete themes on how to develop IT systems were raised in the answers. In particular, developing interoperable IT systems was brought up in several answers. Interoperability was considered important because it improves both preparedness and forming a situational picture. According to the experts, the interoperability of IT systems can be developed if the development is started with the recognition and definition of different kinds of information needs and processes. The needs orientation of IT systems should be taken into account in the planning stage, i.e. the planning of IT systems should be increasingly tailor-made.

The interoperability of IT systems can also be improved through implementing jointly predefined software used in preparedness. In addition to adopting these critical processes (joint planning, common software and recognizing the needs orientation), the interoperability of IT systems can also be developed through developing the availability of information by defining common open interfaces.

Other themes concerning the development of IT systems were for example making company information cards in electronic form and saving the information to a common authorities' IT system. In this way, in the event of an accident, all the information required would be easily available and updating information would become easier. Some of the experts also emphasized that the first thing that must be concentrated on is that the base of the current systems is in good shape before the interoperability development of IT systems can be started.

Also, the view was raised that there is no need to develop IT systems in the near future. Some of the experts considered that developing IT systems has no intrinsic value and developing them as they are now would not improve preparedness. In addition, it also came out in the answers that besides the authorities, companies also have tight data security definitions and strong firewalls and they do not want to weaken them for the sake of IT system interoperability, although it would be possible.

6.2 Findings in the third Delphi round

6.2.1 Development of cooperation on external rescue plans

The experts were asked to assess the development in which rescue authorities makes use of the expertise of a company more than before. The experts were asked to assess the probability of the type of development type mentioned in the claim.

Rescue authorities will make use of the expertise of the company, as well as the internal rescue plan made by the company, when formulating an external rescue plan.

The claim was connected to the current problem that cooperation between authorities and companies is not always adequate. This came up in the interviews of the first Delphi round. Some of the experts felt that, at the moment, company expertise is not sufficiently utilized when formulating the external rescue plan. Because of this, the authorities do not always have an adequate situational picture of the operational processes of a company, so that all risk points of the company

would be included in the external rescue plan and these risk points would be taken into account properly.

The experts were asked to assess the probable development of cooperation on an external rescue plan (-3 = highly unlikely … +3 = highly likely). Forty-three answers were received (Figure 30).

The average answer was 0.72, i.e. the development described in the claim was on average considered fairly likely. The views on probable development diverged somewhat (standard deviation 1.5). 26 experts considered the claim to be likely and 14 experts considered the claim unlikely. Six experts answered neutrally.

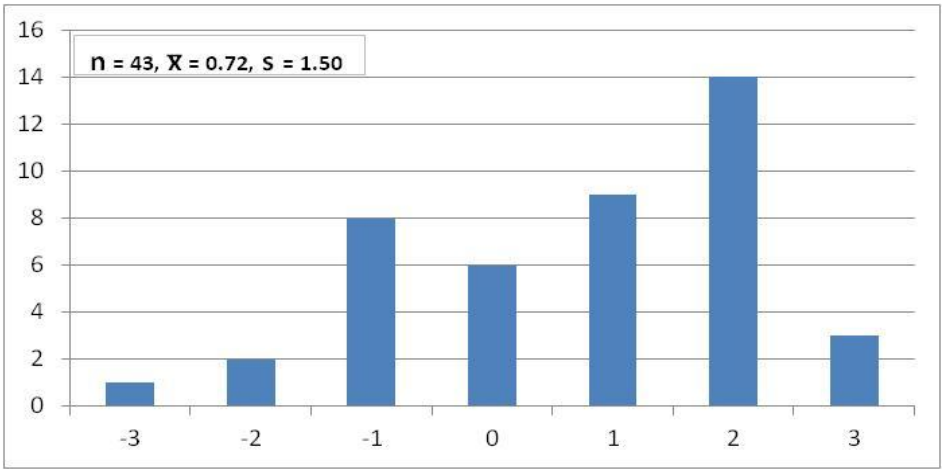

Figure 30 Probability of development of cooperation on external rescue plan

The representatives of the rescue and regulatory authorities considered the development of the development described in the claim to be more desirable. The total average of their answers was 1.19 (Table 26). The company representatives were the most critical towards the claim. They did not see a big change coming to the current state (average answer 0.19). The assessments on the probable development of the claim by the company and stakeholder representatives diverged the most; the standard deviation for the company representatives was 1.55 and 1.54 for the stakeholders. The standard deviation of the answers of the rescue and regulatory authorities was 1.24, i.e., the answers of this group diverged least.

Table 16 Probability of development of cooperation on external rescue plan, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities			2	3	3	6	2	16	1.19	1.24
Companies	1		6	2	3	3	1	16	0.19	1.55
Stakeholders		2		1	3	5		11	0.82	1.54

The development of the type described in the claim was considered unlikely because the cooperation this represented would demand too many extra resources both from the rescue authorities and the companies. One expert argued:

> *"This is unlikely because not all rescue authorities utilize the expertise of companies and this is why the practice will not improve in the future either."*

On the other hand, many considered an increase in cooperation as stated in the claim to be probable, because at the moment, the cooperation between rescue authorities and companies already works well and it was also felt that cooperation would be increased in the future. Also, some of the representatives of the rescue and regulatory authorities observed that in the rescue authorities, the younger generation understand better than before the importance of making use of the experts of the companies, which is the reason why cooperation will most likely increase in the future.

6.2.2 Development of the common use of IT systems

As the second question concerning preparedness, the experts were asked to assess the interoperability development of IT systems. The experts were asked to assess the probable and desired development of the following claim:

In the future a company will have the possibility to analyze its own information (e.g. external rescue plan and information card) and save information (e.g. up-to-date region maps) to an IT system maintained by the authorities.

The claim is connected to the opinions of the experts raised in the interviews of the first Delphi round, i.e. that one of the tasks of preparedness is to create a base to form a convergent situational picture, for example with the help of up-to-date electronic documents. Connected to this, the thought was expressed that

companies could also save up-to-date documents on an IT system maintained by the authorities.

6.2.2.1 Probability of development of the common use of IT systems

The experts were asked to assess the probable development of the development of the common use of IT systems (-3 = highly unlikely … +3 = highly likely). Forty-three answers were received (Figure 31).

The answers of the experts diverged regarding the development of the common use of IT systems (standard deviation 1.53). 19 experts considered the claim to be unlikely and 19 considered the claim likely. Five experts answered neutrally. The total average of the answers was 0.47, i.e. the experts, however, considered the development of the type described in the claim on average to be slightly more likely than unlikely.

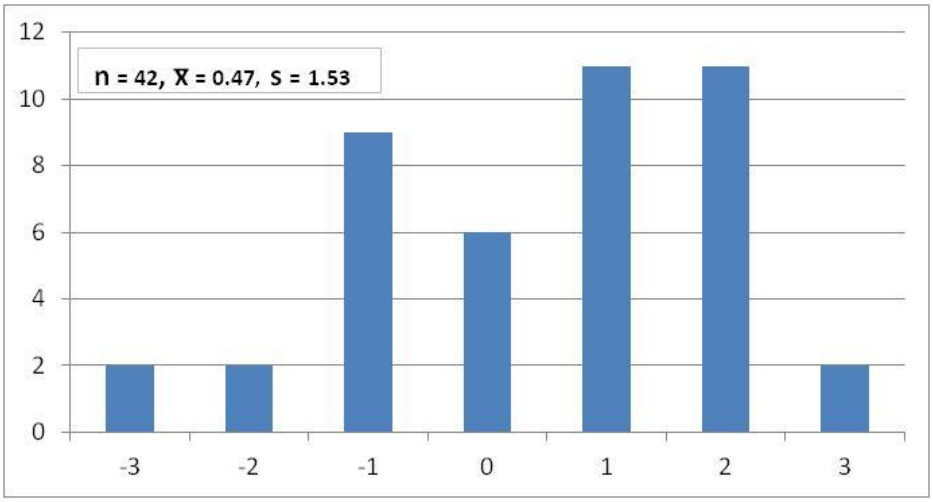

Figure 31 Probability of development of the common use of IT systems

The type of development described in the claim was considered more likely by the stakeholders, whose average of the answers was 0.82 (Table 17). The company representatives considered the type of development described in the claim to be the least unlikely (average answer 0.19). The assessment of the representatives of the rescue and regulatory authorities on the type of development described in the claim (average answer 0.5) was at about the same level as the average of the whole expert group. When analyzed by respondent group, there was no big difference in the divergence of the answers between the respondent groups.

Table 17 Probability of development of the common use of IT systems, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1		3	3	5	3	1	16	0.50	1.46
Companies	1		6	2	3	3	1	16	0.19	1.55
Stakeholders		2		1	3	5		11	0.82	1.54

The unlikelihood of the type of development of the claim was justified from the perspective of resource and information security. Developing the common use of IT systems was felt to be an expensive and time-consuming issue. Developing and maintaining cooperation would demand significant resources. The experts observed that there would be no sponsors for developing the systems because other developmental needs would be prioritized more. The common use of IT systems was also seen as a potential threat for information security. Because of this, such a development was considered unlikely.

On the other hand, the type of development described in the claim was considered likely because there seems to be a common trend towards enhanced cooperation and interoperability. Technical readiness for the common use of IT systems was acknowledged to exist. One expert argument was:

> *"One possibility would be cloud services. Companies could store their documents in a "cloud" so that certain authorities would also have access to them. This would be worth trying."*

The experts also brought up a couple of examples of how interoperability already exists in the systems to some degree or is being developed. For example, the Huovi portal of the National Emergency Supply Agency, which supports the critical players in supply reliability in the cases of serious disruptions, was seen to have elements connected to interoperability and cooperation (see National Emergency Supply Agency 2013a). Also, the ongoing Varanto project regarding the planning and defining of a common knowledge pool and related operational services for the rescue authorities was seen as progress towards the type of development described in the claim (see Tarvainen 2013).

6.2.2.2 Desirability of development of the common use of IT systems

The experts were also asked to assess the desirability of the development of the common use of IT systems (-3 = highly undesirable … +3 = highly desirable). Forty-three answers were received (Figure 32).

The development of the type described in the claim was considered almost unanimously to be desirable. The average of all the answers was 1.88 and the standard deviation was rather small, i.e. 1.07. Only one respondent considered the development of the type described in the claim to be undesirable. 29 respondents considered the claim to be desirable and three respondents answered neutrally.

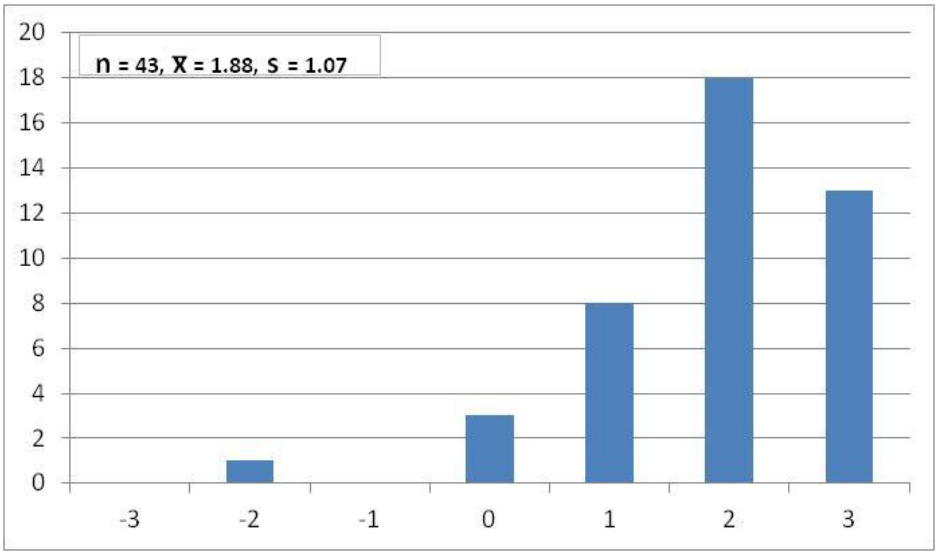

Figure 32 Desirability of development of the common use of IT systems

When analyzed by respondent group, all the stakeholders considered the development of the type described in the claim to be desirable. The development was considered more likely by stakeholder representatives (Table 18). The lowest assessment on desirability was given by the company representatives (average answer 1.63), but they also considered the development of the type described in the claim to be clearly desirable. The standard deviation was small in all the respondent groups, i.e. the experts were quite unanimous on the desirability of development of the common use of IT systems.

Table 18 Desirability of development of the common use of IT systems, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities				1	4	6	5	16	1.94	0.90
Companies		1		2	2	7	4	16	1.63	1.32
Stakeholders					2	5	4	11	2.18	0.75

The development was considered desirable because it was felt to increase the transparency of operations and development of common operational models. One argument was:

> *"This would increase transparency. I think that the quality of external rescue plans would also be better if the authorities knew that the company personnel can see the plans."*

It was also seen to improve the timeliness of information and increasing the amount of information and use of a common terminology. When everybody has the same basic knowledge, the risk of misunderstandings in a rescue situation is decreased. In addition, it was observed that this kind of development would make the information more up-to-date and would make it easier for companies to update their information for the rescue authorities, which could for example improve the quality of external rescue plans.

Those who were most critical towards developing the common use of IT systems considered the development undesirable because developing large systems is both very challenging and expensive. In addition, the development was considered undesirable because of a potential threat for information security linked to it. Leaning on one system might easily paralyze the processes of a wide group of actors if the common IT system crashed.

6.2.3 Preparedness for cyber threats

As a third question concerning preparedness, the experts were asked to assess the probable development of preparedness for cyber threats. The experts were asked to assess the following claim:

In the next five years, the cyber threats faced by major companies and individual authorities will increase so much that they will actively follow the advice and recommendations of the CERT-FI unit of the Finnish Communication Regulatory Authority and/or the soon to be established Cyber Security Center to prepare for threats.

The claim is linked to the topic of information security and cyber security that was brought up in the first and second Delphi rounds. The objective of Finnish cyber security strategy is primarily to take care of the security of society. The effects of threats to the cyber-operational environment have become wider, from the perspective of individuals, companies and the functioning of society as a whole. (see http://www.yhteiskunnanturvallisuus.fi) The perspective of the claim

is not only to secure the vital functions of society but also to secure the continuity of operations of other authorities and companies.

The communication networks and services must work reliably and securely. Malfunctions must be prevented and controlled so that companies and the authorities are able to maintain the highest possible operational functionality. The aim of the Cyber Security Center to be established within the Finnish Communication Regulatory Authority is to produce and maintain a combined situational picture of cyber security. The center will gather information of cyber actions and disseminate it to different players; it will form and disseminate a situational picture of cyber security.

The experts were asked to assess the probability of an increase in preparedness for cyber threats. (-3 = highly unlikely … +3 = highly likely). Forty-two answers were received (Figure 33). The experts considered the development of the type described in the claim to be fairly likely, average answer 1.10. However, views on the probable development diverged somewhat (standard deviation 1.74). A majority of the experts, i.e. 31 experts, considered the development to be likely. 9 experts considered the development of cyber threats unlikely and two answered neutrally.

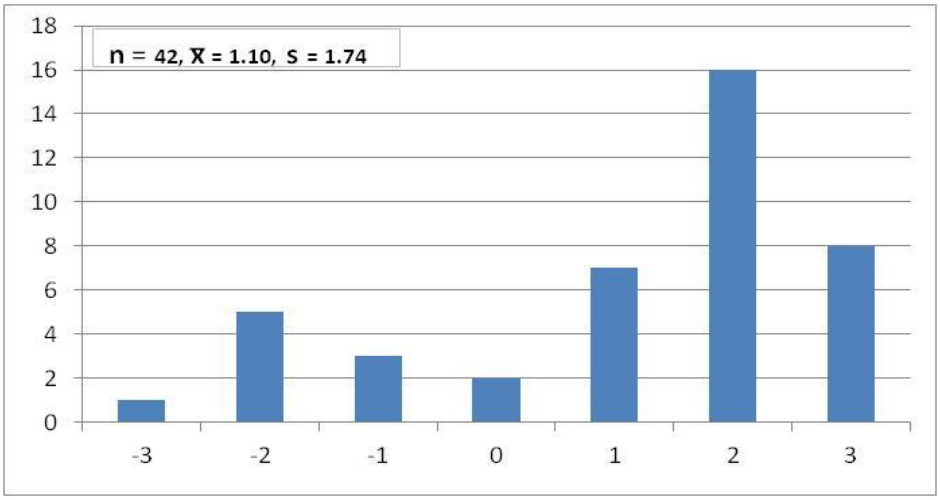

Figure 33 Probability of an increase in preparedness for cyber threats

When analyzed by respondent group, all the groups considered the increase of cyber threats to be quite likely, although the stakeholders considered the increase in cyber threats more likely (Table 19). The companies disagreed with the claim the most, but they also considered the development rather likely (average answer 0.81). There were no big differences in standard deviations between the respondent groups.

Table 19 Probable development of cyber threat; answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1	1	1	1		8	3	15	1.21	1.86
Companies		2	2	1	5	4	2	16	0.81	1.55
Stakeholders		2			2	4	3	11	1.36	1.80

It was argued that cyber threats and preparedness for them are likely to increase because cyber threats have been growing all the time and it was not felt that the trend would change in the next few years. Raising the topic of cyber threats in the media and discussion around the establishment of the Cyber Security Center were considered to raise the interest in preparedness for cyber threats even more; the goal of cyber threats is to paralyze the functioning of society, the authorities, companies and other actors are potential targets of cyber attacks. For example, the more important the field of business or branch of administration, the more should be invested in preparedness for cyber threats. One expert argued:

> *"Cyber threats will increase, but we must not overreact. We must bear in mind that preparing against them should not make the everyday work for the normal user too complicated."*

Those who considered the increase of the type described in the claim unlikely argued that they did not foresee that the increase in preparedness for cyber threats would be as strong as described in the claim. At least it was felt that the increase in cyber threats would not evolve as fast in the next five years as stated in the claim. The development of the type described in the claim was estimated to take years and it was observed that significant growth in preparedness for cyber threats would demand an increasingly dangerous situation before the preparedness operations would evolve to the type mentioned in the claim.

6.2.4 Development of regulation

Several experts mentioned development of regulation as one target to be developed to improve the flow of information. Because of this, the fourth question concerning preparedness in the third Delphi round concerned developing regulation in order to improve the flow of information. The experts were asked an open question about potential improvement, clarification, or developing regulations to improve and streamline the flow of information. Thirty answers were received, 27 of which were relevant to the research (Table 20).

Excessive ambiguity and improving the regulations related to the above were raised as the biggest individual themes concerning regulation. At the moment different players can interpret the same regulations in various ways, which hinders the preparedness operations of companies. Also the fragmentation of the regulations was recognized as a problem in every respondent group. The regulations should be standardized and regulation should be done in a coordinated fashion with more broad-based cooperation than at the moment to avoid fragmentation. Furthermore, in connection with regulation, the authority representatives identified the problem that the decrees and advice regarding the regulations may in some cases be outdated. This hinders the activities of the authorities and therefore keeping the regulation up-to-date was seen as a clear developmental need.

In all the respondent groups, some of the experts observed that the flow of information is not improved by regulation. The successful flow of information between the authorities and the companies was seen more as a matter of will than as something to be developed with the help of regulation. Developing methods and cooperation were considered the best way to improve the flow of information. On the other hand, a few experts recognized that, in general, the flow of information could be improved at the regulatory level by identifying the obstacles to the flow of information in the current regulation. After this it would be possible to develop the flow of information by removing these obstacles from the regulation. For example, at the moment overly tight data security was seen in some cases to be hindering or slowing down the flow of information between different players.

In particular, cyber threats and regulation in the case of incidents stood out from the individual regulation themes. Especially the representatives of the rescue and regulatory authorities identified cyber threats as a theme linked to regulation development. Cyber threats concern all fields of operation and this is why cyber security should be improved from its current state by means of regulation. Issues for development in regulation were seen with regard to incidents. It was recognized that at the moment the regulation does not for example define the responsibilities in incidents clearly enough. It was brought up that, at the moment, incidents are recognized in the regulation concerning telecommunications but there is a need to develop the regulation concerning incidents in other sectors too.

Table 20 Development of regulation

Development themes	Quotes: Rescue and Regulatory Authorities	Quotes: Companies	Quotes: Stakeholders	Quotes: Total
Too much room for interpretation in regulations	2	3		5
Regulations should be improved with a wide base (to avoid fragmentation)	1	2	1	4
Regulation has no effect on improving flow of information	1	2	1	4
Too tight data security prevents data exchange between parties	2		1	3
Development of regulation related to cyber threats	2			2
Making regulation more up-to-date (outdated decrees and guidelines)	2			2
Identification of obstacles to flow of information and improvement of regulation to eliminate them	1		1	2
Improved regulation related to incidents	1	1		2
Other individual mentions of improvement and development themes related to regulation	1		2	3
Quotes : Total	13	8	6	27

In addition, one expert observed that there are elements in the regulation of authority operations which function as an obstacle to developing the cooperation between the authorities. The stakeholders mentioned that there is also a need to standardize the requirements internal and external rescue plans. Similarly, the strictness of current language regulation in Finland was raised by some stakeholders. Emergency notifications must be given in both Finnish and

Swedish on every occasion. In some cases this causes a considerable delay in making the emergency notification. Therefore, the current situation was seen as a potential threat and an issue to be improved.

6.2.5 Improving safety in companies by training

Several development suggestions for training and good practices were raised in the first and second Delphi rounds. The aim was to assess the importance of these development suggestions for improving safety in companies in the third round. The experts were asked to choose three development suggestions out of the nine that they thought were the most important. The nine development suggestions that were proposed by the experts for evaluation are listed below:

- Increasing safety management training directed at managers
- Developing personnel training on initial fire extinguishing and first aid
- Developing guideline info concerning incidents
- Increasing training on crisis communication
- Increasing training on critical processes for the whole personnel; the perspective of managing continuity
- Taking part in other organizations' rescue drills
- Increasing training on secure use of IT systems
- Developing safety induction training for contractors and subcontractors
- Increasing VIRVE training

According to the views of the experts, the most important development suggestions were:

1. Increasing training on critical processes for the whole personnel; the perspective of managing continuity
2. Increasing safety management training directed at managers
3. Developing guideline info concerning incidents
4. Developing safety induction training for contractors and subcontractors

The experts emphasized increasing the training on critical processes because the continuity of critical processes is very important from the perspective of the company's continuity management. The experts argued that increasing training on safety management directed at managers is important because safety culture development in the companies is dependent on the managers and, for this reason, safety management training is an important area when developing the safety culture in companies.

Developing guideline info concerning incidents was also seen as an important development suggestion regarding training. Preparedness for incidents and guidelines on eliminating disruptions are an important area in company preparedness. The experts also emphasized the development of safety induction training for contractors and subcontractors. Transferring safety knowhow to external contractors and subcontractors was felt to be important, although a challenging issue. Safety induction was believed to be important because external actors are not able to recognize the risk and danger factors linked to the safety of the company without proper orientation. The lack of safety knowhow and commitment of subcontractors and contractors poses a major risk, and for this reason induction training was considered important from the perspective of continuity management and worth investing in.

When analyzed by respondent group (Figure 34), the representatives of the rescue and regulatory authorities emphasized almost exactly the same themes in their ranking as the whole Delphi expert group. The representatives of the rescue and regulatory authorities emphasized participation in other organizations' rescue drills far more than the average. The representatives of the rescue and regulatory authorities raised taking part in other organizations' rescue drills as one of the top three themes in training to increase safety.

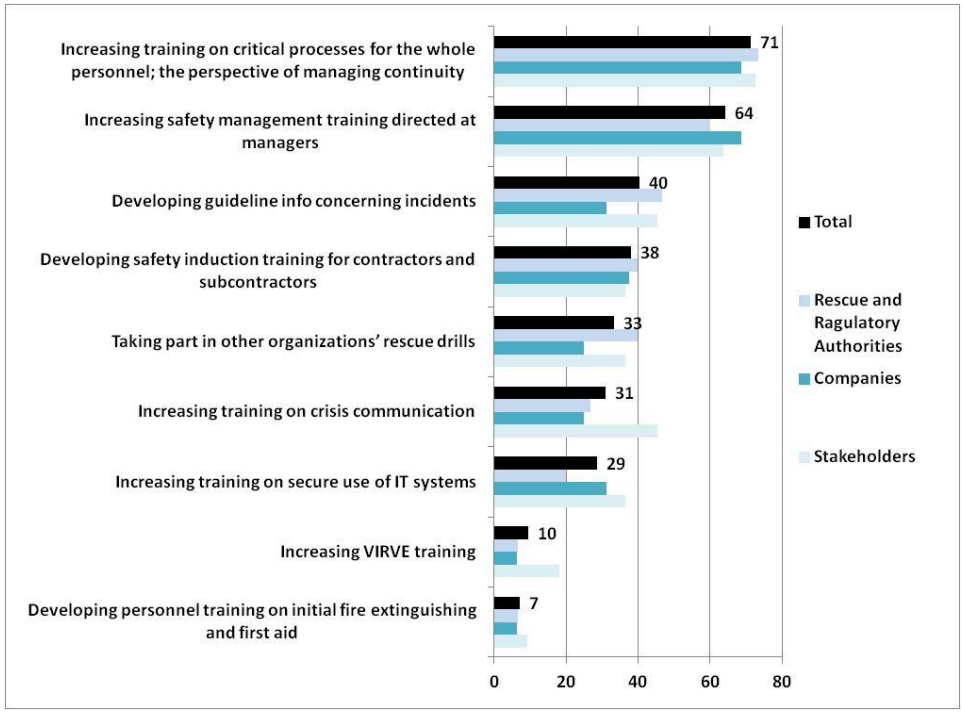

Figure 34 Improving safety in companies with the help of training

In their ranking, the companies emphasized safety training directed at managers more than the average. The safety culture of the companies can be improved with the help of safety management, i.e. it was seen that the best way to improve preparedness is safety training directed at managers. One expert augmented:

> *"Everything starts with understanding: we need to understand what we are doing in our business, why are we doing it, and why certain safety procedures exist. In particular, the management of a business should understand this!"*

The stakeholders emphasized mostly the same themes that had been raised in the rankings of the whole Delphi expert group. One exception was their ranking of increasing training on crisis communication. The stakeholders included crisis communication training in their top three training themes for increasing safety in companies. Increasing of training of crisis communication was considered an important issue because it has an important role in forming a situational picture in an accident and from the perspective of the effective flow of information, and hence its relevance in developing safety in companies is significant.

6.2.6 Improving safety by training the authorities

Several development suggestions were made concerning training and good practices in the first and second Delphi rounds with which it would be possible to develop the knowhow and preparedness of the authorities for major accidents that concern companies. The aim was to assess the importance of these development suggestions in the third round. The experts chose three development suggestions out of the nine, which they thought were the most important ones. The nine development suggestions that were proposed by the experts for evaluation are listed below:

- More training for the authorities that emphasizes preventive actions
- Increasing the number of experts who are specialized in chemical training
- Chemical training for all the rescue authorities
- Increasing crisis communication training
- Multi-authority operations training
- Training of management of major accidents
- Training on the secure use of IT systems
- Training on utilization of IT systems
- Increasing job rotation

According to the views of the experts (Figure 35), the most important development suggestions for improving training for the authorities were:

1. Multi-authority operations training
2. More training emphasizing preventive action
3. Training of management of major accidents
4. Increasing crisis communication training

In particular, multi-authority training was highlighted in the answers because major accidents are often multi-authority situations. Developing rescue operations that are carried out by several authorities and other forms of cooperation were seen to be very important for this reason. Effective cooperation between different authorities is significant in controlling a situation. It was also observed that common rescue drills are a form of multi-authority activity training that should be developed.

Also, increasing preventive actions was raised as a relevant issue linked to authority training development. The experts considered the proactive actions of the authorities to be important, helping to prevent major accidents. Preventive actions also help to build a better situational picture, for example of companies' critical processes, which in part supports decision making and operations by the authorities in potential major accidents.

Training of management of major accidents also stood out clearly as an important development target in authority training. This was considered important because, according to the answers, there are rather few authorities capable of managing major accidents. All in all, skills in management were regarded as important in accidents because the experts recognised that at the moment there is a deficit of skills in basic management.

Crisis communication training stood out as the fourth most important development theme concerning authority training. It was felt that, in general, there is a skill deficit in crisis communication. The developmental needs for skills in crisis communication were recognised, both in internal and external communication. Internal and external crisis communication forms an important part of the information flow and helping to build a situational picture; for this reason training on crisis communication should be increased.

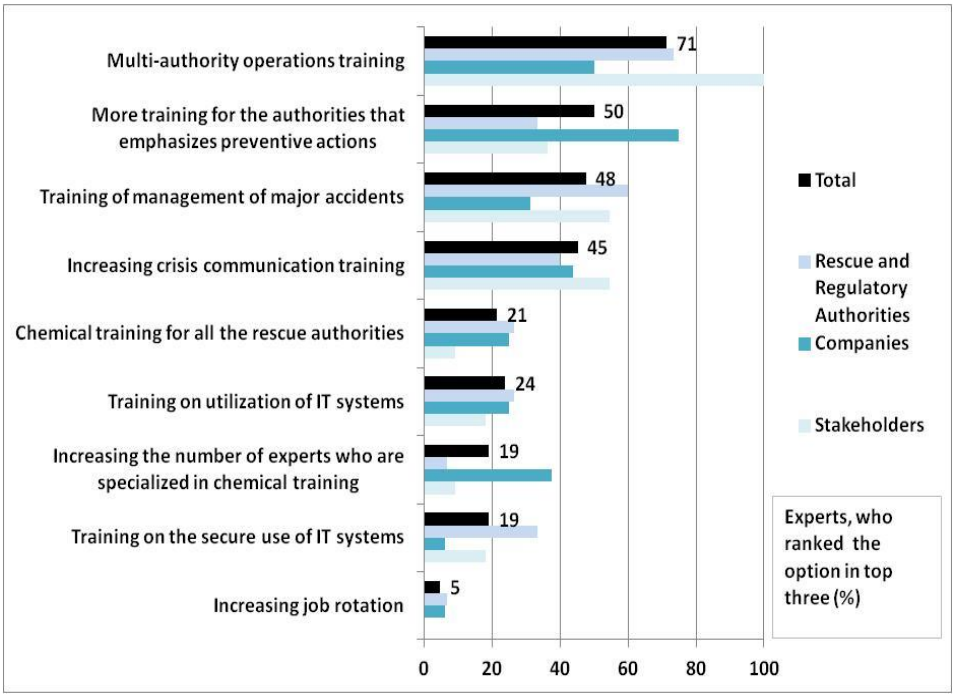

Figure 35 Improving safety by training the authorities

When analyzed by respondent group (Figure 35), the themes that stood out as important for the representatives of the rescue and regulatory authorities and the stakeholders were very similar. However, the representatives of the rescue and regulatory authorities proposed training on the secure use of IT systems as a far more important development target. It was argued that the IT skills of some members of the authorities are not on a sufficiently good level at the moment. The secure use of IT systems increases total security and on the other hand poor skills increase the safety risks and decrease utilization of IT systems. However, the stakeholders emphasized the importance of multi-authority training development more than the average. All the stakeholder respondents ranked multi-authority activity training in the top three most important themes to be developed in authority operations in order to improve the safety of companies, when on average 71 % of the respondents placed the theme in their top three development targets. The stakeholders argued that multi-authority training is important because several authorities take part in major accidents and for this reason developing cooperation between several authorities and training on this topic is important.

The company representatives' answers differed slightly from the answers of the other groups. The company representatives considered increasing the emphasis on preventive actions in all authority training as the most important.

Increasing preventive actions was felt to be important because mitigating accidents is extremely important from the perspective of companies' continuity management and something that should be developed. One expert argument was:

> *"Focusing more on preventive action helps authorities to understand the ways the company does things. Understanding the critical processes of the company in turn helps authorities to make the right decisions in the case of a major accident."*

In addition, the companies emphasized increasing the number of experts who are specialized in chemical training more than the other groups. There is concentrated chemical knowledge in the Finnish Safety and Chemical Agency but adequate expert knowledge should be available outside of office hours in the case of chemical accidents. It was felt that, at the moment, in case of chemical accidents, situations arise where the chemical knowledge of the members of the authority on shift is inadequate.

6.3 Summary of potential improvements in the preparedness phase

1. The second Delphi round

In the second Delphi round there were nine claims, ranking and open ended questions related to preparedness, on the following topics:

- Employment and taxation perspective in prioritization of authority operations
- Changing the implementation of regulation
- Development of preparedness attitudes in companies
- Tightening legislation on major accidents and incidents
- Development of preparedness collaboration
- Development of the operations of authorities in relation to the preparedness of companies
- Improving preparedness from the perspective of companies
- Preparedness collaboration between authorities and companies
- Development of IT systems from the perspective of preparedness

The questionnaire was formulated based on the problem domains identified in the previous Delphi round.

First, the experts were asked to assess the future of target prioritization by the local relevance of the target in the authorities' planning. According to the

experts' view, it is slightly more likely than unlikely that the employment and taxation aspect will be increasingly emphasized in authority operations in future. The prioritization was considered likely because it was felt that, in future, the target's local or even national "effectiveness" would be emphasized in the risk analysis, for example when considering the long-term suspension of activities caused by a major accident at the target.

Secondly, the experts were asked to assess whether the authorities will in future collaborate more with companies in interpreting the regulation, taking the special needs of the company more into account. The experts thought development of this type to be somewhat likely. The claim was considered likely based on the fact that the cooperation of the authorities and the rest of society will increase, as will service-mindedness. This is a precondition for the real development of the safety culture in both authority and company operations. The role of companies in the basic functions of society is increasing, so this development is inevitable. However, some of the experts considered collaboration unlikely because they had seen that in recent years the operations of the authorities have shifted in exactly the opposite direction. They also considered that advising by the authorities might even lead to the endangering of objectivity. Some also felt that resources are decreasing on both sides and there is no time for active cooperation. In all the respondent groups, some of the experts observed that the flow of information is not improved by regulation. They argued that successful flow of information between the authorities and the companies was seen more as a matter of will than as something to be developed with the help of regulation. Also, the experts considered it desirable that in the future the authorities will cooperate more actively with companies in interpreting regulations.

As the third question regarding preparedness, the experts were asked to assess the development of attitudes towards preparedness. The experts considered that, on average, preparedness attitudes would develop somewhat compared to the current state. Good safety expertise is beginning to be found in the companies and it has already become a significant strategic success factor. It was also seen that in certain companies the safety culture is further advanced than among some public sector players.

Preparedness supports the continuity of a company's business, which is an asset for the whole personnel. The only challenge lies in the fact that preparedness is seen as a separate issue and not as part of everyday activity. It was felt that, at the moment, preparedness skills depend on the expertise of a few people, for example shift managers or the corporate employee in charge of safety, and emphasizes prevention and the protection of employees from accidents. For example, safety manuals and other safety instructions are made in companies but it seems that the will to really disseminate preparedness skills to

the whole personnel and for it to be seen as a part of everyday activity is lacking. Unless demands for the personnel to take part in training and or rescue drills become obligatory, attitudes to preparedness will most likely not improve, at least in the near future. Additionally, the "it's not my job" attitude was seen to undermine the positive development of preparedness attitudes.

One key issue that arose was how the highest management level recognizes its own role in controlling the continuity of the company and in the process of developing its operational reliability; the highest management level is that which shares out and assigns responsibilities and allocates resources. Only when everybody understands the process hazards of her/his activity, besides the occupational safety issues, can preparedness issues move forward. The management must take care of expertise and thus motivation.

In the fourth question the experts were asked to assess the development of preparedness for major accidents and incidents and whether the legislation will oblige all players to take major accidents into account more. The experts were fairly unanimous regarding tightening the regulation. The majority of the experts considered that regulation will be tightened because society was seen to be more vulnerable than before as natural accidents seem to be increasing and society is nowadays more dependent on technology. According to the experts, companies should themselves consider the continuity of their processes without legislative sanctions. Instead, according to those in favor of increasing regulation, the regulation should be developed but it should be done in cooperation and open dialogue with companies.

In the future, regulation should oblige all players to take major accidents into account more because different kinds of natural major accidents such as storms and floods, for example, are likely to increase and thus society is more vulnerable than before and is nowadays more dependent on technology. It was felt that at the moment in planning, organizations do not take into account enough the fact that operational processes planned for the normal state do not function in major accidents. Especially the company representatives emphasized that the vulnerability of society will force the tightening of regulation. All the respondent groups were fairly unanimous on the desirability of the tightening of regulation in this respect. The fragmentation of regulations was also recognized as a problem. The regulation should be standardized and done in a coordinated fashion with more broad-based cooperation than at the moment to avoid fragmentation. On the other hand, it was noted that in general the flow of information could be improved at the regulatory level by identifying the obstacles to the flow of information in the current regulation.

Cyber threats concern all fields of operation and this is why cyber security should be improved from its current state by means of regulation. Especially

representatives of the rescue and regulatory authorities identified cyber threats as a theme linked to regulation development.

In the fifth question concerning preparedness, the experts were asked to assess the development of preparedness cooperation and whether company cooperation linked to preparedness (e.g. benchmarking) will not increase because companies are afraid that the motive for some companies (e.g. competitors) is trade secrets rather than developing preparedness. Half of the experts considered this development unlikely and one in five likely. A little over a quarter of the experts answered neutrally. The experts who considered the development of the type described in the claim to be unlikely argued that companies already undertake a lot of cooperation on preparedness and the risk of trade secrets is not considered in the desire for knowledge on safety issues. It was seen that companies in the same field of business could learn from each other's rescue drills but the experts considered that cooperation would increase only slightly. However, it was felt that networking and cooperation between companies in general would increase in the future, which would also increase cooperation connected to preparedness.

Sixthly, the experts were asked to assess the importance of 12 different factors in developing authority operations regarding company preparedness for major accidents in the short and long term. According to the experts, the most important factors for developing authority operations in the short term were:

1. Authorities to take a more active part in company rescue drills
2. Securing the cooperation between the authorities in a way that successful cooperation is not bound to personal relations
3. Shifting the focus in authority operations more to advisory and preventive activities
4. Developing the interoperability of the IT systems of different authorities
5. Developing backup systems
6. Improving the area knowledge of authorities on industrial sites

The experts emphasized knowing each other well as a key to preparedness cooperation between authorities and companies. They especially raised the importance of organizing common rescue drills as often as possible and doing the post-drill analysis together in cooperation. In addition, doing preparedness planning and risk analyses together and making the resulting plans of action were seen as factors that would improve cooperation. Whatever the form of cooperation, the long-term and systematic nature of the cooperation was the desired focus of emphasis concerning the forms of cooperation. Some of the experts felt that, at the moment, the expertise of a company is not sufficiently utilized when formulating the external rescue plan. Because of this, the authorities do not always have an adequate situational picture of the operational

processes of a company so that all the risk points of a company would be included in the external rescue plan and these risk points would be taken into account properly. However, many considered an increase in cooperation to be probable, because at the moment, the cooperation between rescue authorities and companies already works well. It was also felt that cooperation would be increased in the future. Additionally, some of the representatives of the rescue and regulatory authorities observed that in the rescue authorities, the younger generation understand better than before the importance of making use of company experts, which is one reason why cooperation will most likely increase in the future. On the other hand, some of the experts considered an increase in cooperation unlikely because cooperation would demand too many extra resources both from the rescue authorities and the companies.

In the short-term development of authority operations, the experts emphasized the increase and improvement of cooperation between the authorities and companies. Effective collaboration was considered vital because good results are not achieved in safety if only one of the parties improves safety operations. The experts raised the issue of common rescue drills especially as a natural and important way of improving cooperation.

According to the experts, the most important factors that would develop authority operations over a long-term perspective were:

1. Shifting the focus in authority operations more to advisory and preventive activities
2. Securing the cooperation between the authorities in a way that successful cooperation is not bound to personal relations
3. Developing the interoperability of the IT systems of different authorities
4. Readiness of the authorities to make use of the IT systems already existing in the municipalities from the point of view of the companies' hazardous situations
5. Backup system development
6. Securing the quality of the cooperation between the authorities and the companies so that cooperation is not bound to personal relations

Also in the long-term perspective, the experts emphasized development of the cooperation between the authorities and the companies and improving preventive activities. The experts emphasized especially shifting the focus in authority operations more to advisory and preventive actions and developing cooperation between different parties in a way that successful cooperation is not bound to personal relations. The cooperation must be open and aimed at a common goal.

Regarding training of the authorities, multi-authority training was highlighted because major accidents are often multi-authority situations. Developing rescue

operations that are carried out by several authorities and other forms of cooperation were seen to be very important for this reason. It was also observed that common rescue drills are a form of multi-authority activity training that should be developed. Also, increasing preventive actions was raised as a relevant issue linked to training development for the authorities. The experts considered the proactive actions of the authorities to be important. Preventive actions also help to build a better situational picture, for example of companies' critical processes, which in part supports decision making and operations by the authorities in potential major accidents. Training of management of major accidents also stood out clearly as an important development target in authority training. All in all, skills in management were regarded as important because the experts recognised that at the moment there is a deficit of skills in basic management. Crisis communication training stood out as an important development theme concerning authority training. The development need for skills in crisis communication was recognised, both in internal and external communication. Internal and external crisis communication forms an important part of the information flow and helps to build a situational picture; for this reason training on crisis communication should be increased.

Seventhly, the experts were asked to assess 13 different factors that would improve the preparedness of the companies for major accidents in the short and long term. In the short-term perspective, the most important development themes raised were:

1. Change in attitude: e.g. the rescue plan in companies is not made so much for the authorities as for securing the continuity of the company's own organization
2. Development of backup plans to secure business processes
3. Personnel training development in companies to take the companies' continuity perspective also more into account
4. Safety management development in companies
5. Maintaining up-to-date information cards in conjunction with the rescue authorities
6. Increasing company cooperation on preparedness (e.g. benchmarking of companies in the same field of business)

Developing an attitudinal climate towards preparedness and the companies' operational reliability was emphasized the most. The attitudinal climate towards preparedness should be developed by increasing the personnel training in companies and improving safety management. Companies should invest in risk management and develop backup systems so that the continuity of the processes of the company can be ensured. In particular, regarding the short-term

improvement of company preparedness, the representatives of the rescue and regulatory authorities highlighted paying more attention to the development of company employee training in terms of the continuity of company operations.

The experts were also asked to assess the development work on preparedness in the long-term perspective. For the long term, the experts considered the most important development themes to be:

1. Taking major accidents into account better in preparedness
2. Change in attitude: e.g. the rescue plan in companies is not made so much for the authorities as for securing the continuity of one's own organization
3. Increasing company cooperation in preparedness (e.g. benchmarking of companies in the same field of business)
4. Personnel training development in companies to emphasize the companies' continuity perspective
5. Safety management development in companies

Taking major accidents into account better was given special emphasis. In the longer perspective, it is important to take into account different kinds of incidents, such as floods. This is important especially in companies that produce critical infrastructure and service operations from the perspective of society. Shaping attitudes and opinions was also emphasized in long-term perspective development. Attitudes towards preparedness change slowly in time. An attitudinal climate for preparedness must also be developed in a longer perspective of time because maintaining the safety culture at a good level demands continuous investments in safety management.

Regarding the training of company personnel, the experts emphasized increasing training on critical processes because the continuity of critical processes is very important from the perspective of the company's continuity management. The experts also argued that increasing training on safety management directed at managers is important because safety culture development in companies is dependent on the managers and, for this reason, safety management training is an important area when developing the safety culture in companies.

Developing guideline info concerning incidents was also seen as an important development suggestion regarding training. Preparedness for incidents and guidelines on eliminating disruptions are an important area in company preparedness. The experts also emphasized the development of safety induction training for contractors and subcontractors. Transferring safety knowhow to external contractors and subcontractors was felt to be important, although a challenging issue. Safety induction was believed to be important because external players are not able to recognize the risk and danger factors linked to the safety

of the company without proper orientation. The lack of safety knowhow and commitment of subcontractors and contractors pose a major risk, and for this reason induction training was considered important from the perspective of continuity management and worth investing in.

Next, the experts were asked to give concrete examples of how the cooperation between the companies and the authorities could be improved concerning the preparedness. Knowing each other well was emphasized in the answers. The experts especially raised the importance of organizing common rescue drills as often as possible and doing the post-drill analysis together in cooperation between companies and authorities. The experts also emphasized the organizing of different kinds of common events: in different kinds of seminars, regional cooperation forums and events, "best practice" knowledge could be shared and training on preparedness organized.

Finally, the experts were asked to give examples of how IT systems should be developed from the perspective of preparedness. In particular, developing interoperable IT systems was brought up in several answers. Interoperability can be improved through jointly implementing predefined software used in preparedness. In addition to adopting critical processes (joint planning, common software and recognizing the needs of orientation), the interoperability of IT systems can also be developed by improving the availability of information through defining common open interfaces.

The experts recognized the IT systems linked to preparedness as a challenge. The challenge is that the life span of various kinds of IT systems is very short and the procurements of IT systems are made specifically for a field of business and/or company. According to the experts, the interoperability of IT systems can be developed if the development is started with the recognition and definition of different kinds of information needs and processes. The technical readiness for the common use of IT systems was acknowledged to exist. However, it came out that, besides the authorities, companies also have tight data security definitions and strong firewalls and do not want to weaken them for the sake of interoperability, although it would be possible. Developing the common use of IT systems was also felt to be too expensive and time-consuming an issue to be realized.

Despite tight data security, another theme concerning the development of IT systems was to make information cards and external rescue plans of the companies in electronic form and save the information on a common IT system for the authorities so that company personnel also have access to them. In this way, in the event of an accident, all the information required would be easily available and updating information would become easier. This was considered almost unanimously desirable because it was seen as increasing the transparency of operations and developing common operational models. It was also seen as

improving the timeliness of information and increasing the amount of information and use of a common terminology. When everybody has the same basic knowledge, the risk of misunderstandings in a rescue situation decreases. In addition, it was noted that this kind of development would make the information more up-to-date and would make it easier for companies to update their information for the rescue authorities, which could for example improve the quality of external rescue plans. Other themes were for example putting company information cards into electronic form and saving the information on a common authorities' IT system.

2. The third Delphi round

In the third Delphi round there were six claims, rankings and open ended questions related to preparedness, on the following topics:

- Development of cooperation on external rescue plan
- Interoperability development of IT systems
- Preparedness for cyber threats
- Development of regulation
- Increasing safety in companies by training
- Increasing safety by training the authorities

The questionnaire was formulated based on the findings of the previous Delphi rounds.

First, the experts were asked to assess the development in which the rescue authorities make use of the expertise of a company more than before. The experts were asked to assess whether rescue authorities will make use of company expertise, besides the internal rescue plan made by the company, when formulating an external rescue plan. The development described in the claim was on average considered fairly likely because at the moment, the cooperation between rescue authorities and companies already works well and it was also felt that cooperation would be increased in the future.

As the second question, the experts were asked to assess whether in the future a company will have the possibility to analyze its own information (e.g. external rescue plan and information card and save information (e.g. up-to-date site area maps) on an IT system maintained by the authorities. The experts considered the claim on average to be slightly more likely than unlikely. The unlikelihood of the claim was justified from the perspective of resource and data security. Developing the common use of IT systems was felt to be an expensive and time-consuming issue. On the other hand, the development described in the claim was considered likely because there seems to be a common trend towards enhanced

cooperation and interoperability. The technical readiness for the common use of IT systems was acknowledged to exist. Those who were most critical towards developing the common use of IT systems considered the development undesirable, because developing large systems is both challenging and expensive.

As a third question concerning preparedness, the experts were asked to assess the probable development of preparedness for cyber threats. They were asked to assess whether, in the next five years, the cyber threats faced by major companies and individual authorities will increase so much that they will actively follow the advice and recommendations of the CERT-FI unit and/or soon to be established Cyber Security Center to prepare for threats. The experts considered the claim to be fairly likely. It was argued that cyber threats and preparedness for them are likely to increase because cyber threats have been increasing all the time and it was not felt that the trend would change in the next few years. Those who considered the increase of the situation described in the claim unlikely argued that they did not foresee that the increase in preparedness for cyber threats would be as strong as described in the claim. At least it was felt that the increase in cyber threats would not evolve as fast in the next five years as stated in the claim.

The fourth question concerned developing regulation in order to improve the flow of information. The experts were asked an open question about potential improvement, clarification, or development of regulations to improve and streamline the flow of information. Excessive ambiguity and improving the regulations were raised as the biggest individual themes concerning regulation. At the moment, different actors can interpret the same regulations in various ways, which hinders the preparedness operations of companies. Also, the fragmentation of the regulations was recognized as a problem in every respondent group. The regulations should be standardized and legislation should be done in a coordinated fashion with more broad-based cooperation than at the moment to avoid fragmentation. In particular, cyber threats and regulation in the case of major incidents stood out.

Fifth, the experts were asked to assess development suggestions on increasing safety in companies through training. According to the views of the experts, the most important development suggestions were:

1. Increasing training on critical processes for the whole personnel; the perspective of managing continuity
2. Increasing safety management training directed at managers
3. Developing guideline info concerning incidents
4. Developing safety induction training for contractors and subcontractors

Finally, the experts were asked to assess development suggestions on increasing safety by training the authorities. According to the views of the experts, the most important development suggestions were:

1. Multi-authority operations training
2. More training emphasizing preventive action
3. Training of management of major accidents
4. Increasing crisis communication training

In particular, multi-authority training was highlighted in the answers because major accidents are often multi-authority situations. The experts considered the proactive actions of the authorities to be important in helping to prevent major accidents. Preventive actions also help to build a better situational picture, for example of companies' critical processes, which in part supports decision making and operations by the authorities in potential major accidents. Training of management of major accidents also stood out clearly as an important development target in authority training. This was considered important because, according to the answers, there are rather few authorities capable of managing major accidents. Crisis communication training stood out as the fourth most important development theme concerning authority training. It was felt that, in general, there is a skill deficit in crisis communication. The developmental needs for skills in crisis communication were recognised, both in internal and external communication.

7 POTENTIAL IMPROVEMENTS IN THE RESPONSE PHASE

Response and potential improvements in communication and the flow of information were the other topic of the second and the third Delphi rounds. The questionnaires are presented in APPENDIX 5 and APPENDIX 6.

7.1 Findings in the second Delphi round

7.1.1 Common terminology

The experts were asked to assess the theme concerning the situational picture and the flow of information by assessing the future development of a common terminology. The experts were asked to assess the following claim:

The problems of terminology and use of jargon can be eliminated by forcing the parties to use a common terminology, which is independent of the field of operation, in crisis communication.

In the first Delphi round interviews, it was revealed that the lack of a common terminology and use of jargon is a major issue in the flow of information in rescue operations and when forming a situational picture. At the moment, each sector of business and branch of administration uses special vocabulary tied to their field of operation, but the majority of these special terms could be standardized and simplified in a coordinated fashion.

7.1.1.1 Probability of a common terminology

The experts were asked to assess the probability of the development of a common terminology (-3 = highly unlikely … +3 highly likely). Forty-two answers were received (Figure 36). The experts did not foresee any big changes coming in the next five years because the experts considered the development of the type described in the claim to be only slightly likely (the average answer 0.31).

However, the answers of the experts diverged somewhat (standard deviation 1.77). Slightly over 50 % of the experts considered enforcing the use of a common terminology to be likely and 35 % unlikely. Four experts answered neutrally.

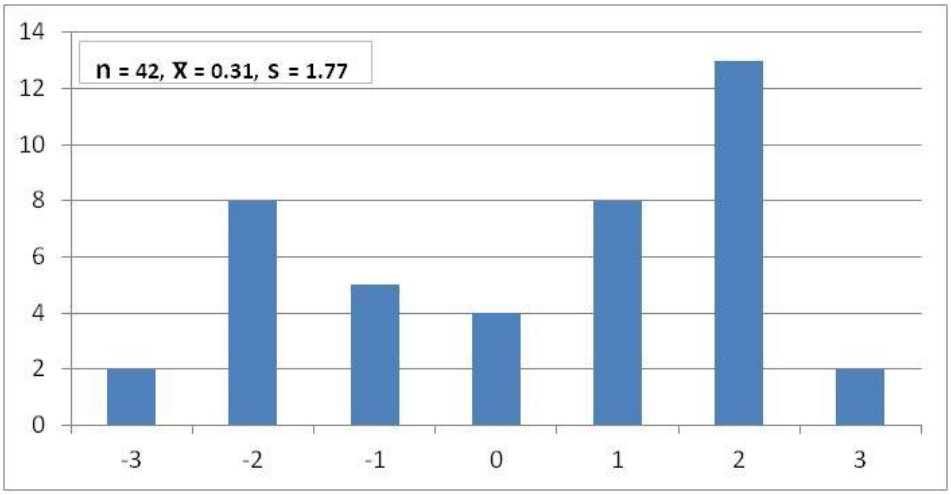

Figure 36 Probability of a common terminology

The stakeholders considered the development of the type described in the claim more unlikely than the other respondent groups (Table 21). They considered the claim slightly more unlikely than likely (the average answer -0.10). However, the answers of the stakeholders diverged quite a lot (standard deviation 2.23). The rescue and regulatory authorities considered the claim slightly likely. The companies considered enforcing the use of a common terminology to be more likely.

Table 21 Probability of a common terminology, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities		3	3	2	3	3	1	15	0.20	1.60
Companies		3	2	1	3	8		17	0.65	1.57
Stakeholders	2	2		1	2	2	1	10	-0.10	2.23

Those who considered the development of the type of the claim unlikely argued that the terminology could not be developed by enforcement. Jargon is easily used during major accidents because the situation is so hectic in an accident that it cannot be affected by practicing the use of a different kind of vocabulary. Some of the experts also observed that enforcement would entail its inclusion in the regulation, and this development was not seen as likely. The

terminology problem cannot be solved by regulation alone. Instead, increased awareness and understanding can steer people towards the use of common terms. Some of the experts also emphasized that it would be easier for the authorities to develop a common terminology. On the other hand, according to the view of some experts, companies would still be 'allowed' to use jargon. However, the terms and jargon that are most often used should be simple and understandable also for a person who has to deal with the matter only occasionally.

The development of the type of the claim was considered likely because the use of a common terminology in other fields of society has developed. Thus it is bound to develop through common benefits in the field of safety. One expert argued:

> *"The increased use of a common terminology is a natural development. However, that can also be improved through developing the regulations."*

In Finland this development is also supported by vocabulary work done by the Finnish Terminology Centre. One respondent also pointed out that a condition for developing commonly usable IT systems is a common terminology; on a more general level, this is the aim of the ontology service which it is planned to establish in connection with the Finnish National Library. The goal of this ontology service is a centralized online service, executed with an open source code, for the use of both the public and private sectors.

Some of the experts observed that the problems concerning terminology and jargon can be eliminated but the issue cannot be fully fixed by force because also people who are caught up in accidents very rarely take part in crisis communication. The problem can be decreased by changing attitudes and partly with the help of training. For example, the authorities could quite easily increase their use of a common terminology. The most important issue in crisis communication is to understand for whom the communication is meant. If the target group is company personnel, jargon linked to work might be necessary. However, if the communication is meant for local people, the language should be simple and understandable. The importance of training and practice in order to improve the situation is extremely significant in this case.

7.1.1.2 Desirability of a common terminology

The experts were also asked to assess the desirability of the development of the type described in the claim (-3 = highly undesirable … +3 = highly desirable). Forty-two answers were received (Figure 37).

On average, the expers considered the claim to be desirable (average answer 1.48). However, the answers diverged (standard deviation 1.57). A majority of

the experts, i.e. 78 %, considered the development of the type described in the claim desirable and 15 % considered the development undesirable. Three answered neutrally.

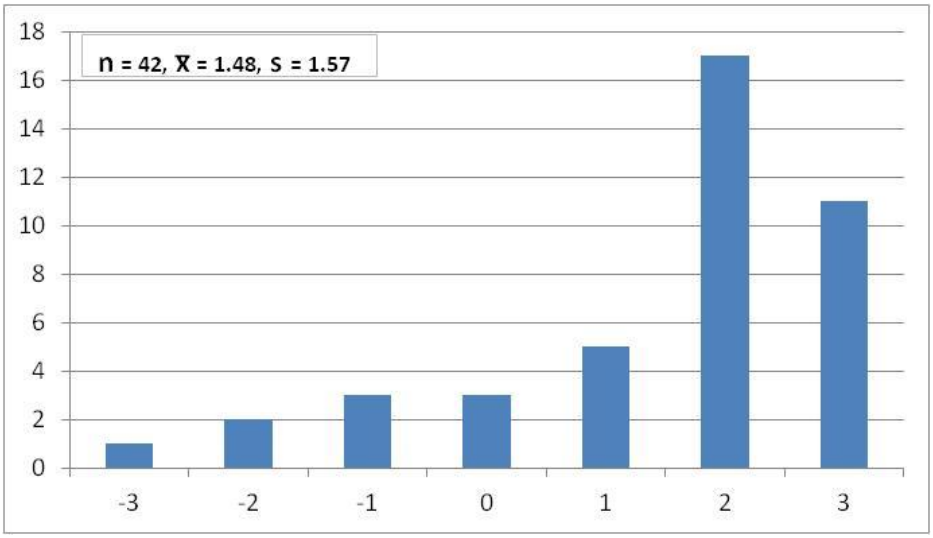

Figure 37 Desirability of a common terminology

When analyzed by respondent group, it can be noticed that there are no major differences between the respondent groups (Table 22). On average, all the respondent groups considered the development described in the claim to be desirable. The most unanimous, concerning desirability, were the company representatives, whose assessments diverged relatively little (standard deviation 1.14). The answers of the stakeholders diverged most (standard deviation 2.07).

Table 22 Desirability of a common terminology, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities		1	2	2	1	5	4	15	1.27	1.61
Companies		1		1	3	10	2	17	1.59	1.14
Stakeholders	1		1		1	2	5	10	1.60	2.07

The development of the type described in the claim was considered desirable because a common terminology would decrease the possibility of misunderstandings. The terminology in use must be so clear and established in practice that everybody understands it, to avoid mistakes and misunderstandings. The importance of the issue will be highlighted even more in the future because multi-authority situations are expected to become more common. In that case, it

is important to speak the same language with the same terms. Improving the situation calls for increasing common practice and feedback sessions.

Developing practices must be based on common needs and the development must be based on good preparedness cooperation. One expert argued:

> "A common terminology is a definite condition for effective practice in response and in preplanning of accidents as well as authorities' decrees on rescue authorities. The significance is being highlighted as society becomes more vulnerable and the number of natural major accidents increases where different organizations, which might even come from other countries, are needed to cope with accidents. This poses big challenges for the accuracy of communication and understandability, certainly in the right way."

Some of the experts considered the development to be undesirable. In particular, the representatives of the rescue and regulatory authorities saw enforced use as something undesirable and it was not believed that this would improve safety. Instead, different parties should be made to understand the importance of the use of a common terminology in other ways. It was felt that problems of terminology could be eliminated through training for example.

7.1.2 Development of communication training

In the second question concerning response, the experts were asked to assess the communication linked to response. The experts were asked to assess the following claim:

Communication training will be made more use of in order to improve the briefings and communication linked to major accidents.

The claim was connected to the need for both the companies and the authorities to invest in the briefings and communication linked to major accidents. Especially in the case of major accidents, communication is extremely important because major accidents often have impacts outside the actual accident site, e.g. to the inhabitants of the neighbouring areas and other companies. Investment in briefings and communication includes practising cooperation with the media and taking part in communication training.

7.1.2.1 Probability of development of communication training

The experts were asked to assess the likelihood of a significantly wider use of communication training (-3 = highly unlikely … +3 = highly likely). Forty-two answers were received (Figure 38). The experts considered the increased use of communication training to be likely (average answer 1.33). The experts were fairly unanimous on the likelihood of the development of the type described in the claim (standard deviation 0.95). Less than 10 % of the experts considered the development to be unlikely and the majority, i.e. 85 % of the experts, likely. Three experts answered neutrally.

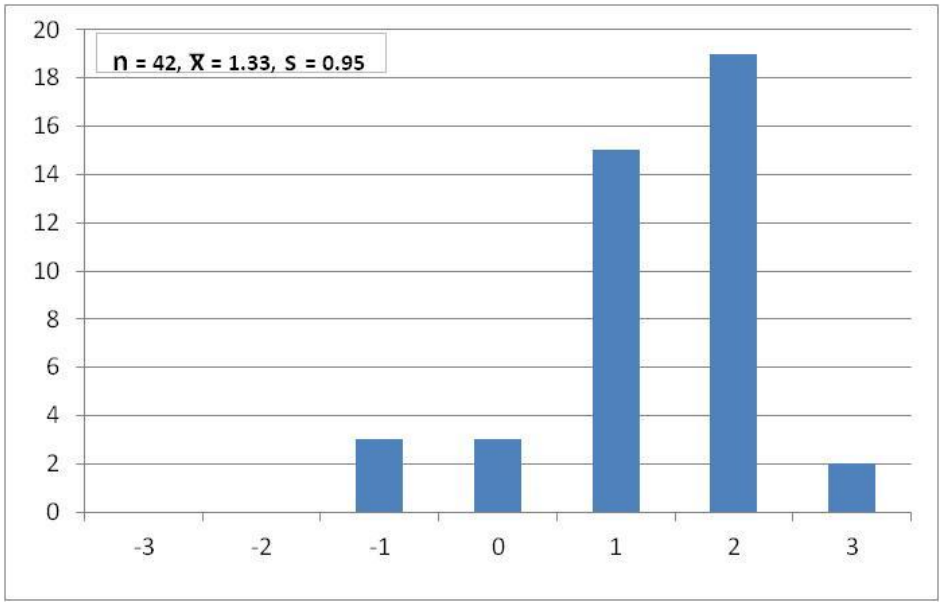

Figure 38 Probability of development of communication

The companies considered a significant increase in the use of communication training to be more likely (Table 23). The companies were quite unanimous on the development because none of the company representatives considered the development to be unlikely. Also, on average the other respondent groups considered the development likely; however, in these respondent groups a few individual experts observed that a significant increase in the use of communication training was slightly unlikely.

Table 23 Probability of development of communication, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities			2	1	7	4	1	15	1.07	1.06
Companies				1	5	11		17	1.59	0.60
Stakeholders			1	1	3	4	1	10	1.30	1.16

The development represented in the claim was considered to be likely because shortcomings in communication have almost always been the reasons for problems in major accidents and in tackling them. For this reason, the shortcomings in communication are foreseen to be so significant in the future that communication training will be made more use of than it is at the moment. Communication plays a central part in practice in the case of major accidents; therefore different players must invest in its development.

Some of the experts brought up the fact that the problems of some electricity companies in managing communication during the Tapani and Hannu storms raised communication as an important development target more widely among other actors in society. The experts also emphasized the fact that the increase in the use of social media, increases pressure regarding the dissemination of information. For this reason, the significance of communication is growing and demanding even more investments and preparedness, both from companies and the authorities. If information is not given in time, the media draws conclusions about the situation based on unreliable sources. Poorly executed communication can cause problems and negative publicity. For this reason, communication training and practice are ways of improving communication in major accidents.

A few experts considered the development stated in the claim to be unlikely because they did not see significant increases coming in communication training. They observed that communication will not be practised separately but practising it will become a part of rescue drills.

7.1.2.2 Desirability of development of communication training

The experts were also asked to assess the desirability of the development described in the claim (-3 = highly desirable … +3 = highly undesirable). Forty-one answers were received (Figure 39). On the whole, the development was considered to be clearly desirable (average of all the answers 1.9). The experts were also fairly unanimous on the desirability of the development: almost 90 % of the experts considered the development desirable. Two experts considered the development described to be slightly undesirable and three experts answered neutrally.

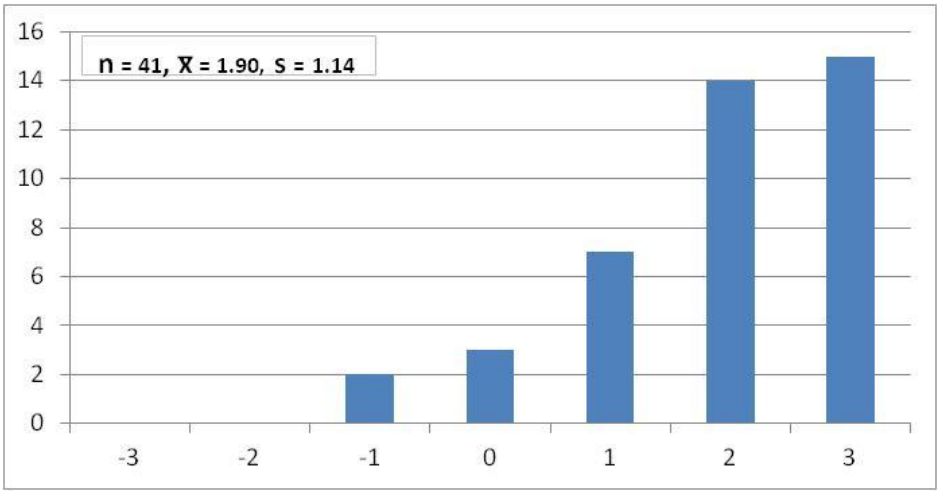

Figure 39 Desirability of development of communication

The stakeholders considered the development to be more desirable. They assessed an increase in utilizing communication training as extremely desirable (Table 24). Also, the representatives of the rescue and regulatory authorities considered the development described in the claim to be clearly desirable.

Table 24 Desirability of communication development, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities				3	2	6	4	15	1.73	1.06
Companies			1		5	8	2	16	1.63	0.93
Stakeholders			1				9	10	2.60	1.26

It was argued in general that an increase in communication training is desirable because adequacy and clear content is one of the most important areas in good management of major accident, on all levels of activity. The damage to the organization and the rest of society may be increased significantly due to insufficiently or poorly executed communication unless the relevant information, on which to act properly, is available.

The experts also observed that poor management of communication leads to difficulties in response to major accidents, e.g. through uninformed citizens blocking the telecommunications networks or blocking the road traffic. In addition, clear and functioning communication practices open up the opportunity for executing response operations adequately. For this reason, communication should be developed and awareness of for example utilizing new methods of communicating should be increased. One expert commented as follows:

> "Clear and effective communication practices allow people to "get on with their work" to carry out response and recovery operations adequately."

Only 12 % of the experts considered the development undesirable or answered neutrally. The experts did not feel that communication would in fact be as essential as it is generally believed. The basics of communication should be taught but better results are achieved through practical training rather than communication training.

7.1.3 Development of post-accident analyses

In the third question concerning response, the experts were asked to assess the development of post-accident analyses. The experts were asked to assess the following claim:

As a result of analyzing their own rescue drills and accidents, and also accidents that have taken place somewhere else, the players will change their own processes in order to prevent accidents significantly more than before.

The claim was linked to the view that arose in the interviews of the first Delphi round that it would be good to obtain more information than at present on analyses of rescue drills and follow-up of accidents. It is possible to learn from accidents that have taken their place somewhere else how similar situations could be avoided in one's own organization.

7.1.3.1 Probability of development of post-accident analyses

The experts were asked to assess the probable development of increased post-accident analyses (-3 = highly unlikely … +3 = highly likely). Forty-two answers were received (Figure 40). On average, the experts assessed the development described in the claim as fairly likely (the average of all answers was 1.17). The experts were fairly unanimous on the development: 76 % of the experts considered the development likely and 12% unlikely (standard deviation 1.31). Five experts answered neutrally.

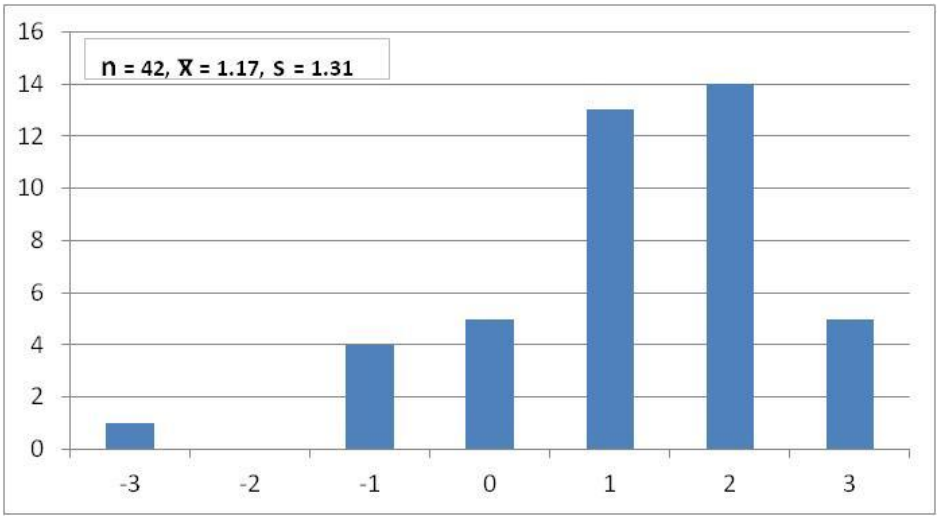

Figure 40 Probability of development of post-accident analyses

When analyzed by respondent group (Table 25), it can be observed that the companies considered it more likely that accidents will be analyzed more and more in the future and through that the players will change their own processes (the average answer of the company representatives was 1.53). The companies were also fairly unanimous on the development because only one from the company respondent group considered the development unlikely. The stakeholders and the representatives of the rescue and regulatory authorities also considered the development described in the claim to be rather likely.

Table 25 Probability of development of post-accident analyses, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities			3	2	5	5		15	0.80	1.11
Companies			1	2	4	7	3	17	1.53	1.09
Stakeholders	1			1	4	2	2	10	1.10	1.73

The development of the type described in the claim was considered likely because, among other reasons, the experts had noticed an increase in the number of observers in rescue drills. The company representatives also emphasized the fact that the quality assurance systems of companies call for the documenting of observations on accidents and near-miss situations and making corrective measures more precisely than before.

The experts also observed that the more experience that is gained from the positive effects of the processes in question in the operations of different

organizations, the more the development of the type of the claim would increase. One expert argument was:

> *"Especially those who have a big safety risk utilize the information obtained from the analyses already, at least to some extent. I think that they will also develop their operations based on that more than before."*

For example, the Safety Investigation Authority of Finland has already shown the benefits of studying major accidents and the proposals for action based on it, which increases the analyzing of accidents. Also, rescue drills produce important observations that will be increasingly taken into account.

A few experts considered the development of the type of the claim unlikely; or at least it was not believed that the situation would change from the current state. These respondents were sceptical towards a change in the current situation occurring within the next five years. It was for example estimated that the rescue authorities and companies will still operate very reactively and the situation of the type of the claim would call for a big change in operational culture, which can only happen extremely slowly.

7.1.3.2 Desirability of development of post-accident analyses

The experts were also asked to assess the desirability of the development of the type of the claim (-3 = highly desirable … +3 = highly undesirable). Forty-one answers were received (Figure 41). The experts considered analyzing the accidents and through that changing the processes of the players on average to be either desirable or highly desirable (the average of all answers 2.32). The experts were unanimous on the development because none of the experts considered the development of the type of the claim undesirable. Forty experts considered the development desirable and one answered neutrally.

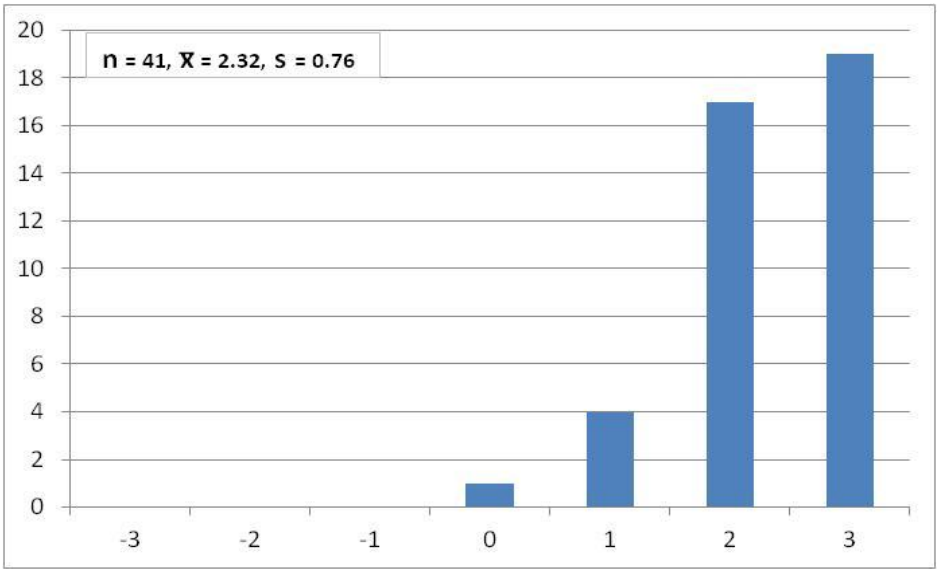

Figure 41 Desirability of development of post-accident analyses

The stakeholders' respondents considered increasing post-accident analyses to be highly desirable (Table 26). The stakeholders were also fairly unanimous on the development (standard deviation 0.170). There were no big differences in the answers of the companies and the authorities because these respondent groups also considered the development desirable, and the standard deviation of the answers was low.

Table 26 Desirability of development of post-accident analyses, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities				1	1	7	6	15	1.57	0.83
Companies					2	8	6	16	2.25	0.66
Stakeholders					1	2	7	10	2.60	0.70

The development of the type of the claim was considered desirable because it was also desirable that the experiences from accident situations would bring additional value to response and preventive actions. Practising and learning from accidents that have taken their place somewhere else is highly recommended. Why repeat mistakes made by others if it is possible, with the help of analyzing, to gain additional information on the reasons that led to accidents and the means to prevent similar occasions from happening. One argument was:

> *"The post-analyses of accidents and also rescue drills are highly desirable. However, in everyday life there is often too little time for them - both in authorities and business organizations."*

The accidents should be reported in a way that development suggestions from them could be used all along the line in risk management development. Accident analyses can be utilized in many processes connected to safety, such as in monitoring operations, quality manuals, and rescue plans.

All in all, post-accident analysis and development as a result of analysis is extremely desirable in the aim of preventing accidents. A few experts raised the possibility that reducing resources might hinder this desirable development. That is why it is important to acknowledge that the changes in procedures and processes increase not only safety but also efficiency and competitiveness of operations.

7.1.4 Development of VIRVE usage

In the fourth question concerning response, the experts were asked to assess the development of VIRVE use. The experts were asked to assess the following claim:

The use of VIRVE handsets will become mandatory in all high major accident risk companies in order to improve the flow of information.

The usefulness of VIRVE came out in the interviews of the first Delphi round. On the other hand, the challenges in using VIRVE in connection with the flow of information in major accidents were also raised in the interviews; many of the experts mentioned the weaknesses in the skills of using VIRVE handsets and the ineffectiveness of the VIRVE network.

7.1.4.1 Probability of mandatory use of VIRVE

The experts were asked to assess the probability of the development of using VIRVE (-3 = highly unlikely … +3 = highly likely). Forty-two answers were received (Figure 42). The experts considered the mandatory use of VIRVE handsets in major accidents to be slightly more likely than unlikely (the average of all the answers was 0.52). There was some divergence in the answers, as about 64 % of the experts considered the development to be likely and slightly over 25

% of the experts considered it unlikely (standard deviation 1.63). Five experts answered neutrally.

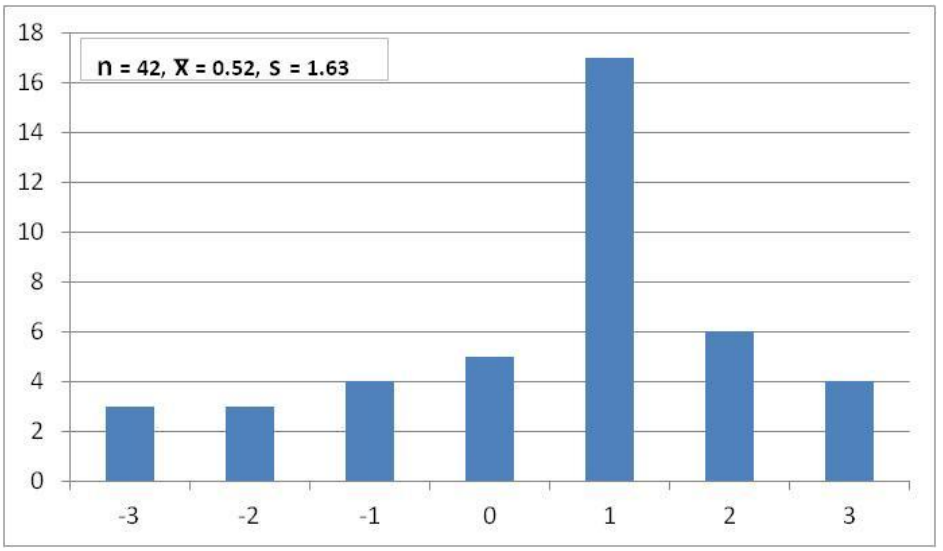

Figure 42 Probability of mandatory use of VIRVE

When analyzed by respondent group, it can be observed that the representatives of the rescue and regulatory authorities and the companies considered the mandatory use of VIRVE in major accidents to be rather likely (Table 27). In contrast, the stakeholders considered the development stated in the claim to be slightly unlikely. There was more divergence in the answers of the stakeholders than in the answers of the other respondent groups.

Table 27 Probability of mandatory use of VIRVE, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities		1	1	2	7	3	1	15	0.87	1.20
Companies	1	1	1	2	7	3	2	17	0.76	1.55
Stakeholders	2	1	2	1	3		1	10	-0.40	1.96

Some of the experts considered the development of the type described in the claim to be unlikely, since they did not believe that use of VIRVE would become mandatory. Some also emphasized that the development described is not technically or economically justified. The companies would consider the benefits achieved with the help of VIRVE thoroughly before procuring the equipment because the big challenge is that the skills in using VIRVE would be forgotten and in the event of an accident, VIRVE could not be utilized in the company. The

stakeholders also emphasized the fact that VIRVE may be replaced with some other and better system in the future.

Those who considered the development of the type described in the claim to be likely argued that VIRVE is a definite prerequisite in improving communication during major accidents and VIRVE handsets are already used in some companies. With the help of VIRVE, different players are able to be in contact with each other in the event of a major accident. These days the pressures on VIRVE use are big enough that the challenges in its use can be addressed. The technology and usability of VIRVE were also expected to develop in the future, which increases the likelihood of the development mentioned in the claim. The experts observed that VIRVE is necessary regarding information but that its correct use calls for training.

7.1.4.2 Desirability of mandatory use of VIRVE

The experts were also asked to assess the desirability of making VIRVE handsets compulsory in all high accident risk companies (-3 = highly undesirable … +3 = highly desirable). Forty-two answers were received (Figure 29). The mandatory use of VIRVE handsets was considered on average as quite desirable or desirable (the average of all answers was 1.5). The experts were fairly unanimous on the desirability of the development: almost 90 % of all the experts considered the development desirable and 7 % undesirable (standard deviation 1.31). Two experts answered neutrally.

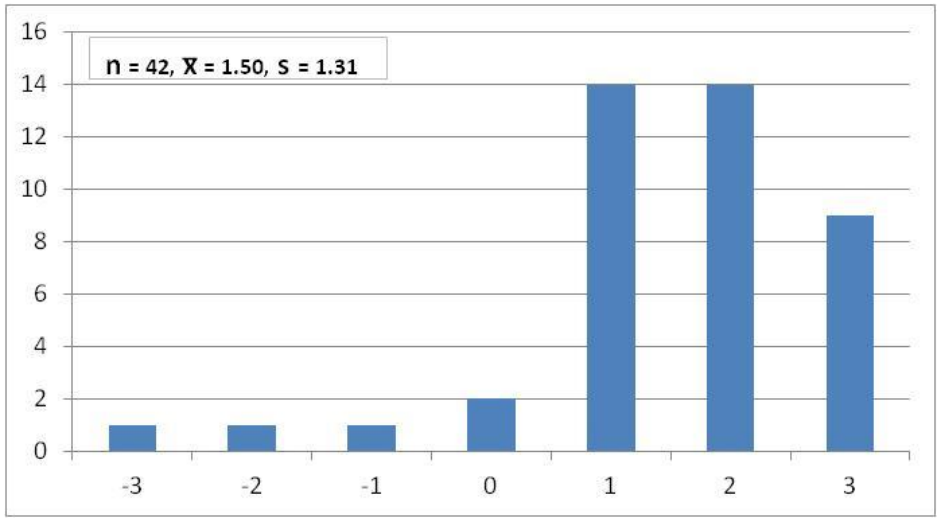

Figure 43 Desirability of mandatory use of VIRVE

When analyzed by respondent group, it can be seen that there were no significant differences between the respondent groups regarding the desirability of the development stated in the claim (Table 28). All the respondent groups considered the development mostly desirable. All the respondent groups were also fairly unanimous on the desirability of mandatory use of VIRVE.

Table 28 Desirability of mandatory use of VIRVE, answers by respondent group

	-3	-2	-1	0	1	2	3	n	$\bar{x}$	s
Rescue and Regulatory Authorities			1	2	5	4	3	15	1.40	1.14
Companies		1			5	8	3	17	1.65	1.13
Stakeholders	1				4	2	3	10	1.40	1.78

It was argued that the development of the type mentioned in the claim is desirable because VIRVE is a definite prerequisite for the development of flow of information, as it facilitates the speeding up and improvement of the flow of information between companies and authorities. According to the companies, VIRVE could for example help in the better use of the experts in companies during response. The use of VIRVE should be widened because that is the best way to secure communication in all situations. Having more handsets at the risk targets would improve the connections between different players.

The development was also seen to be desirable because at the moment it is hard to find the optimal medium and one common system is always better than many different ones. One expert argued:

> *"At the moment there is no better equipment available. Without VIRVE it would be impossible to communicate at a major accident. It should be mandatory for businesses with high risks. Very desirable"*

The VIRVE network was seen to have almost limitless usability in different areas of communication. However, it also poses challenges for training and practice so that the efficiency and qualities of the handsets are made the best possible use of. A VIRVE handset without a skilled user does not improve the flow of information and communication.

Those who considered the development of the type mentioned in the claim to be undesirable argued that the VIRVE construction is becoming outdated and no longer meets cost efficiency demands. The use of VIRVE between the companies and the rescue authorities should always be considered case by case because it does not bring equivalent benefits to all companies. VIRVE has some useful features because of the separate authority network but making it mandatory would not be justified technically or economically. Other commercially available

telecommunications services, such as video services using mobile broadband, should also be utilized and their use should be practised..

7.1.5 Ranking of topics related to situational picture

One of the goals of this Delphi study was to find out situations in which there have been problems with the flow of information related to major accidents. Thus, in the interviews of the first Delphi round, different factors were revealed which the experts felt could help to improve the problem issues with the situational picture and flow of information. In the second Delphi round, the experts were asked to assess the importance of these factors to improve the flow of information in developing rescue operations during major accidents. The experts were asked to rank the eight factors listed below:

- Development of alarm instructions
- Information card concerning every establishment at risk of a major accident
- Development of better interoperable authorities' IT systems
- Technical development of situational picture system
- Improving flow of information through standardizing terminology
- Guidance and development of briefings and communication
- Better opportunities for the authorities to utilize company IT systems
- Increasing the use of VIRVE in companies

Figure 44 should be interpreted as follows: Guidance and development of briefings and communication was ranked as the most important most often (24 experts). In addition, it was the second most important according to four experts, the third most important according to six experts, and the fourth most important according to four experts, etc. This question was answered by forty-three experts.

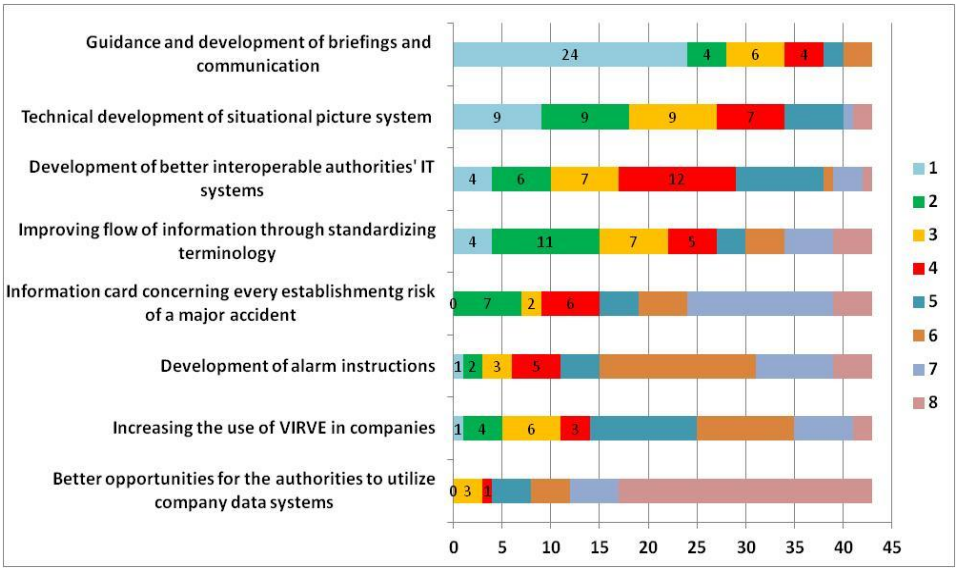

Figure 44 Ranking of topics related to situational picture and flow of information

According to the experts, the most important factors were:

1. Guidance and development of briefings and communication was in the four most important factors according to 38 experts (88 % of the experts)
2. Technical situational picture system development was in the four most important factors according to 36 experts (84 % of the experts)
3. Development of better interoperable authorities' IT systems was in the four most important factors according to 29 experts (67 % of the experts)
4. Improving flow of information through standardizing the terminology was in the four most important factors according to 27 experts (63 % of the experts)

The experts had pretty much the same arguments for the importance of briefing and communication guidelines and development as they did for the development of communication training in chapter 7.1.2 on page 165. Briefing is one of the most important areas linked to the situational picture and the flow of information because in an accident timely and good quality safety communication is important for both authorities and companies. Communication is crucial in the event of a major accident because the effects of it can cover a wider area than the actual accident site, e.g. the neighbouring residential districts and other companies. Inadequately executed communication can exacerbate the problems linked to a major accident. On the other hand, successful briefings and communication can help reduce damage and enable the fluency of response.

Analyzed by respondent group (Table 29), it can be seen that especially the representatives of the rescue and regulatory authorities as well as the stakeholders stressed guidance and development of briefings and communication. The companies also raised guidance and development of briefings and communication as the most important development theme by far, but their opinions diverged more than the other respondent groups.

Table 29 Ranking of topics related to situational picture and information flow, answers by respondent group (%)

Development theme	Ranking	Rescue and Regulatory Authorities	Companies	Stake-holders	Total
Guidance and development of briefings and communication	1.	60.0	47.0	60.0	55.8
	2.	13.3	5.8	10.0	9.3
	3.	13.3	23.5	0.0	14.0
	4.	0.0	11.8	20.0	9.3
Technical situational picture system development	1.	20.0	23.5	20.0	20.9
	2.	20.0	11.8	40.0	20.9
	3.	20.0	29.4	0.0	20.9
	4.	20.0	5.9	30.0	16.3
Improving flow of information through standardizing the terminology	1.	0.0	11.8	20.0	9.3
	2.	33.3	23.5	10.0	25.6
	3.	20.0	11.8	20.0	16.3
	4.	13.3	17.6	0.0	11.6
Development of better interoperable authorities' IT systems	1.	13.3	11.8	0.0	9.3
	2.	6.7	17.6	20.0	13.9
	3.	20.0	11.8	20.0	16.3
	4.	26.7	29.4	20.0	27.9

The experts raised technical situational picture development as the second most important factor which would improve the flow of information and situational picture because in their opinion, situational picture systems are not interoperable enough at the moment. The lack of a common situational picture system causes problems in creating a common real-time situational picture. The answers by respondent group were fairly unanimous regarding the development of a technical situational picture system. This complicates for example the adequate dimensioning of response. An effective situational picture system

would help make it possible to gather all the necessary information in one place, which would improve the flow of information.

Standardizing terminology was raised as the third most important factor that would develop the situational picture and the flow of information. It is very important in an accident that the terminology is accurate and understandable. A common terminology decreases misunderstandings linked to the flow of information in a major accidents. Some experts in the stakeholder and company groups pointed to a standardized terminology as the most important theme in improving information flow. Not a single representative of the representatives of the rescue and regulatory authorities raised this theme as the most important, but on the other hand some experts in this group ranked this issue as the second most important development theme in improving the situational picture and flow of information.

7.1.6 Developing response

Several development suggestions stood out in the interviews of the first Delphi round, with the help of which, according to the experts, the response in major accident situations could be developed in the future. The importance of the development suggestions, from the perspective of improving safety, was evaluated in the second round questionnaire. In the second round questionnaire, the experts were asked to assess 12 different factors that would improve the response in major accidents. The experts were asked to choose 3 factors from the following 12 factors that they considered as most important in both the short-term (1–2 years) and long-term (5 years) perspective:

- Improving plant guidance
- Alarm instructions development
- Command center practise development
- Information card requirement for establishments at risk of a major accident
- Developing crisis management training
- Increasing investments in plant fire brigade
- Developing rescue drills to correspond better to reality
- Better post-analyses of rescue drills and accidents
- Developing of management skills related to major accidents
- Improving the local knowledge of the authorities at the risk targets
- Increasing the expertise of the authorities (e.g. knowledge of chemicals)
- Increasing the utilization of the expertise of company personnel

7.1.6.1 Developing response, short-term

The most important development themes in the short-term perspective were found to be as follows (Figure 45):

1. Increasing the utilization of the expertise of company personnel (49 % had ranked this in their top three)
2. Developing rescue drills to correspond better to reality
3. Better post-analyses of rescue drills and accidents
4. Information card requirement for establishments at risk of a major accident
5. Improving the area knowledge of the authorities at the risk targets
6. Developing of management skills related to major accidents

Concerning short-term development, the experts emphasized different kinds of factors that would develop response, such as making use of the experts in companies, developing rescue drills, and post-analyses of drills and accidents. All these factors would improve the cooperation between companies and authorities. In addition, the experts considered the information card requirement for major accident risk targets and improving the area knowledge of the authorities to be important. These factors linked to development would improve successful handling of an accident.

When analyzing the respondent groups, it can be seen that especially the rescue and regulatory authorities placed emphasis in their answers on making better use of company experts in major accidents and developing rescue drills. In addition, the rescue and regulatory authorities were the only group to stress the improvement of plant/local guidance as one of the development themes for response (23% of rescue and regulatory authorities). In contrast, only 8 % of the rescue and regulatory authorities' respondents ranked the local knowledge of the authorities as one of the three most important themes for developing response, whereas, according to the average of the answers of all the experts, it was one of the most important development themes.

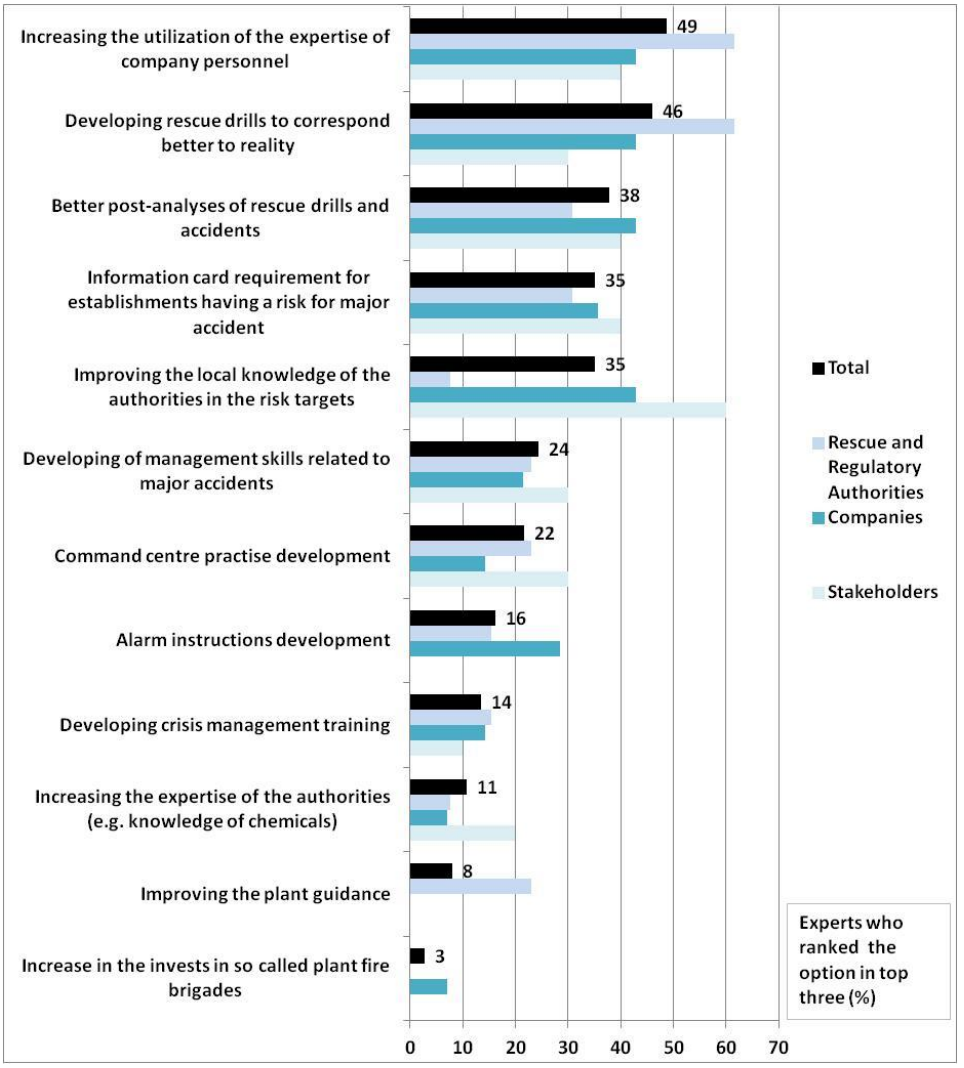

Figure 45 Developing of response in the short-term

The company respondent group for their part highlighted more than the other groups improved post-analyses of rescue drills and accidents and developing alarm instructions. All the respondent groups and particularly the stakeholders' group emphasized improved authority local knowledge of risk targets as one development theme for response. The stakeholders ranked the improvement of the authorities' local knowledge as the most important development theme for response in the short-term perspective

7.1.6.2 Developing response, long-term

The experts were also asked to assess the importance of developmental factors concerning response in the long-term perspective (Figure 46). In a longer time perspective the most important developmental targets, according to the experts were:

1. Developing of management skills related to major accidents (50 % had ranked this in their top three)
2. Command center practice development
3. Developing crisis management training
4. Increasing the utilization of the expertise of company personnel
5. Developing rescue drills to correspond better to reality
6. Better post-analyses of rescue drills and accidents

Concerning long-term development, the experts especially emphasized management development. All three factors that received most mentions can be considered to relate to management; command center operations development is also largely linked to management, since collaboration and the flow of information can be improved by developing management in major accidents. Management development is also connected to preventing major accidents because the safety culture can be developed on a more general level.

Other long-term development targets were connected to factors that can prevent the major accident from escalating or even prevent accidents from occurring. These kinds of factors were making better use of the experts of companies in accidents, and rescue drill development and better post-analyses of the rescue drills or accidents, which were both mentioned 10 times. These factors were also considered such that their development can also be done in the short-term perspective.

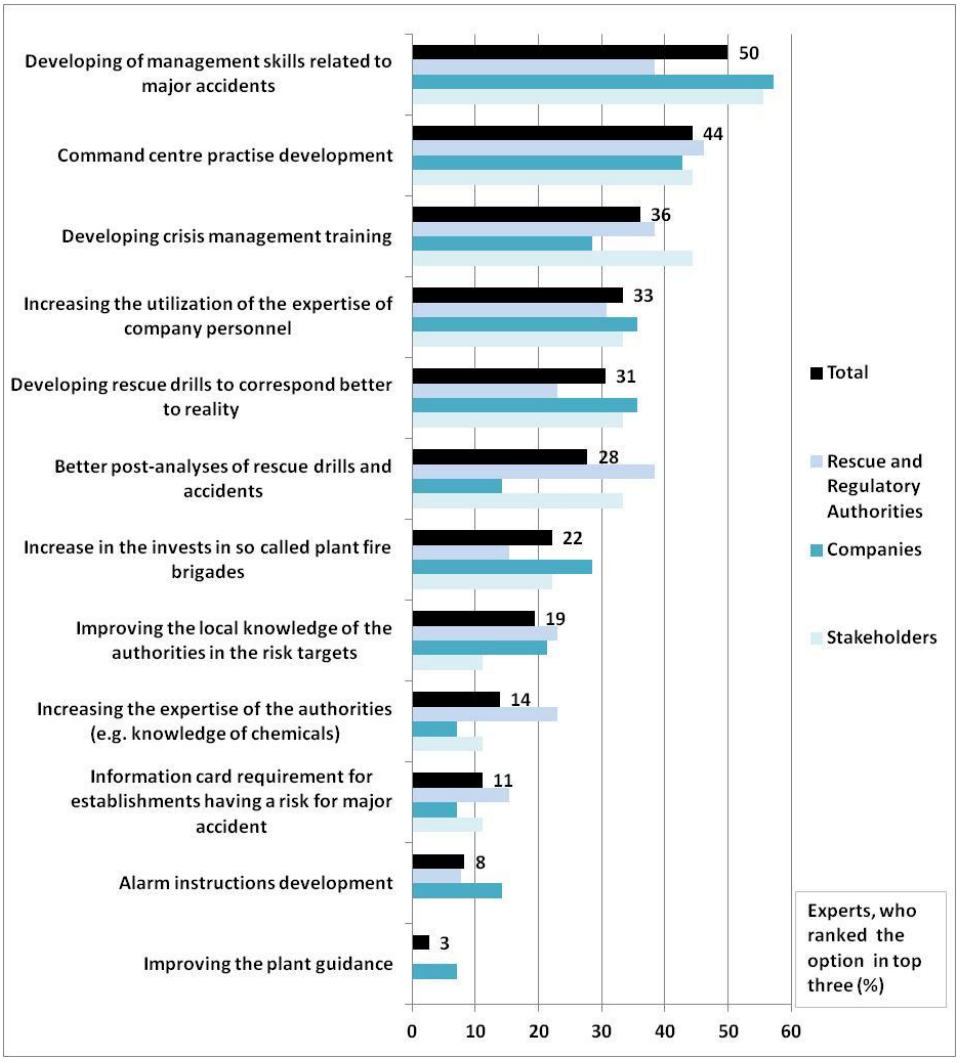

Figure 46 Developing of response in the long-term

The rescue and regulatory authorities also highlighted management development in their answers. In particular they emphasized the development of command center operations. The representatives of the rescue and regulatory authorities also raised the issue of better post-analyses of rescue drills or accidents as one of the most important themes to develop in response in the longer term. The companies for their part regarded the development of post-analyses of rescue drills or accidents as an important measure in the short term, which is why they did not emphasize post-analysis in long-term development, unlike the other respondent groups. In contrast, in their answers, the companies stressed the development of management of major accidents. The stakeholders also emphasized all themes related to management development. In particular,

they stressed more than the other respondent groups the development of crisis management training.

7.1.7 Development of IT systems related to major accidents

The experts were asked to give development suggestions for IT systems related to major accidents. They were asked to give examples of how the usability of the IT systems should be developed.

The experts raised the electronic information card system as one development theme. The electronic information cards and up-to-date maps of the high risk targets should be available to the authorities in a common network. It should be possible to collect the information on the dangers concerning the target in a single source. The IT system should have improved information on the target, the target's processes, the substances used in them, the risk types of the target and other matters to be taken into consideration.

The IT systems could also be utilized generally when improving the situational picture of different players. There should be a possibility in the situational picture systems to share one's own situational picture with other cooperation parties. Besides sharing the situational picture, one possible development target could also be a common IT system application or server where all the players log in, in the event of a major accident. There could be a common data pool for the use of all those who need it. The planning of a common IT system for the rescue authorities is in the pipeline.

Some of the experts especially emphasized the fact that IT system development has no intrinsic value and developing systems alone does not improve safety. Identifying the information processes of response, interfaces containing information and creating technical prerequisites should be central development targets. Some of the experts also observed that the use of the IT systems of different players by outsiders is not realistic, for example for security reasons. Every player has their own situational picture system and IT system and the regulation does not allow access to others' systems.

7.1.8 Improving flow of information in major accidents

Based on the interviews in the first Delphi round, it came out that the flow of information during major accident should be developed. For this reason, in the second round questionnaires, the experts were asked to give concrete examples on how the information flow could be improved.

The importance of pre-practising and defining jointly in advance the agreed operational processes in the case of major accidents was stressed in the answers. It is important to define in advance the most important stakeholders regarding major accidents and train and practice the operational models connected to the accidents. The stakeholders must be defined and engaged in the process, as well as specifying the contact persons of different organizations and their substitutes.

Clear processes and distribution of tasks ease managerial work because in the command center everybody must be conscious of his/her tasks and know them in order to work properly from the beginning of the accident. Pre-practising is also important because major accidents occur so rarely that otherwise there is not enough routine in, for example, creating the right kinds of channels and discussion groups.

The flow of information between different players must be planned in advance: between the company and the rescue authorities, between different authorities and also organizing and implementing external communication. The communication of these different players should be recognised, planned and practised in advance. Whether it is a matter of the internal communication of the rescue authorities, external communication or communication between companies, all of these can be improved through practising. It is especially important to take account of the different kinds of information needs of different stakeholders. The flow of information in the case of a major accident often falters because an individual is not capable of conveying the right kind of information to different parties because he/she lacks the understanding of what information the others need.

One of the other issues connected to the improvement of information flow was the improved utilization of different kinds of communication equipment. Many of the experts observed that increasing use of the VIRVE network would be beneficial. Some of the experts emphasized the adding of VIRVE handsets to high-risk targets and further improving VIRVE coverage. In the case of VIRVE, improving skills in using it was also brought up. People must be trained in the use of VIRVE handsets and it is also important to practise this in multi-authority tasks.

Other mentions regarding communication concerned the better utilization of mobile communication equipment in particular. It came out in the answers that it would be important that announcements by the authorities could be sent to all mobile phones in the area. Also, the social media could be utilized more when making announcements.

Another point brought up in the answers was developing management. It was regarded that at the moment the management system is not clear for everybody during response. Currently, the skills in management are not at the level they should be when managing major accidents. Management skills in managing a

major accident are insufficient because management training has not been emphasized enough before. Thus, the skills in managing major accident situations should be developed. The flow of information was also observed to improve as a result of improved skills in management.

7.2 Findings in the third Delphi round

7.2.1 Probable development of information cards and rescue plans

The experts were asked to assess the future of the development of electronic information cards and plans. The experts were asked to assess the following claim:

In the next five years the information cards and rescue plans concerning risk targets (e.g. up-to-date area maps and information on operational processes) will be saved in electronic form on an IT system that is maintained by the authorities.

The claim concerned the experts' view, which came out in the second Delphi round that developing electronic information cards and rescue plans is important from the perspective of the improvement of the flow of information

The experts were asked to assess how likely they considered the development of information cards and plans in electronic form and that they will be saved on a IT system maintained by the authorities (-3 = highly unlikely … +3 = highly likely). 41 answers were received (Figure 47).

The experts thought the development of the type described in the claim to be quite likely (the average answer 0.83). The views on the development diverged somewhat (standard deviation 1.56). Thirty-three experts considered the development described in the claim to be likely and 8 considered the development unlikely.

When analyzed by respondent group (Table 30), the stakeholder representatives considered the development described in the claim more likely (average answer 1.40). Also, the representatives of the rescue and regulatory authorities considered the development to be fairly likely.

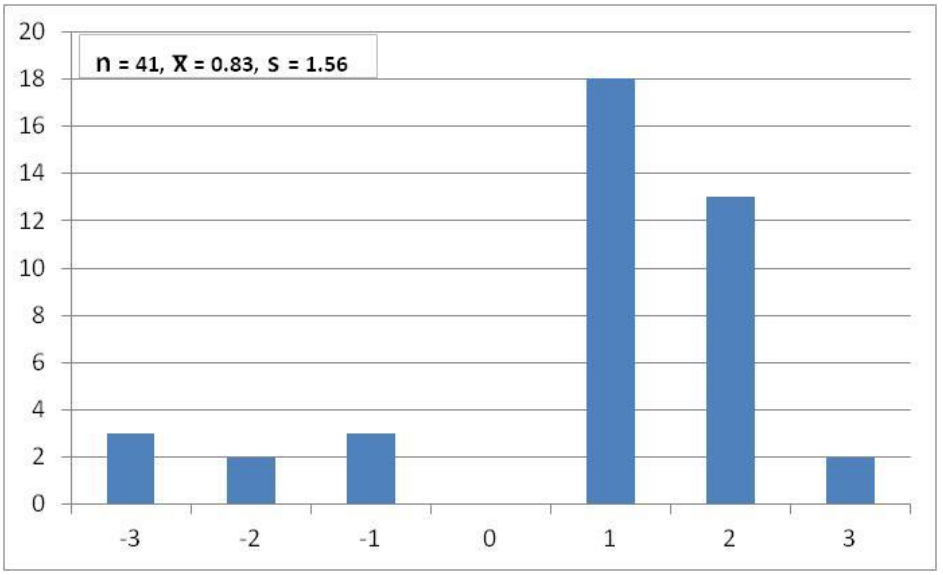

Figure 47 Probability of development of information cards and rescue plans in electronic form

The company representatives in general answered neutrally (average answer 0.06) but the divergence in the answers of the company representatives was fairly wide: six respondents considered the development to be unlikely and 10 respondents likely. The assessment of the representatives of the rescue and regulatory authorities and the stakeholders on this development were fairly unanimous because in both respondent groups, only one respondent considered the development to be unlikely and the other respondents likely.

Table 30 Probability of development of information cards and rescue plans in electronic form, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1				7	6	1	15	1.27	1.29
Companies	2	1	3		8	2		16	0.06	1.60
Stakeholders		1			3	5	1	10	1.40	1.35

Some of the experts considered the development of the type described in the claim unlikely because the IT system development projects in the public sector have taken time to get off the ground and have been very lengthy. For this reason, the experts did not consider the implementation of electronic information cards and plans within five years to be realistic. Also, some of those who considered the development fairly likely justified their cautious assessment that the development of electronic information cards and plans was likely but the time

perspective of five years was considered too short a time for the development to materialize. Also, some of those who considered the development unlikely reasoned that the authorities' resources are diminishing, which it was felt would hinder the IT system development required.

Those who considered the development of the type described in the claim likely argued that the benefits of electronic information cards and plans are so big that the situation is bound to develop in the next five years. The development described in the claim was seen clearly as improving the operations of the rescue authorities in response. One expert commented:

> *"Companies already have all the information in electronic form. The problem here is that rescue authorities do not have IT systems in which all the company information could be stored. However, I believe that within five years, authorities will have IT systems that allow them at the time of the alarm to open a screen containing all the information they have with one or two clicks."*

In addition, the development was seen as likely because the skills in using IT systems and technical development are expected to improve so much that saving the information cards and plans in electronic form in the authorities' IT system will be easier than nowadays, from the perspective of implementation.

7.2.2 Probability of major accident caused by cyber attack

As the second question concerning response, the experts were asked to assess the possibility of risk for major accident caused by cyber attacks in Finland. The experts were asked to assess the following claim:

During the next five years a cyber attack will cause risk for a major accident in Finland.

The claim was linked to the theme of IT security and cyber security that came up in the first and second Delphi rounds. The perspective in Finnish cyber security strategy is primarily taking care of the security of society. The effects of threats against the cyber-operational environment have become wider and wider, from the perspective of individuals, companies and the whole of society (see, Secretariat for Defence Committee 2013). The perspective in the claim in addition to securing society's vital operations is ensuring the continuity of other authorities and company operations.

The experts were asked to assess the likelihood of risk for a major accident caused by a cyber attack (-3 = highly unlikely … +3 = highly likely). Forty answers were received (Figure 48).

The expert assessments on the likelihood of a cyber attack diverged fairly strongly (standard deviation 1.67). The average of all the answers was 0.23, i.e. the risk of a cyber attack was considered on average to be only slightly likely. Eighteen experts considered the risk of the type represented in the claim to be unlikely and thirteen experts likely. Nine answered neutrally.

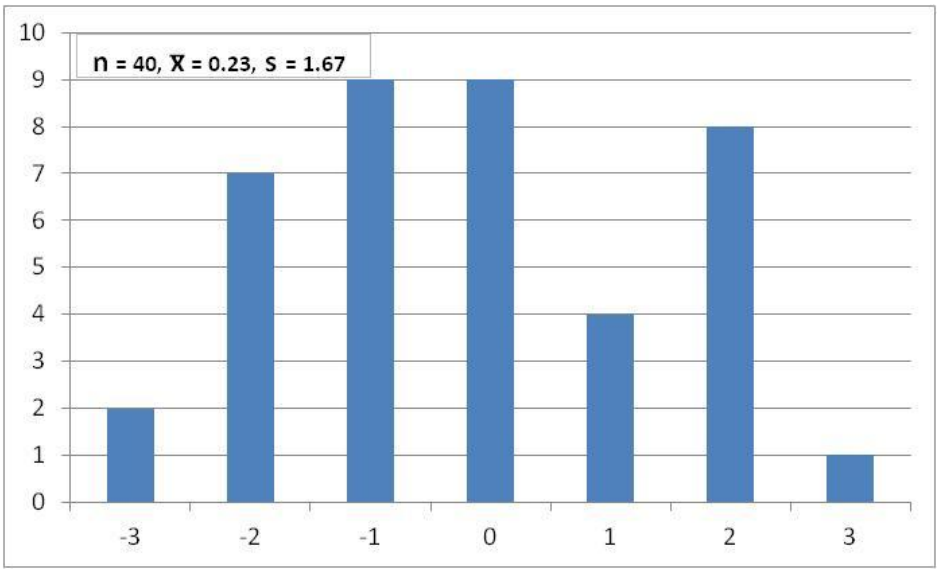

Figure 48 Probability of major accident caused by cyber attack

When analyzed by respondent group (Table 31), the stakeholder representatives considered the threat scenario described in the claim to be more likely (average answer 1.40) and their views on future development were the most unanimous. The company representatives considered this development the most unlikely. The company representatives assessed the development of the claim as neutral (average answer -0.06) and at the same time the differences in the views on the imminent development were rather large (standard deviation 1.64) compared to the other respondent groups.

Table 31 Probability of a cyber attack, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1	3	1	5	2	2		14	-0.29	1.48
Companies	1	2	5	2	1	5		16	-0.06	1.64
Stakeholders		2	3	2	1	1	1	10	1.40	1.35

Many of those who considered the development described in the claim as unlikely recognised the possibility of a cyber attack but they did not see any immediate major accident risk in the current situation because it is possible to protect against cyber threats. It was also seen that different kinds of incidents have been taken into account in preparedness quite well in Finland. In addition, some of the respondents argued that Finland is not the most probable target of a cyber attack.

Those who considered the claim to be likely argued that cyber attacks are also possible or highly likely in Finland because they are being experienced all the time around the world and the risk of cyber attack is also increasing in Finland. One expert argued:

> *"I see this as highly probable unless there are major corrective actions for all of the IT systems of the public sector. Generally speaking, resilience is at a very low level. I wouldn't be surprised if the situation is the same in the business sector"*

On the other hand, the risk for cyber attacks escalating into a major accident was considered to be only slightly likely. The effects of a cyber attack were seen as likely to be limited to individual organizations with fairly minor consequences. The effects of cyber attacks were assessed to be fairly minor because there are different kinds of operations linked to IT security development with the help of which the resistance capacity of both authorities and companies can be improved.

7.2.3 Development of situational picture system

As the third question concerning response, the experts were asked to assess the development of a common situational picture system. The experts were asked to assess the probability and desired development of the following claim:

The development of a common situational picture system for all players (both authorities and companies) will receive significant investment in the coming years.

The claim is linked to the view, which came up in the second Delphi round, that the experts considered the development of a situational picture system as one of the most important factors that would improve the situational picture and flow

of information. The systems are not interoperable enough at the moment. The lack of a common situational picture system causes problems in building a common situational picture.

7.2.3.1 Probability of development of situational picture system

Experts were asked to assess the probable development of a situational picture system (-3 = highly unlikely… +3 = highly likely). Forty-one answers were received (Figure 49).

The claim was considered on average to be slightly more likely than unlikely (average answer 0.51). The views of the experts vis-à-vis the likelihood of development diverged somewhat (standard deviation 1.49). Eleven experts thought the development of a situational picture system unlikely and 24 thought it likely. Six answered neutrally.

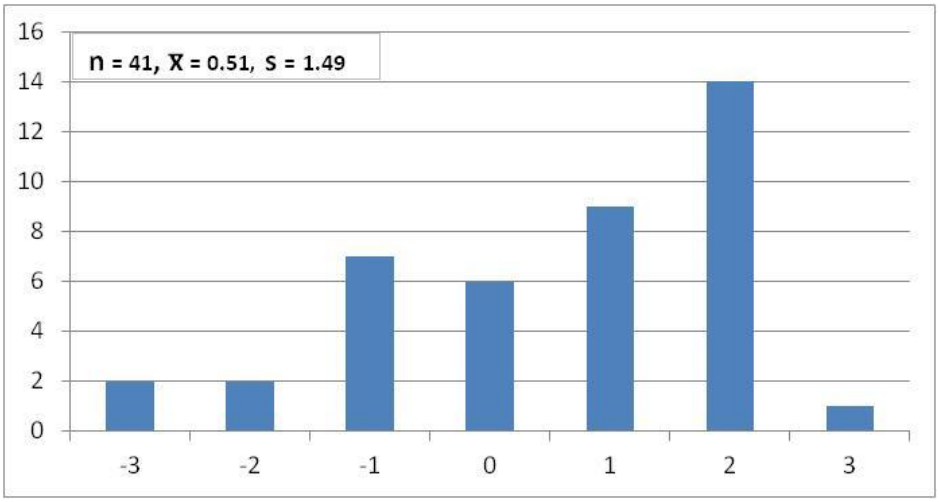

Figure 49 Probability of development of situational picture system

When analyzed by respondent group, the representatives of rescue and regulatory authorities considered the development of a situational picture system more likely (Table 32).

The average answer of the representatives of the rescue and regulatory authorities was 1.07, i.e. they believed the development of a situational picture system was fairly likely to happen. The most skeptical regarding this development were the company representatives. The average of their answers was 0.19, i.e. development was considered to be only slightly more likely than unlikely. The opinions of company representatives diverged clearly: seven

respondents felt that development was unlikely and five likely (standard deviation 1.47). The views of the representatives of stakeholders differed the least (standard deviation 1.14).

Table 32 Probable development of situational picture system, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities	1		1	1	4	8		15	1.07	1.39
Companies	1	2	4	4	2	3		16	-0.19	1.47
Stakeholders			2	1	3	3	1	10	0.80	1.14

The experts concluded that the development of a situational picture system was likely, because the public sector had already started to develop the collaborative activities presented in the claim. The public sector wishes to invest in this. It was also observed that the authorities already have some systems. At present, certain confidentiality provisions have limited the expansion of the general use of authority systems. In the future however, collaboration with companies could be developed, since the experts had recognized an interest among the players and the desire to extend the user community of their systems.

Some of the experts thought that the development of a common situational picture system was unlikely, since, instead of developing a single system they predicted improved interoperability between different systems in the future. One expert argument was:

> *"It is waste of time to think that a common system for authorities and companies would even be possible. There isn't even any mutual understanding of what information a situational picture should contain. Things should be developed towards a common interface between different systems, so that the system would allow actors to add information to it. Later, with user authentication, it would be possible to share information in a controlled manner."*

In addition, some of the experts also believed that a common situational picture system between authorities would indeed be implemented, but that the creation of a common system between the authorities and companies would not be developed. This assessment was based on the fact that the lack of resources would prevent the type of development stated in the claim. The challenges inherent in this kind of development work were seen as an obstacle to the development of a common situational picture system for all those involved.

7.2.3.2 Desirability of development of situational picture system

Experts were also asked to assess the desirability of situational picture system development. (-3 = highly undesirable… +3 = highly desirable). Forty-one answers were received (Figure 50). The development of the type described in the claim was considered desirable (average of all answers 1.68). Thirty-four experts considered that a common system for all players was desirable and five undesirable. Two experts gave a neutral answer. The standard deviation of the answers was 1.82, i.e. the answers diverged somewhat, even though the majority of the experts considered the development to be desirable.

Representatives of the rescue and regulatory authorities were far more in favor of the development of a situational picture system (Table 33). The average of their answers was 2.33. Almost all the representatives of the rescue and regulatory authorities considered the development of a common system to be either desirable or highly desirable (standard deviation 0.60).

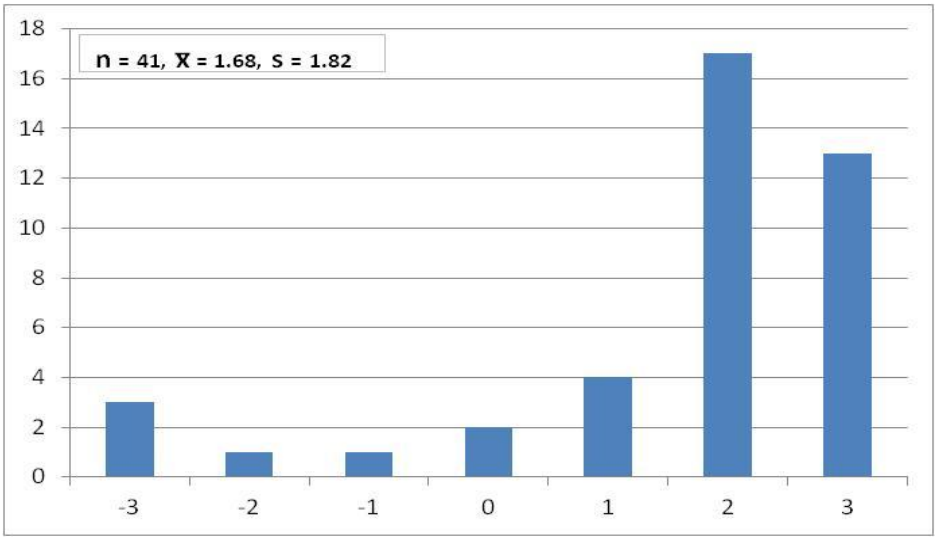

Figure 50 Desirability of development of situational picture system

Stakeholder representatives also assessed the development of a common system as desirable (average answer 1.70), although there was some divergence in their answers (standard deviation 1.49). The most divergence concerning this topic was seen among the company respondent group (standard deviation 2.44). Four company respondents considered the development of a common system to be undesirable and 10 desirable. On average, companies considered the development described in the claim as fairly desirable (average answer 1.06).

Table 33 Desirability of development of situational picture system, answers by respondent group

	-3	-2	-1	0	1	2	3	n	x̄	s
Rescue and Regulatory Authorities					1	8	6	15	2.33	0.60
Companies	3		1	2	1	5	4	16	1.06	2.44
Stakeholders		1			2	4	3	10	1.70	1.49

Improved flow of communication through the development of a situational picture system was raised as the justification for its desirability. An accurate situational picture is the basis for all leadership and decision making related to major accidents. Several players are involved in major accidents. The formation of an accurate and real-time situational picture is indispensable to support the effective decision making of each player. The issue was also considered important for the reason that, currently, different sectors are becoming increasingly dependent on each other. Some experts also raised the point that rather than embarking on the development of a common system, the interoperability of the different players' systems should be developed instead.

Some experts considered that the development of a situational picture system was undesirable. They argued that there was no need for a common system. Instead, there was a need for the interoperability of different systems. In addition, some of the experts explained that they felt it was undesirable because they did not see it as feasible in the current economic climate.

7.2.4 Development of rescue drills

Based on the answers of earlier Delphi rounds, developing rescue drills was seen as one of the most significant factors that would develop response both in the short- and long-term perspective. In the fourth question of the third Delphi round concerning response, the experts were asked to give concrete development suggestions or examples of good practices with the help of which rescue drills could be developed in the future. Thirty-one answers were received (Table 34)

Getting a wider group of players involved in planning work and actual rescue drills was seen as the most significant theme linked to rescue drill development. The company representatives in particular emphasized the significance of this theme to develop rescue drills practically. Rescue drills can be developed if a wider group of players can be motivated to cooperate in the planning of rescue drills and taking part in them. Besides the rescue authorities, also other authority players should be motivated towards cooperation. In addition, it is possible for the companies to develop and increase cooperation with the people responsible for the rescue drills of other companies. For example, the good practices of

rescue drills that are gained from other fields of operations can benefit rescue drill development in one's own organization.

Table 34 Development of rescue drills

Theme	Quotes: Rescue and Regulatory Authorities	Quotes: Companies	Quotes: Stakeholders	Quotes: Total
A wider player group involved in planning work of rescue drills	3	7	2	12
Systematic follow up and development of the rescue drills	2	1	3	6
Development of better accident scenarios	3	2		5
More virtual and command center drills, etc.	1	1	1	3
Other individual mentions concerning rescue drill development	2	2	1	5
Quotes total	11	13	7	31

Motivation towards cooperation was raised as a particularly important issue when developing the cooperation of a wider group of players. The experts mentioned for example that the basis for the drills should be that all the parties taking part in response receive additional information of the rescue drill and feedback to develop their own operations, instead of developing only one organization. The common benefits from rescue drills would thus motivate people towards better cooperation. It was also brought up that attendance of some parties in a certain time perspective should become mandatory.

One development theme that received several mentions was developing rescue drills to become more systematic than they are at present. Especially the stakeholder representatives emphasized the importance of this issue. Formulating a rescue drill plan of a longer time perspective was brought up as a good practice.

It is good to make a drill plan within a wide group of players. Among other things, common planning meetings, the timetable and the goal of the drills would be written down in the drill plan. When clear goals for the drills have been defined, their development can be analyzed after the drills in feedback sessions and also the necessary development measures can be defined.

Investing in formulating better accident scenarios stood out as one important development theme, especially from the perspective of the rescue and rescue authorities and companies. Some of the experts admitted that only a few accident scenarios are used currently, which were created several decades ago. It was also viewed that the accident scenarios should be based on the risk mapping of companies more. Also, the authorities should practise especially the accident types that are recognised in the risk mapping jointly with the personnel of the company. On the other hand, it was observed that also unlikely accident scenarios are important because surprising situations are the best way to reveal the problems and development targets in operations and management. It was also felt to be important that the rescue drills would test different kinds of operational processes in incidents more than at present because the world is now more networked than before and thus more vulnerable. For example, it is good to practice how one should operate when information networks are not functioning or, from the operational perspective of a company, when some other critical system is out of use.

Furthermore, a few experts brought up as a development theme the fact that not all rescue drills have to be wide-ranging drills, demanding lots of resources. For example, it is possible to separate a smaller part of a major accident scenario and practice only this certain area. The drills do not always have to be concrete. For example, it is possible to map different kinds of problems and tackle the problems that have been observed with the help of table-top drills.

In addition, some individual mentions about rescue drill development stood out. For example, one point raised was the taking into account of the professional skills of the head of the rescue drills and also the development of proficiency during training. For example, it depends a lot on the skills of the head of the rescue drill as to how widely the experts in the companies are used in the process. Also post-accident procedures, such as cleaning up the environment should be taken more into account when planning a rescue drill. In addition, it was brought up that it would be good to involve the media in executing rescue drills because in the case of an actual accident the media is also present and issues concerning safety would receive more publicity.

7.2.5 Making better use of the expertise in companies

Based on the answers from the earlier Delphi rounds, making better use of the experts in companies was seen as one significant factor when improving response in both short- and long-term perspective. In the fifth question of the third Delphi round concerning response, the experts were asked for development suggestions on how the expertise in companies could be used better than currently in response phase. The experts were asked to consider what changes this would entail in operations on the part of the company and authority players. 31 answers were received, out of which 27 were relevant to the question (Table 35).

Table 35 Making better use of the expertise in companies

Theme	**Quotes: Rescue and Regulatory Authorities**	**Quotes: Companies**	**Quotes: Stakeholders**	**Quotes: Total**
Establishing a regional or a national expert pool	3	4	2	9
Making better use of experts in operations connected to rescue drills	1	4	1	6
Making better use of experts in command center operations	1	3	1	5
Making use of experts in proactive planning	1	1	1	3
Other individual mentions on making better use of experts	1	3		1
Quotes total	7	15	5	27

Establishing either a national or regional expert pool for the use of both the rescue authorities and companies was identified as the most important factor in improving the use of experts in companies (see Suomen Riistakeskus 2013). Thus it would be possible to contact an expert by phone via text message. This kind of operation would require the pre-mapping of people who would add value to the response. Thus experts and their substitutes could be named along with their special fields of knowhow. The experts observed that this would require the

authorities to maintain a register and require commitment from the experts to the pool operations. The expert pool of the type described would demand economic resources, which was seen as a challenge for the development of the practice. It was also brought up that this kind of expert pool could possibly work on the same principle as assistance of local hunters' associations (see SRVA), which provide official assistance for the police. In addition, one expert mentioned the perspective that the experts also need training so that the tasks linked to expert cooperation and the cooperation with the authorities related to them work properly in accidents.

Making better use of company experts in all operations concerning rescue drills was brought up as another development theme. There should be more cooperation with the experts. They could be increasingly made use of for example in planning work and post-analyses of rescue drills. In addition, the experts should be more closely involved in the actual rescue drill situation. Furthermore, the company representatives in particular brought up the point that the experts should be made better use of in command center operations in an actual major accident. Improving the use of company experts must be developed because it is possible to obtain information from the experts immediately. The companies' own experts have the best knowledge of company operations. Up-to-date and quickly available information can significantly arrest the expansion of an accident.

In addition, the experts raised the issue of making better use of experts in all proactive planning work. The experts could clearly be made more use of, for example, in authority training and when developing different kinds of operational models and rescue plan formulation. The expertise of the companies could also be increasingly made use of in developing the authorities' equipment.

7.3 Summary of potential improvements in the response phase

In order to find answers to the third research question: "What kinds of improvements related to communication and the flow of information can be made in the response phase of the management of major accidents in the next five years?", the second and third Delphi rounds were organized by using online eDelfoi software.

1. The second Delphi round

In the second Delphi round there were eight claims and open ended questions related to response. The claims and open-ended questions were on the following topics:

- Common terminology
- Development of communication training
- Development of post-accident analyses
- Development of VIRVE usage
- Ranking of topics related to situational picture and flow of information
- Developing response
- Development of IT systems related to major accidents
- Improving flow of information in major accidents

The questionnaire was formulated based on the problem domains identified in the first Delphi round.

At first, the experts were asked to assess the development of a common terminology concerning the theme of the situational picture and the flow of information. The experts did not foresee any big changes in the next five years. Jargon is easily used in accidents because the situation is so hectic in an accident that it cannot be affected by practicing the use of a different kind of vocabulary. Some of the experts also emphasized that it would be easier for the authorities to develop a common terminology. However, a common terminology was considered likely because the use of a common terminology in other fields of society has developed. Thus it is bound to develop through common benefits in the field of safety. The increased use of a common terminology was observed partly as a natural development that can also be improved through developing the regulations. A common terminology was considered desirable because it would decrease the possibility of misunderstandings.

In the second question, the experts were asked to assess communication training linked to response. The experts considered the increased use of communication training to be likely, because shortcomings in communication have almost always been the reasons for problems in accidents and in tackling them. Communication plays a central part in the cases of major accidents; therefore different players must invest in its development.

In the third question, the experts were asked to assess the development of post-accident analyses. On average, the experts considered that post-accident analyses would increase. Among other reasons, the experts had noticed an increase in the number of observers in rescue drills. The companies also emphasized the fact that the quality assurance systems of companies call for the documenting of observations on major accidents and near-miss situations and making corrective measures more precisely than before.

In the fourth question concerning response, the experts were asked to assess the development of VIRVE usage. The experts considered the mandatory use of VIRVE terminals in accidents to be slightly more likely than unlikely. Those

who considered that use would increase argued that VIRVE is a definite prerequisite in improving communication during accidents and that VIRVE terminals are already used in some companies. The companies would consider the benefits achieved with the help of VIRVE thoroughly before procurement of the equipment because the big challenge is that the skills in using VIRVE would be practised rarely and perhaps forgotten in the event of a major accident.

Next, the experts were asked to rank some factors to improve the flow of information during accidents. The four most important were:

1. Guidance and development of briefings and communication
2. Technical situational picture system development
3. Development of better interoperable authorities' IT systems
4. Improving flow of information through standardizing the terminology

Especially the representatives of the rescue and regulatory authorities as well as the stakeholders stressed guidance and development of briefings and communication. The companies also raised guidance and development of briefings and communication as the most important development theme by far, but their opinions diverged more than the other respondent groups. The experts raised technical situational picture development as important factor which would improve the flow of information and situational picture because in their opinion, situational picture systems are not interoperable enough at the moment.

The experts were next asked to assess different factors that would improve response in major accidents in the short and long term. In the short term, the six most important were:

1. Increasing the utilization of the expertise of company personnel
2. Developing the rescue drills to correspond better to reality
3. Better post-analyses of rescue drills and accidents
4. Information card requirement for establishments at risk of a major accident
5. Improving the area knowledge of the authorities in the risk targets
6. Developing management skills related to major accidents

Concerning short-term development, the experts emphasized different factors that would develop response, such as making use of the experts in companies, developing rescue drills, and post-analyses of drills and incidents. All these factors would improve the cooperation between companies and authorities. In addition, the experts considered the information card requirement for high risk targets and improving the local knowledge of the authorities to be important.

In the long-term, the six most important were:

1. Developing management skills related to major accidents
2. Command center practice development
3. Developing crisis management training
4. Increasing the utilization of the expertise of company personnel
5. Developing the rescue drills to correspond better to reality
6. Better post-analyses of rescue drills and accidents

Concerning long-term development, the experts especially highlighted management development. All three factors that received the most mentions can be considered to relate to management; command center operations development is also largely linked to management since collaboration and the flow of information can be improved by developing management in major incidents. Management development is also connected to preventing accidents because the safety culture can be developed on a more general level.

Then the experts were asked to make suggestions for the development of IT systems related to major accidents. They were asked to give examples of how the usability of IT systems should be developed. The experts raised the electronic information card system as one development theme. Electronic information cards and up-to-date maps of high risk targets should be available to the authorities in a common network. IT systems could also be utilized generally when improving the situational picture of different players. There should be a possibility in the situational picture systems to share one's own situational picture with other cooperation parties.

Last in the questionnaire the experts were asked to give concrete examples of how the information flow in major accidents could be improved. The importance of pre-practising and defining jointly in advance the agreed operational processes in the case of major accidents was stressed in the answers. It is important to define in advance the most important stakeholders regarding major accidents and train and practice the operational models connected to major accidents. Clear processes and distribution of tasks ease managerial work because, in the command center, everybody must be conscious of his/her tasks and know them in order to work properly from the beginning of the accident. The flow of information between different players must be planned in the advance planning stage: between the company and the rescue authorities, between different authorities, and also organizing and implementing external communication. The communication of these different players should be recognised, planned and practised in advance. Whether it be a matter of the internal communication of the rescue authorities, external communication or communication between companies, all of these can be improved through practice. One of the other issues connected to the improvement of information flow was the improved utilization

of different kinds of communication equipment like VIRVE and other mobile communication equipment. Another point brought up in the answers was developing management. It was viewed that at the moment the management system is not clear for everybody during response. Currently, management skills are not at the level they should be when managing major accidents.

2. The third Delphi round

In the third Delphi round there were five claims and open-ended questions related to response. The claims and open-ended questions were on the following topics:

- Probable development of information cards and plans in electronic form
- Probability of major accident caused by cyber attack
- Development of situational picture system
- Development of rescue drills
- Making better use of the expertise in companies

The questionnaire was formulated based on the findings of the previous Delphi rounds.

First, the experts were asked to assess the future of the development of electronic information cards and plans. The experts thought the development of electronic information cards and plans to be quite likely because these would improve the operations of the rescue authorities in response. However, some justified their cautious assessment that the development of electronic information cards and plans was likely but the time perspective of five years was considered too short a time for the development to materialize.

As the second question the experts were asked to assess the possibility of risk for major accident caused by cyber attack in the next five years. The risk of a cyber attack was considered on average to be only slightly likely. Many of those who regarded a cyber attack as unlikely recognised the possibility of a cyber attack but they did not see any immediate risk in the current situation because it is possible to protect against cyber threats. It was also seen that different kinds of incidents have been taken into account in preparedness quite well in Finland. Those who considered the claim to be likely argued that cyber attacks are also possible or highly likely in Finland because they are being experienced all the time around the world and the risk of cyber attack is also increasing in Finland.

As the third question, the experts were asked to assess the development of a common situational picture system. It was considered on average to be slightly more likely than unlikely. The experts concluded that the development of a common situational picture system was likely, because the public sector had already started to develop collaborative activities. In the future, collaboration

with companies too could be developed, since the experts had recognized an interest among the players and the desire to extend the user community of their systems. Some of the experts thought that the development of a common situational picture system was unlikely, since, instead of developing a single system they predicted improved interoperability between different systems in the future. In any case, a common situational picture system was considered desirable.

In the fourth question, the experts were asked to give concrete development suggestions or examples of good practices with the help of which rescue drills could be developed in the future. Involving a wider group of players in the planning work and actual rescue drills was seen as the most significant theme linked to rescue drill development. It is also possible for companies to develop and increase cooperation with the people responsible for the rescue drills of other companies. Motivation towards cooperation was raised as a particularly important issue when developing the cooperation of a wider player group. One approach would be to develop rescue drills to become more systematic than they are at present. The stakeholder representatives in particular emphasized the importance of this issue. Formulating a rescue drill plan with a longer time perspective was brought up as an example of good practice. Investing in formulating better major accident scenarios stood out as one important development theme, especially from the perspective of the rescue authorities and companies. Furthermore, experts brought up as a development theme the fact that not all drills have to be wide-ranging drills, demanding lots of resources. For example, it is possible to separate a smaller part of some wider accident scenario and practice only this certain area or have table- top exercises. One point raised was taking into account the professional skills of the head of the rescue drills and also the development of proficiency during training.

On the other hand, unlikely accident scenarios were also seen as important because surprising situations are the best way to reveal problems and development targets in operations and management. In addition, it was brought up that it would be good to involve the media in executing rescue drills because in the case of an actual incident the media is likely to be present and thus issues concerning safety would receive more publicity.

In the last question of the third Delphi round, the experts were asked for development suggestions on how the expertise in companies could be used better than at the moment in an accident. Establishing either a national or regional expert pool for the use of the rescue authorities was identified as the most important factor in improving the use of experts in companies. Thus it would be possible to call an expert or experts together via text message. This kind of operation would require the pre-mapping of people who would add value to response. Making better use of experts in all operations concerning rescue drills

was brought up as another development theme. There should be more cooperation with experts. They could be increasingly made use of, for example in planning work and post-analyses of the rescue drills. In addition, the experts raised the issue of making better use of experts in all proactive planning work linked to preparedness. The experts could clearly be made more use of, for example in training the authorities and when developing different kinds of operational models and rescue plan formulation.

8 DISCUSSION

8.1 The key results of the research

8.1.1 Problem domains in communication and flow of information in management of major accidents

The first Delphi round focused on finding answers to the first research question: In which domains have there been challenges or problems related to communication and the flow of information in the preparedness and response phases of the management of major accidents? The first Delphi round was carried out by means of semi-structured interviews. The interviews were recorded and then transcribed. Next, applying qualitative content analysis to the transcribed texts, the quotes of the interviewees were coded, and finally the codes were grouped into domains.

On the whole, the problem domains in communication and the flow of information raised by the experts support the findings made in the theoretical framework. Some of the problem domains are such that they could be improved relatively easily and quickly. However, there are also problem domains that obviously require more time and resources. The identified problem domains formed a basis for the planning of the questionnaires for the next Delphi rounds.

1. Problem domains in the preparedness phase

In the preparedness phase in relation to the operations of the authorities, firstly, there is lack of cooperation between the authorities and also the need for better coordination between different authorities. Secondly, cooperation between the companies and authorities was seen as insufficient. It is important for authorities to have more have time to interact with companies, e.g. when compiling major accident scenarios. And thirdly, collaboration between companies working in the same area or close to each other was also seen to need improvement. The experts interviewed felt that problems occur in communication with the members of other organizations because they have different backgrounds, organization cultures, and ways of doing things. These problems are closely linked to organizational embeddedness and may be reduced by people getting to know each other better. In addition, it was noted that the authorities are not good at

disseminating their safety knowhow to companies, although they possess a lot of knowledge of good practices. The hope was clearly expressed that authorities would act in more of an advisory or briefing role in relation to preparedness than they do at present. This was somehow surprising because, for instance the Law on Rescue clearly states that advising companies is the responsibility of the authorities (Laki 29.4.2011/379).

One important aspect of preparedness is its close connection with regulation. Actions must take place against a background of the legal instruments that mandate, facilitate, or regulate it. (Alexander 2002.) The experts indicated that in some cases legislation is too open to interpretation. In general, it was found that when legislation develops in the future it should take into account disruptive situations (floods, storms, etc.) and preparedness for them so that the preparedness obligation is made to cover all parts of society, including the public and business sectors.

The achievement of preparedness takes place through a process of planning, training, and practicing (Gillespie and Collignon 1993). In the experts' opinion, both companies and authorities should train their personnel more, for example on knowhow regarding chemicals. It was particularly felt that the rescue authorities that come to a plant area should improve their knowhow of chemicals. Especially in major accidents where there are several actors, the view was that leadership knowhow should be improved, on the part of both companies and authorities.

Planning how to respond to accidents is an integral part of good business practice for all organizations. The greatest shortcoming in attitude towards preparedness seems to be in implementing the plans throughout the organization. The reason for this would appear to be a lack of the right attitude on management level, because management often allows itself to believe that "this will not happen to us."

2. Problem domains in the response phase

In the response phase, clear situation awareness is a key factor for the effectiveness of rescue operations. Problems were often experienced with special vocabulary and terminology as well as the lack of a proper system for collecting and sharing situation-related information. For instance, differences were observed between the interpretations made by actors from the authorities and business life. Each sector and branch of administration may have its own special words related to its own field.

Company instructions on raising the alarm have been inadequate; examples came to light where corporate staff had not been able to express themselves clearly when making the emergency call, nor were they able for instance to guide the rescue authorities adequately when they arrived at the plant site. The poor

level of information, and inaccurate or inappropriate information given to the rescue authorities at the site was also raised, as well as the lack of sufficient instructions and to-do lists for company personnel. One problem was felt to be that there is often a tendency in companies to underestimate the seriousness of the situation initially.

On the other hand, one deficiency was felt to be the fact that the rescue authorities did not have sufficient prior knowledge available of the risks at the company. Electronic and up-to-date information cards would help in this. In addition to communication at the accident site, the importance of good communication outside the accident site (e.g. via radio, press and Internet) was also emphasized. In major accidents that occur inside a company or on a company site, it was considered important that the expertise and local knowledge of the company representatives regarding the special features of the plant were brought to the knowledge of the rescue authorities.

Well-functioning IT systems are mandatory in the management of major accidents for rescue personnel in order to achieve situation awareness in response, and require timely connection to data resources from different actors while maintaining security of information that should not be shared (Comfort 1994; Lundberg and Asplund 2011). There is a desire for greater interoperability of organizations' IT in accidents. Also, the utilization of VIRVE terminals, particularly in companies at risk of a major accident, was believed to be a factor that increased safety, since the flow of information between the company and the authorities would remain unbroken during the accident, even if the normal phone networks were not working for some reason. However, as e.g. Dutt et al. (2013) Mintc (2011) state, the vulnerability of electronic IT systems has to be borne in mind, for example, as the result of an IT systems failure or a prolonged power outage.

Post-accident analysis helps us to be able to prepare better for the future. If lessons can be learnt from post-accident analysis and more importantly the lessons absorbed so as to prevent or mitigate future accidents, then the original accident will also have had a beneficial impact on society (Choularton 2001). According to the experts, the analysis of accidents and near-miss situations is important, but analyzing was nevertheless felt to be insufficient. Even though analyzed information does exist, it is not exploited enough (cf. repeated incidents of the collapse of buildings such as shopping malls, sports halls, and riding schools). In particular, the authorities expressed the wish for more active information sharing of analyzed accidents, for example by posting them on company websites in the form of a briefing on the accident situation supplied to companies in the same sector and other authorities.

The experts were quite dissatisfied with the rescue drills they had attended and above all with the execution of the development ideas arising from the drills. The

experts also argued that the planning of rescue drills was very often poor and also that the commitment of attendees could have been better. Shortcomings were also found in the analysis of rescue drills.

8.1.2 Potential improvements in the preparedness phase

The second research question of the thesis was: *What kinds of improvements related to communication and the flow of information can be made in the preparedness phase of the management of major accidents in the next five years?* In order to find answers to this research question, the experts were provided with questionnaires for the second and third Delphi rounds using online eDelfoi software.

1. Improvements in the preparedness of authorities

In line with the concept of organizational embeddedness, the experts emphasized that knowing each other well was a key to preparedness cooperation between authorities and companies. They especially raised the importance of organizing common rescue drills as often as possible and doing the post-drill analysis together in cooperation. In addition, doing preparedness planning and risk analyses together and compiling the resulting plans of action were seen as factors that would improve cooperation. Whatever the form of cooperation, the long-term and systematic nature of the cooperation was the desired focus of emphasis concerning forms of cooperation. The experts emphasized the organizing of different kinds of common events with companies: seminars, regional cooperation forums and events where "best practice" knowledge could be shared and training on preparedness organized.

Some of the experts felt that, at the moment, company expertise is not sufficiently utilized by the authorities when formulating external rescue plans. This was somehow surprising because the Law on Rescue and instructions given by the Ministry of the Interior stress that rescue authorities should collaborate with companies when preparing an external rescue plan (Laki 29.4.2011/379; Sisäasiainministeriö 2012). Due to insufficient collaboration with companies, the authorities do not always have adequate information on company processes so that all the risk points would be taken into account properly in the external rescue plan. Supposedly, the result of this specific matter would also be different if the regulations were followed by the authorities.

Also in the long-term perspective, it is important to shift the focus in authority operations more to advisory and preventive actions and developing cooperation between different parties in a way that successful cooperation is not bound to

personal relations. Cooperation must be open and aimed at a common goal. Cooperation also helps the authorities to understand for example the risks in company processes, which in part supports decision making and operations by the authorities in potential major accidents.

Regarding training of the authorities, multi-authority training was highlighted because major accidents are often multi-authority situations. Developing operations that are carried out by several authorities and other forms of cooperation were seen to be very important for this reason. All in all, skills in management were regarded as important because at the moment there is a deficit of skills in basic management. Crisis communication training also stood out as an important development theme concerning authority training, both in internal and external communication.

2. Improvements in the preparedness of companies

Preparedness supports the continuity of a company's business, which is an asset for the whole personnel. Good safety expertise is beginning to be found in companies and has already become a significant strategic success factor for some companies. The safety attitude was seen as crucial both in the short and long term. However, on average, preparedness attitudes in companies could improve somewhat compared to the current state. The challenge lies in the fact that preparedness is seen as a separate issue and not as part of everyday activity. It was felt that, at the moment, preparedness skills depend on the expertise of a few people, and unless demands for the personnel to take part in training and or rescue drills become obligatory, attitudes to preparedness will most likely not improve, at least in the near future.

One key issue that arose was how the top management recognizes its own role in controlling the continuity of the company and in the process of developing its operational reliability; the top management shares out and assigns responsibilities and allocates resources. The management must take care of expertise and motivation, because only when everybody understands the process hazards of her/his activity, can preparedness issues move forward.

Regarding the training of company personnel, increasing training on critical processes should be emphasized because the continuity of critical processes is very important from the perspective of the company's continuity management. Increasing training on safety management directed at managers is important because safety culture development in companies is dependent on the managers and, for this reason safety management training is an important area when developing the safety culture in companies.

It was believed that companies in the same field of business could learn from each other's rescue drills but that cooperation would increase only slightly.

However, it was felt that networking and cooperation between companies in general would increase in the future, which would also increase cooperation connected to preparedness. In the longer perspective, it was considered important to pay enough attention to major accidents and different kinds of incidents, such as floods. This is important especially in companies that produce infrastructure and service operations that are critical from the perspective of society.

3. Improvements in IT systems related to preparedness

There is potential for improving IT systems and preparing for cyber threats. In particular, the development of interoperable IT systems was brought up. Interoperability was considered important because it improves both preparedness and the forming of a situational picture. The interoperability of IT systems can be developed if development starts with the recognition and definition of different kinds of information needs and processes. The technical readiness for the common use of IT systems was acknowledged to exist. However, the interoperability of IT systems was seen to be challenging, because all users had slightly different needs. However, it came out that, besides the authorities, companies also have tight data security definitions and strong firewalls and do not want to weaken them for the sake of interoperability, although it would be possible.

Despite tight data security, another theme concerning the development of IT systems was to make information cards and external rescue plans of the companies in electronic form and save the information on a certain authority IT system so that company personnel would also have access to them. In this way, in the event of an accident, all the information required would be easily available and updating information would become easier. This was considered almost unanimously desirable because it was seen as increasing the transparency of operations and developing common operational models. It was also seen as improving the timeliness of information and increasing the amount of information and use of a common terminology. When everybody has the same basic knowledge, the risk of misunderstandings in a rescue situation decreases. In addition, it was noted that this kind of development would make the information more up-to-date and would make it easier for companies to update their information for the rescue authorities, which could for example improve the quality of external rescue plans.

It was felt that in the next five years, the cyber threats faced by major companies and individual authorities will increase so much that they will actively follow the advice and recommendations of the CERT-FI unit and/or Cyber Security Center to prepare for threats. It was argued that cyber threats and preparedness for them are likely to increase because cyber threats have been

increasing all the time and it was not felt that the trend would change. It was also felt that because cyber attacks are being experienced all the time around the world, the risk of cyber attack is also increasing in Finland. Moreover, cyber threats concern all fields of operation which is why cyber security should also be improved from its current state by means of regulation.

4. Development of regulation

Different kinds of natural accidents such as storms and floods, for example, are likely to increase and thus society is more vulnerable than before. In addition, society is nowadays more and more dependent on technology. At the moment, in planning, organizations do not take into account enough the fact that operational processes planned for the normal state may not function in major accidents. Therefore in the future, regulation should oblige all players to take major accidents into account more. The experts were fairly unanimous on the desirability of tightening regulation in this respect. In particular, cyber threats and regulation in the case of major incidents stood out.

The fragmentation of regulation was recognized as a problem. The regulation should be standardized and done in a coordinated fashion with more broad-based cooperation than at the moment to avoid fragmentation. On the other hand, it was noted that in general the flow of information could be improved at the regulatory level by identifying the obstacles in the current regulation. Excessive ambiguity and improving the regulation were raised as the biggest individual themes in this regard. The experts felt that, at the moment, different actors can interpret the same regulations in various ways, which hinders the preparedness operations of companies. It is desirable that in the future the authorities will cooperate more actively with companies in interpreting regulations. However, some of the experts considered that advising by the authorities might even lead to the endangering of objectivity. Also, some contradictions in regulations were noticed. However, there are basic rules like “lex superior degorat legi inferiori”, which means that the higher regulation supersedes the lower and “lex specialis degorat legi generali”, which means that specific regulation supersedes the general. If this had been known, most misunderstandings could have been avoided (Aarnio 1982, 101; Aarnio 1989, 254; Turunen 2004, 1-2).

Companies should themselves consider the continuity of their processes, even without legislative sanctions. However, according to the experts in favor of increasing regulation, the regulation should be developed but it should be done in cooperation and open dialogue with companies. Nevertheless, increased collaboration between the authorities and companies was expected because of the fact that the cooperation between the authorities and the rest of society will

increase, as will service-mindedness. In addition, the role of companies in the basic functions of society is increasing, so this development is inevitable.

8.1.3 Potential improvements in the response phase

The third research question of the thesis was: *What kinds of improvements related to communication and the flow of information can be made in the response phase of the management of major accidents in the next five years?* In order to find answers to this research question, the second and third Delphi round questionnaires were provided online.

1. Common terminology and communication training

One potential improvement in the response phase relates to common terminology and communication training. A common terminology was considered desirable because it would decrease the possibility of misunderstandings. However, the experts did not foresee any big changes in the development of a common terminology in the next five years. Jargon is easily used when there is an accident because the situation is so hectic that it cannot be affected by practicing the use of a different kind of vocabulary. Some of the experts emphasized that it would be easier for the authorities to develop a common terminology. However, a common terminology was considered somewhat likely because the use of a common terminology in other fields of society has developed. Thus it is bound to develop through common benefits in the field of safety.

Companies should invest in more proper instructions and training on raising the alarm. In order to avoid inaccurate or inappropriate information given to the rescue authorities, sufficient instructions and to-do lists for company personnel together with training should be provided. These would allow more company personnel, especially immediately after a major accident, to react and recover more quickly (Nurmi 2006, 36-66). Since shortcomings in communication training have often been the reasons for problems in accidents and in tackling them, all players must invest in its development.

2. Improvements in IT systems related to response

Another potential improvement area in the response phase relates to IT systems. The experts concluded that the development of a common situational picture system was somewhat likely, because the public sector had already started to develop collaborative activities. In the future, collaboration with companies too could be developed, since there is at least partial interest among

the players and the desire to extend the user community of their systems. Identifying the response information processes, interfaces containing information and creating technical prerequisites should be central development targets. Situational picture systems should feature the possibility to share one's own situational picture with other cooperation parties. Thus, instead of developing a single system, some of the experts predicted improved interoperability between different systems in the future. In any case, a common situational picture system was considered desirable.

As for preparedness, the experts raised the electronic information card system as one development theme for response. Electronic information cards and up-to-date maps of high-risk targets should be available to the authorities in a common network.

One of the other issues connected to the improvement of information flow was the improved utilization of different kinds of communication equipment like VIRVE and other mobile communication equipment. The experts considered the mandatory use of VIRVE for the companies at risk of major accidents to be slightly more likely than unlikely. Those who considered that use would increase argued that VIRVE is a definite prerequisite in improving communication during accidents and that VIRVE terminals are already used in some companies. However, companies should consider the benefits achieved with the help of VIRVE thoroughly before procurement of the equipment because the big challenge is that the skills in using VIRVE would be practiced rarely and perhaps forgotten in the event of an accident.

3. Improvements in analysis of accidents and near-miss situations

There is potential for improvement in the analysis of accidents and near-miss situations. Practicing and learning from accidents that have taken place somewhere else is also highly recommended. Why repeat mistakes made by others if it is possible, with the help of analysis, to gain additional information on the reasons that led to accidents and the means to prevent similar occasions from happening? Accidents should be reported in a way that development suggestions from them could be used all along the line in risk management development. Accident analyses can be utilized in many processes connected to safety, such as in monitoring operations, quality manuals, and rescue plans. It was noted by the experts that company quality assurance systems call for the documenting of observations on accidents and near-miss situations and making corrective measures more precisely than before. For example, the Safety Investigation Authority of Finland has already shown the benefits of studying major accidents and the proposals for action based on it. Also, rescue drills produce important observations that will be increasingly taken into account.

All in all, post-accident analysis was seen as extremely desirable in the aim of preventing accidents. It was also acknowledged that changes in procedures and processes increase not only safety but also the efficiency and competitiveness of operations.

4. Making better use of company experts

A company's own experts have the best knowledge of company operations. Up-to-date and quickly available information can significantly arrest the expansion of an accident when the expertise and local knowledge of the company representatives regarding the special features of the plant are brought to the knowledge of the rescue authorities. Therefore, making better use of the experts in companies was seen as one significant factor when improving response in both the short- and long-term perspective.

The company experts could be increasingly made use of for example in planning work and post-analyses of rescue drills. In addition, the experts should be more closely involved in the actual rescue drill situation. Furthermore, the experts should be made better use of in command center operations in an actual major accident as an "interpreter" between the company and the rescue authority.

One possibility is to establish either a national or regional expert pool for the use of both the rescue authorities and companies in order to improve the use of experts in companies. Thus it would be possible to contact an expert by phone via text message. However, this kind of operation would require the pre-mapping of people who would add value to the response and that experts and their substitutes should be named along with their special fields of knowhow. It was seen that this would require the authorities to maintain a register and require commitment from the company experts to pool operations. An expert pool would demand economic resources, which was seen as a challenge for the development of the practice. It was also brought up that this kind of expert pool could possibly work on the same principle as that arranged by local hunters' associations (see SRVA), which provide official assistance to the police.

5. Improvements for rescue drills and other training

The development of rescue drills is important for better rescue operations. The importance of pre-practicing and defining jointly in advance the agreed operational processes in the case of major accidents cannot be stressed enough. It is important to define in advance the most important stakeholders regarding major accidents and train and practice the operational models connected to major accidents. Clear processes and distribution of tasks ease managerial work

because, in the command center, everybody must be conscious of his/her tasks and know them in order to work properly from the beginning of the accident.

Communication between different players must be recognized, planned and practised. These include communication between the company and the rescue authorities, communication between different authorities, and also organizing and implementing external communication. Whether it is a matter of the internal communication of the rescue authorities, external communication or communication between companies, all of these can be improved through practice. In addition, it would be good to involve the media in executing rescue drills because, in the case of an actual incident, the media is likely to be present and thus issues concerning safety would receive more publicity.

Another point is to train and develop managerial skills. Currently, management skills are not at the level they should be when managing major accidents. Involving a wider group of players in the planning work and actual rescue drills was seen as the most significant theme linked to rescue drill development. One possibility for companies is to develop and increase cooperation with the people responsible for the rescue drills of other companies. Motivation towards cooperation was raised as a particularly important issue when developing the cooperation of a wider group of players.

Investing in formulating better major accident scenarios is an important development theme. On the other hand, unlikely accident scenarios were also seen as important because surprising situations are the best way to reveal problems and development targets in operations and management. It is notable that not all drills have to be wide-ranging drills, demanding lots of resources. For example, it is possible to separate a smaller part of some wider accident scenario and practice only this certain area or have table-top exercises. One approach would be to make rescue drills more systematic than they are at present. Formulating a rescue drill plan with a longer time perspective would be good. As Lagadec (1997) puts it, at their best, well-trained organizations are equipped with quality leadership, plans, and other necessities including communicational aspects.

8.2 Methodological considerations

The purpose of the research was to emphasize the situation where authorities and companies meet in relation to preparedness for and response to major accidents. The goal was to create an overall picture of the challenges in the communication and flow of information both in the preparedness phase and in the response phase of major accidents by exploiting experts' knowledge. The aim was also to find

out what improvements experts in the field would be able to suggest that should be made in the near future, i.e. over a time span of five years.

In order to find answers to the three research questions by structuring a group communication process among experts in the field, the method chosen for this research was the Delphi method. The Delphi method is a widely used method for gathering data from experts within their domain of expertise. It has been used in a variety of ways, for example in government, business, and education, especially in futures-oriented research. The Delphi application in this thesis was Problem-Solving Delphi on the management of major accidents.

In order to be able to identify and cover the necessary expertise areas, a competence-interest group matrix was applied. Based on theoretical analysis of the topic and the research questions, three competence areas for experts were identified; (1) preparedness for major accidents, (2) responding to major accidents, i.e. the response phase, and (3) regulation related to major accidents. Correspondingly, three interest groups were identified: (1) rescue and regulatory authorities, (2) companies, and (3) stakeholders. In the literature there are no exact recommendations for the number of experts in a Delphi study, however it is often mentioned that the optimal amount would be between ten and fifty (e.g. Buriak 1989; Loo 2002; Powell 2003). As variety in the group of experts was felt to be important in order to produce both more varied quantitative data and more viewpoints, especially within the first round of interviews, a total of thirty-nine organizations in the desired interest groups were invited to nominate experts for this Delphi study. Forty-eight experts were nominated (seventeen experts representing Rescue and Regulatory Authorities, nineteen representing Companies, and twelve representing Stakeholders). All the experts had several years of experience related to the management of major accidents with backgrounds in different lines of business. As highlighted e.g. by Varho and Tapio (2013), the use of a matrix also makes the selection of experts more transparent, even to international audiences who do not know the local organizations.

Instead of placing experts in any specific competence area (Preparedness, Response, or Regulation), in the early stage of the Delphi the experts were asked to assess their own skills in each of these competence areas. The aim was to ascertain whether experts in the three interest groups (Rescue and Regulatory Authorities, Companies, and Stakeholders) possessed enough expertise as a group in each competence area. Of course, not all of the experts were expected to have expertise in all of the desired competence areas, but however, the results varied relatively little by interest group. This is believed to increase the reliability of the research results. The experts were also asked about the length of their work experience in major accident matters. As a whole, this group of forty-nine experts had extensive expertise in the field of management of major accidents,

considered both cognitively and socially as proposed e.g. by Varho and Huutoniemi (2014). This was considered to be adequate for the objectives of the study. However, education and experience of top management in rescue operations was not required of the experts and it would be interesting to find out whether this would change the findings.

In this Delphi application, the complete anonymity of panelists was considered unnecessary. At the beginning of the Delphi process, the experts on the panel were given the names of all the other participating panelists - however, the individual answers and arguments were kept anonymous.

The Delphi process included three rounds. The aim of the first round was to find out the problem domains in communication and the flow of information related to management of major accidents. The first round was carried out by means of individual face-to-face interviews. The interviews were recorded, transcribed, and documented. The decision was taken to use computer-assisted qualitative data analysis, which was felt to increase the openness and transparency of analytic procedures. On the whole, qualitative data analysis using software was considered to increase the reliability of the research since the number of potential mistakes is decreased by managing data systematically.

The online Delphi software eDelfoi was used in the second and third Delphi rounds. The questions and claims in the second round were based on the findings of the first round. The aims were to gain more in-depth information on problem domains that were raised in the first round and to ask about the probable and desirable development of some topics. Correspondingly, the questions and claims in the third round were based on the findings of the preceding rounds. The aims were to gain more in-depth information on topics that were raised in the first and second Delphi rounds, to evaluate the importance of the development suggestions raised in previous rounds, and finally to gain concrete suggestions for improvement and development. Between the rounds the experts were provided with interim reports containing the findings of the preceding rounds. When analyzing the results, the means of answers by interest group did not vary as much as might have been expected considering the differences between the interest groups.

The Delphi method proved to be a powerful tool in achieving the objectives of the research. The Delphi process gathered people from different backgrounds together on an equal basis in a communication platform and inspired solution-oriented mutual learning among the experts. In a way, this Delphi process filled in the organizational holes and communicational obstacles originating from organizational embeddedness, as pointed out in the literature. Having diverging interests represented was definitely an asset from the perspective of the validity and reliability of this Delphi study.

To sum up, the relevance of this Delphi process was to engage experts from the authorities, business organizations, and stakeholders in a mutual learning process of how to overcome communication challenges and how to innovate effective management practices. In addition, in the field of futures studies, the Delphi application developed the Delphi method towards a process of building up each round based on information gathered and material carefully analyzed from the previous round.

8.3 Theoretical implications

The thesis focused on major accidents which may happen to a company or be caused by a company. Events may occur within business organizations which constitute an accident affecting that organization and possibly the community in general. In major accidents, the impacts can extend even beyond national borders. As for instance Coleman (2006) and McEntire (2009) argue, we can expect that major natural and technological accidents will become worse and more frequent and that their effects will increase in scale, due to the complexity of human society and the ever-growing size and density of urban regions and the built-up environment. Examples of these can be seen for instance in the huge material damage of the Tepco nuclear accident in Japan, the BP oil spill, and recent hurricanes in the USA.

Management of major accidents is a collective term encompassing all aspects of planning for and responding to major accidents, including both pre-accident and post-accident activities. Both the pre-accident preparedness phase and post-accident response phase were of interest in this thesis.

Preparedness has a close connection to futures studies (see, Section 2.3.2 Past, present and future – Concept of time in management of major accidents, page 50). Preparedness includes risk assessments based on probabilities and vulnerabilities, and planning how to respond in the event of an accident in future (Aubrecht, Freire, Fröhlich, Rath, and Steinnocher 2011). Preparedness is essential for an effective response; it is essential for any organization likely to be affected by a major accident to determine what preventive and protective measures can and should be taken before and at the time of an accident (Turoff, Hiltz, White, Plotnick, Hendela and Yao 2011). Preparedness practices are future-oriented actions taken to provide the human and material resources needed to support an active response at the time of the accident. Smooth communication during the preparedness phase is fostered by factors that promote trust in other organizations and familiarity with how they function. Thus, planning for future accidents and how to respond to them is an integral part of good business practice for all organizations.

In addition, the Delphi study revealed that organizing common rescue drills with authorities as often as possible and carrying out the post-drill analysis in cooperation would be a clear improvement for companies. On the other hand, unlikely accident scenarios were also seen as important because surprising situations are the best way to reveal problems and development targets in operations and management. In addition, for companies, performing preparedness planning and risk analyses together with authorities was seen as a factor that would improve cooperation and thus overall safety. Whatever the form of cooperation, the long-term and systematic nature of cooperation was the desired focus of emphasis.

The response phase is entered when prevention efforts fail and events trigger an accident. At this point, organizations shift their resources and efforts to minimizing damage to the people, facilities, and environment. At a major accident effective collaboration and communication require making sense of what has happened and what is going to happen in an understandable way; placing things in the right frameworks, comprehending, constructing meaning, interacting in pursuit of mutual understanding, and patterning (Weick 1995, 5). Communication in response includes conveying ongoing events to stakeholders, decision making within the management team, and organizational decisions regarding whether and what amount of information to share in and between the organizations involved and with the general public. Unless planned and practiced properly in the preparedness phase, different types of concrete and abstract challenges in communication in response will be evident.

Since major accidents are not the sole problem of any one organization, challenges associated with communication are evident in several different categories of organizational behavior. As described by Quarantelli (1988), there are inter- and intra-organizational behaviors that cause concrete challenges for communication in and between the organizations involved as well as with the general public. To overcome intra-organizational challenges in communication, cooperation and close interaction inside the company between management, safety and security personnel, line management, and workers should be emphasized. The management needs to recognize its role in controlling the continuity measures of the organization. Hence, the attitude towards actions taken relies on management, which has to take care of expertise and motivation throughout the organization.

Inter-organizational communication and teamwork relies on information sharing and mutual understanding. One source of the concrete challenges in communication in the management of major accidents comes from their complexity and the diversity of the available information. The actors may use different names for entities, process rules, information systems, data and communication formats, organizations, etc. As proposed by Galton and Worboys

(2011), an ontology that can provide unified definitions of entities, their properties and relationships, and thus facilitate improved communication would be one solution to this problem.

Moreover, IT systems may inflict concrete challenges to the smooth flow of information; they form an essential part of the collection, computing and sharing of information. However, often the problem is that different IT systems are not interoperable. One possibility to start with would be to make company information cards and rescue plans in electronic form and save the information on the IT system of a certain authority so that company personnel also have access to them. There are also severe external threats, i.e. cyber threats, to IT systems, which have to be taken care of. In this respect, the expert opinion was that in the next five years, the cyber threats faced by major companies and individual authorities will increase so much that they will actively follow the advice and recommendations of the Cyber Security Center.

Along with timing, mentioned above, another abstract challenge in communication related to the management of major accident is organizational embeddedness. The influence of organizations on the behaviors of their members forms another abstract challenge in communication related to the management of major accidents. Nee (2001) and Svedberg (2003) explain these behaviors by the interrelated rules and norms that govern social relationships, comprising the formal and informal social constraints that shape the choice-set of actors.

Granovetter's conceptualization of embeddedness offers an ideal basis to explore the relations between the actors involved in a major accident: there is a distinction between an actor's immediate connections and the more distant ones; this situation may also be described with the terms relational embeddedness and structural embeddedness (Granovetter 1985, 485-510; 1992a; 1992b). The concept of organizational embeddedness in the management of major accidents (see, Section 2.3.1 The role of organizational embeddedness, page 48) indicates the distinctions in communication in and between the organizations involved in major accidents.

The findings of the Delphi study included several issues related to organizational embeddedness. Firstly, the lack of cooperation and collaboration between different authorities. Secondly, the cooperation between the companies and authorities was seen as insufficient. In this respect, it was clearly expressed that authorities should have more time to interact with companies, e.g. when compiling major accident scenarios. And thirdly, collaboration and cooperation between companies working in the same branch or physically close to each other was also seen to be improved. Problems in communication occur with members of other organizations because others may have different backgrounds, organization cultures, and ways of doing things.

The results of the Delphi study also underline the fact that communication challenges between different actors should be recognized. Communication planning and training should be emphasized. These include active cooperation and communication between different authorities, between authorities and companies, and also organizing and implementing external communication with e.g. the media.

In conclusion, this study underlines the importance of forward-looking management to anticipate major accidents that are potentially foreseeable and potentially avoidable. The findings demonstrate that organizations with effective plans are able to react more quickly to problems and are able to respond more appropriately to the situation than organizations without such plans. Organizations should provide appropriate training and promote learning within and across networks, and personally involve organizational leaders in preparedness, who should be engaged in a continuous effort for future-oriented decision-making. Especially in the preparedness phase, futures orientation provides techniques such as scenarios for allowing organizations both to perceive some of the ways in which the future could unfold and to envision what a plausible future would be like. Planning can then be focused on how to bring about the desirable future, i.e. fewer accidents and an effective response.

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APPENDIXES

APPENDIX 1 Background questionnaire

(Translated from Finnish)

Personal data

Gender

☐ Male

☐ Female

Age

☐ 20 — 29 years

☐ 30 — 39 years

☐ 40 — 49 years

☐ 50 — 60 years

☐ 60 — 69 years

Work experience in management of major accidents

☐ 1 — 5 years

☐ 6 — 10 years

☐ 11 — 15 years

☐ 16 — 20 years

☐ Over 20 years

Competence in Regulation

Assess your competence in regulation regarding management of major accidents.

Note that the term regulation here includes instructions given by authorities.

Scale: 1 = poor ..... 5 = excellent

☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

Competence in the Preparedness phase

Assess your competence in preparedness regarding management of major accidents.

Note that preparedness here includes all aspects of mitigation, preparation, prevention, and risk assessment and also related training, communication, and IT systems.

Scale: 1 = poor ..... 5 = excellent

☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

Competence in the Response phase

Assess your competence in response regarding management of major accidents.

Note that response here includes rescue drills.

Scale: 1 = poor ..... 5 = excellent

☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

APPENDIX 2 Interview themes for the first Delphi round

Preparedness, including regulation

In major accidents often several organizations are involved, i.e. companies and authorities. If you think about communication and the flow of information in preparedness, have you noticed any challenges or problems?

- Please describe those situations.
- In or between companies?
- In or between authorities?
- Between authorities and companies?
- How would you solve these problems?

There are several laws and lower level regulation including instructions given by authorities. Have you noticed any

- Contradictions in the regulation?
- Difficulties in understanding the regulation?
- Difficulties in following the regulation?
- How would you solve these problems?

Response, including rescue drills

Presumably you have been involved in a major accident or participated in rescue drills. Have you noticed any challenges or problems in communication or in the flow of information in the response phase?

- Please describe those situations.
- In or between companies?
- In or between authorities?
- Between authorities and companies?
- How would you solve these problems?

APPENDIX 3 Preparedness: The second Delphi round questionnaire

(Translated from Finnish. The numbering has been added to correspond to the numbering of the thesis.)

6.1.1 Employment and taxation perspective in prioritization of authority operations

Claim: In the future, authority operations will be steered by the target's local relevance more than before.

The resources available for the authorities were seen as one of the challenges connected to preparedness. A target might be critical in terms of local influence; the target might be for example an important employer in a small municipality.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

6.1.2 Changing the implementation of regulation

Claim: In the future, the authorities will collaborate more with companies in interpreting regulation, taking the special needs of the company into account more.

This was raised in the interviews of the first Delphi round as one development possibility, because the interviewees brought up the point that many companies feel it challenging to implement the regulations concerning safety in their

companies at the moment. It was seen as a problem and an issue for development that the demands from the authorities concerning preparedness are executed only to obey the regulation and are not felt to be useful from the perspective of the continuity of company operations.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

6.1.3 Development of preparedness attitudes in companies

Claim: In the future the attitudes of the whole personnel towards preparedness will not improve because the company personnel are not motivated enough towards preparedness.

The claim relates to the observation raised by the experts in the interviews that, at the moment, preparedness skills depend on the expertise of a few people, for example shift managers or the person in charge of safety in the company, and emphasizes prevention and protection of employees from accidents.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

6.1.4 Tightening regulation on major accidents and incidents

Claim: In the future regulation will oblige all players to take major accidents into account more.

The claim concerns the trend that was raised in the interviews that society is more vulnerable than before because different kinds of natural major accidents such as storms and floods, for example, are likely to increase.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

6.1.5 Development of preparedness cooperation

Claim: Company cooperation linked to preparedness (e.g. benchmarking) will not increase because companies are afraid that the motive for some companies (e.g. competitors) is trade secrets rather than developing preparedness.

The claim is connected to the development suggestion that arose in the interviews that company cooperation should be developed and that companies in the same field of business could learn from each others' rescue drills.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

6.1.6 Development of the operations of authorities in relation to company preparedness

Assess the importance of the 12 different factors below in developing authority operations regarding response to major accidents in the short- and long-term.

Choose (drag and drop) 3 out of the 12 factors that you think are the most important development suggestions in both the short-term (1–2 years) and long-term perspective.

Developing the interoperability of IT systems of different authorities

Backup system development

Increasing the authorities' resources

Improving the area knowledge of authorities on industrial sites

Securing the quality of cooperation between the authorities and the companies so that cooperation is not bound to personal relations

Authorities to take a more active part in company rescue drills

Improving expertise of the authorities with the help of training (e.g. chemical knowledge)

Readiness of the authorities to utilize municipal IT systems from the perspective of companies' hazardous situations

Improving the preparedness of the authorities to make use of companies' IT systems

Securing the cooperation between the authorities in a way that successful cooperation is not bound to personal relations

Shifting the focus in authority operations more to advisory and preventive activities

Taking into account the local relevance of the companies when prioritizing preparedness

Development of the operations of authorities in relation to the preparedness of companies. **Short-term**	Development of the operations of authorities in relation to the preparedness of companies. **Long-term**

Is anything important missing?

Please comment on your answer in the box below.

6.1.7 Improving preparedness from the perspective of companies

Assess the 13 different factors below that would improve the preparedness of companies for major accidents.

Choose (drag and drop) 3 out of these 13 factors that in your opinion are the most important factors to be developed in the short-term (1–2 years) and long-term perspective.

Change in attitude: e.g. company rescue plan is not made so much for the authorities as for securing the continuity of one's own organization

Development of backup plans to secure business processes

Development of personnel training in companies to take the companies' continuity perspective more into account too

Safety management development in companies

Maintaining up-to-date information cards in cooperation with rescue authorities

Increasing advice on preparedness available from the authorities

Decreasing the safety risks caused by outsourcing

Increasing company cooperation on preparedness (e.g. benchmarking of companies in the same field of business)

Taking major incidents better into account in preparedness (e.g. increased risk of floods)

Development of IT systems in companies to serve the preparedness of the companies better

Making better use of open information (e.g. notifications from the Finnish Meteorological Institute or the flood warnings of a municipality)

Making better use of information from insurance companies

Speeding up law-making

Improving preparedness from the perspective of the companies. **Short-term**	Improving preparedness from the perspective of the companies. **Long-term**

Is anything important missing?

Please comment on your answer in the box below.

6.1.8 Preparedness cooperation between companies and the authorities

Please give concrete examples of how the cooperation between companies and the authorities could be improved concerning response to major accidents.

6.1.9 Development of IT systems from the perspective of preparedness

In the interviews of the first round, it was proposed that IT systems for preparedness should be developed.

Please give examples of how the IT systems should be developed from the perspective of preparedness.

APPENDIX 4 Preparedness: The third Delphi round questionnaire

(Translated from Finnish. The numbering has been added to correspond to the numbering of the thesis.)

6.2.1 Development of cooperation on external rescue plan

Claim: Rescue authorities will make use of the expertise of the company, besides the internal rescue plan made by the company, when formulating an external rescue plan.

The claim is connected to the current problem that the cooperation between the authorities and companies is not always adequate. This came out in the interviews of the first Delphi round.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

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6.2.2 Interoperability development of IT systems

Claim: In the future a company will have the possibility to analyze its own information (e.g. external rescue plan and information card) and save information (e.g. up-to-date region maps) on an IT system maintained by the authorities.

The claim is connected to the opinions of the experts brought up in the interviews of the first Delphi round, that one of the tasks of preparedness is to create a base to form a convergent situational picture, for example with the help of up-to-date electronic documents. Connected to this, the thought was expressed that companies could also save up-to-date documents on an IT system maintained by the authorities.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

6.2.3 Preparedness for cyber threats

Claim: In the next five years, the cyber threats faced by major companies and individual authorities will increase so much that they will actively follow the advice and recommendations of the CERT-FI unit of the Finnish Communication Regulatory Authority and/or soon to be established Cyber Security Centre to prepare for threats.

The claim is linked to the topic of information security and cyber security that was brought up in the first and second Delphi rounds. The objective of Finnish cyber security strategy is primarily to take care of the security of society. The effects of threats to the cyber operational environment have become wider, from the perspective of individuals, companies and the functioning of society as a whole. (see http://www.yhteiskunnanturvallisuus.fi) The perspective of the claim is not only to secure the vital functions of society but also to secure the continuity of operations of other authorities and companies.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

6.2.4 Development of regulation

Several experts mentioned development of regulation as one target to improve the flow of information.

Please give suggestions for potential improvement, clarification, or tightening of regulations to improve and streamline the flow of information.

6.2.5 Improving safety in companies by training

Several development suggestions for training and good practices were raised in the first and second Delphi rounds. The aim is to assess the importance of these development suggestions for improving safety in companies.

Assess the following nine development suggestions for training in companies. Choose 3 out of the nine factors below that you think are the most important development suggestions.

- ☐ **Increasing safety management training directed at managers**
- ☐ **Developing personnel training on initial fire extinguishing and first aid**
- ☐ **Developing guideline info concerning incidents**
- ☐ **Increasing training on crisis communication**
- ☐ **Increasing training on critical processes for the whole personnel; the perspective of managing continuity**
- ☐ **Taking part in other organizations' rescue drills**
- ☐ **Increasing training on secure use of IT systems**
- ☐ **Developing safety induction training for contractors and subcontractors**
- ☐ **Increasing VIRVE training**

Please comment on your answer in the box below.

6.2.6 Improving safety by training the authorities

Several development suggestions were made concerning training and good practices in the first and second Delphi round with which it would be possible to develop the knowhow and preparedness of the authorities for major accidents concerning companies. The aim here is to assess the importance of these development suggestions in the third round of the questionnaire.

Assess the following nine development suggestions for training the authorities. Choose 3 out of the nine factors below that you think are the most important development suggestions.

☐ **More training for the authorities that emphasizes preventive actions**

☐ **Increasing the number of experts who are specialized in chemical training**

☐ **Chemical training for all the rescue authorities**

☐ **Increasing crisis communication training**

☐ **Multi-authority operations training**

☐ **Training of management of major accidents**

☐ **Training on the secure use of IT systems**

☐ **Training on utilization of IT systems**

☐ **Increasing job rotation**

Please comment on your answer in the box below.

APPENDIX 5 Response: The second Delphi round questionnaire

(Translated from Finnish. The numbering has been changed to correspond to the numbering of the thesis.)

7.1.1 Common terminology

Claim: The problems of terminology and use of jargon can be eliminated by forcing the parties to use a common terminology, which is independent of the field of operation, in crisis communication.

In the first Delphi round, it was revealed that the lack of a common terminology and use of jargon is a major issue in the flow of information in response and when forming a situational picture.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

7.1.2 Development of communication

Claim: Communication training will be made more use of in order to improve the briefings and communication linked to major accidents.

The claim is connected to the need for both companies and the authorities to invest in the briefings and communication linked to major accidents. Investment in briefing and communication includes practicing cooperation with the media and taking part in communication training.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

7.1.3 Development of post-accident analyses

Claim: As a result of analyzing their own rescue drills and accidents and also accidents that have taken place somewhere else, actors will change their own processes in order to prevent accidents significantly more than before.

The claim below is linked to the view that arose in the interviews of the first Delphi round that it would be good to obtain more information than at present on analyses of rescue drills and follow-up of accidents

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

7.1.4 Probability of mandatory use of VIRVE

Claim: The use of VIRVE handsets will become mandatory in all high major accident risk companies in order to improve the flow of information.

The usefulness of VIRVE came out in the interviews of the first Delphi round. On the other hand, the challenges in VIRVE use in connection with the flow of information in major accidents were also mentioned.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

7.1.5 Ranking of topics related to situational picture and flow of information

Below there are eight factors which improve problem issues in the situational picture and flow of information. Using up and down arrows rank the eight factors listed below.

↓ Development of alarm instructions

↓↑ Information card concerning every establishment at risk of a major accident

↓↑ Development of better interoperable authorities' IT systems

↓↑ Technical development of situational picture system

↓↑ Improving flow of information through standardizing terminology

↓↑ Guidance and development of briefings and communication

↓↑ Better opportunities for the authorities to utilize company IT systems

↑ Increasing the use of VIRVE in companies

Please comment on the three most important in the box below.

7.1.6 Developing response

Below there are 12 factors, that improve response. Assess the factors below that would improve response in relation to major accidents. Choose (drag and drop) the 3 out of these 12 factors that in your opinion are the most important factors to be developed in the short term (1–2 years) and in the long-term perspective.

Improving plant guidance

Development of alarm instructions

Command center practise development

Information card requirement for establishments at risk of a major accident

Developing crisis management training

Increase in investments in plant fire brigade

Developing rescue drills to correspond better to reality

Better post-analyses of rescue drills and accidents

Developing of management skills related to major accidents

Improving the local knowledge of the authorities at the risk targets

Increasing the expertise of the authorities (e.g. knowledge of chemicals)

Increasing the utilization of the expertise of company personnel

Developing response. **Short-term**	Developing response. **Long-term**

Is anything important missing?

Please comment on your answer in the box below.

7.1.7 Development of IT systems related to major accidents

In the first round interviews it came up that IT systems related to response should be developed. How would you develop these IT systems? Give examples.

Please write your answer in the box below.

7.1.8 Improving flow of information in major accidents

In the first round interviews it came up that the flow of information in major accidents should be improved. How would you improve it? Give examples.

Please write your answer in the box below.

APPENDIX 6 Response: The third Delphi round questionnaire

(Translated from Finnish. The numbering has been added to correspond to the numbering of the thesis.)

7.2.1 Probable development of information cards and plans in electronic form

Claim: In the next five years information cards and rescue plans concerning risk targets (e.g. up-to-date regional maps and information on operational processes) will be saved in electronic form on an IT system maintained by the authorities.

In the second round it came out that developing the electronic area cards and rescue plans is important from the perspective of improving the flow of information.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

7.2.2 Probability of major accident caused by cyber attack

The claim below is linked to the theme of IT security and cyber security that came up in the first and second Delphi rounds. The effects of threats against the cyber-operational environment have become wider and wider, from the perspective of individuals, companies and the whole of society (see http://www.yhteiskunnanturvallisuus.fi). The perspective in the claim in addition to securing society's vital operations is to ensure the continuity of other authorities and operations of the companies.

Claim: During the next five years a cyber attack will cause the risk of a major accident in Finland.

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

7.2.3 Development of situational picture system

Claim: The development of a common situational picture system for all the players (both the authorities and the companies) will receive significant investment in the coming years.

The claim is linked to the view, which came up in the second Delphi round, that the experts considered the development of a situational picture system as one of the most important factors that would improve the situational picture and flow of information. The systems are not interoperable enough at the moment. The lack of a common situational picture system causes problems in building a common situational picture

Assess the probability of the claim (-3 = highly unlikely … +3 highly likely).

Please comment on your answer in the box below.

Assess the desirability of the claim (-3 highly undesirable … +3 highly desirable).

Please comment on your answer in the box below.

7.2.4 Development of rescue drills

Based on the answers from the second Delphi round, developing rescue drills was seen as one of the most significant factors that would develop response both in the short- and long-term perspective.

Give concrete development suggestions or examples of good practices with the help of which rescue drills could be developed in the future.

Please write your answer in the box below.

7.2.5 Making better use of the expertise in companies

Based on the answers from the earlier Delphi round, making better use of the experts in companies was seen as one significant factor when improving response in both the long- and short-term perspective.

How could the expertise in companies be used better than it is at the moment in response phase? What changes would this entail in operations on the part of the company and authority players?

Please write your answer in the box below.

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ISBN 978-952-249-356-9